Guidebook 19

Illinoian and Wisconsinan Stratigraphy and Environments in Northern Illinois: the Altonian Revised

Midwest Friends of the Pleistocene 32nd Field Conference

Illinois Department of Energy and Natural Resources
STATE GEOLOGICAL SURVEY DIVISION

1985

FORMER MEETINGS
MIDWEST FRIENDS OF THE PLEISTOCENE

		Location	Leaders
1	1950	Eastern Wisconsin	S. Judson
2	1951	Southeastern Minnesota	H. E. Wright and R. V. Ruhe
3	1952	Western Illinois and Eastern Iowa	P. R. Shaffer and H. W. Scholtes
U	1952	Southwestern Ohio	R. P. Goldthwait
U	1953	Northeastern Wisconsin	F. T. Thwaites
U	1954	Central Minnesota	A. E. Wright and A. F. Schneider
6	1955	Southwestern Iowa	R. V. Ruhe
U	1956	NW Lower Michigan	J. H. Zumberge et al.
8	1957	Southcentral Indiana	W. D. Thornburg and W. J. Wayne
9	1958	E. North Dakota	W. Laird et al.
10	1959	Western Wisconsin	R. F. Black
11	1960	E. South Dakota	A. F. Agnew et al.
12	1961	Eastern Alberta	C. Gravenor et al.
13	1962	Western Ohio	R. P. Goldthwait
14	1963	Western Illinois	J. C. Frye and H. B. Willman
15	1964	Eastern Minnesota	H. E. Wright and E. J. Cushing
16	1965	Northeastern Iowa	R. V. Ruhe et al.
17	1966	Eastern Nebraska	E. C. Reed et al.
18	1967	SC North Dakota	L. Clayton and T. F. Freers
19	1969	Cyprus Hills, Saskatchewan and Alberta	W. Kupsch
20	1971	Kansas-Missouri Border	C. K. Bayne et al.
21	1972	East-central Illinois	W. H. Johnson et al.
22	1973	Lake Michigan Basin	E. B. Evenson et al.
23	1975	Western Missouri	W. H. Allen et al.
24	1976	Meade County, Kansas	C. K. Bayne et al.
25	1978	Southwestern Indiana	R. V. Ruhe and C. G. Olsen
26	1979	Central Illinois	L. R. Follmer et al.
27	1980	Yarmouth, Iowa	G. R. Hallberg et al.
30*	1981	NE Lower Michigan	W. A. Burgis and D. F. Eschman
29	1982	Driftless Area Wisconsin	J. C. Knox et al.
30	1983	Wabash Valley Indiana	N. K. Bleuer et al.
31	1984	Western Wisconsin	R. W. Baker
32	1985	North-central Illinois	R. C. Berg et al.

U — Unnumbered
* — Misnumbered

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ERRATA

Illinois State Geological Survey Guidebook 19
Illinoian and Wisconsinan Stratigraphy and Environments in Northern Illinois: the Altonian Revised

Page	
i	*for* Madison, Wisconsin 53141 *read* Madison, Wisconsin 57706 *for* Champaign, Illinois 61801 *read* Champaign, Illinois 61820
23	figure 1-1: unnumbered profile is 134
30	line 3: *for* gravel (<2 mm in diameter) *read* gravel (>2 mm in diameter)
72	*delete entire section* **Post-Sangamon Erosion**
87	*for* SW NE SE Sec. 33, T 45 W, R 2 E, Winnebago County *read* SW NE SE Sec. 33, T 45 N, R 2 E, Winnebago County
100	line 4: *for* This section is the first tollway boring to be described *read* This is the first section to be described
125	figure 8-2: *for* A East *and* A′ West *read* A West *and* A′ East
127	figure 8-4, the material in the High terrace: *for* g-o *read* hm

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FIELD TRIP

The 32nd Field Conference of the Midwest Friends of the Pleistocene will view and discuss ten sites. Seven sites will be visited on Saturday and three on Sunday morning. The stops are organized so that the youngest materials will be presented first. At Stop 1, we will discuss the genesis of the Rock River valley terrace system, sand and gravel deposits, and the history of deglaciation of the area. At Stops 2 and 3, the Clinton and Capron Tills will be discussed with major emphasis on the possible relationship of these two uppermost units.

Stop 4 is a roadside view of the site where the Oak Crest Bog is buried. This is the northernmost location in North America of any bog yet discovered with a Middle Wisconsinan age of 24,830 ± 350 to 47,400 ± 2400 RCYBP. We will discuss the pollen sequence and relationships of the bog to the underlying Winnebago Formation diamictons while we observe cores taken from the site.

Stop 5 is one of the few multiple diamicton exposures in central northern Illinois. The Argyle, Nimtz, and possibly the Oregon, Foxhollow, Belvidere, and Kellerville Till Members are exposed atop a 45-m section of Ordovician rocks. An organic silt, rich in wood fragments, can also be observed.

At Stop 6, the Wempletown Southeast Section, is an exposure of a sequence including the Peoria Loess, the Farmdale Soil, the Roxana Silt, and the Sangamon Soil formed into the Argyle Till Member. Unleached Argyle Till is at the base of the exposure.

Stop 7 is located on the Rockford Terrace. The age of this terrace, its relationship to numerous ice-wedge casts in the sand and gravel, the overlying Sangamon Soil, and the underlying diamicton will be discussed.

Stops 8, 9, and 10 will be visited on Sunday morning. At Stop 8, we will view an exposure of the Argyle and Nimtz Tills overlying sands and gravels of the Beaver Creek Sand Member. The relationship of this gravel to diamictons as well as to the gravel deposits of the upper terrace of the Rock River valley will be discussed. Stop 9 is an exposure of two Glasford Formation units, the Oregon Till Member silty facies and the underlying Fairdale Till Member. These diamictons are below those of the Winnebago Formation.

At Stop 10, the Browning-Ferris Landfill provides a good exposure of the Esmond Till Member. Depending on the depth of trenching at the site, an underlying silt and the Oregon Till Member can also be observed. Both the Esmond and Oregon Tills lie above the Fairdale Till Member, but below the Winnebago Formation till members. The recognition of the Esmond Till as an Illinoian-age unit, rather than early Wisconsinsan, was the turning point for our stratigraphic reorientation of central northern Illinois.

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Many individual landowners and quarry and pit operators provided access to their property for Survey geologists to observe the geology and to conduct test drilling. We appreciate their cooperation. We particularly thank the following property owners for allowing the Friends of the Pleistocene to visit the field trip sites:

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Robert Ford
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Browning-Ferris Industries
Porter Brothers, Inc.

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We are particularly grateful to H. D. Glass for providing X-ray diffraction (clay-mineral composition).

Revision of the Stratigraphy and Nomenclature of Glacial Deposits in Central Northern Illinois

John P. Kempton, Richard C. Berg,
and Leon R. Follmer

Ice-wedge casts formed into sand and gravel of the Rockford Terrace.

INTRODUCTION

This report reviews 20 years of stratigraphic information generated through studies of the glacial deposits of northern Illinois and presents a revised stratigraphic classification for deposits older than the Woodfordian (Wisconsinan) drift. Our purpose is

- to supplement the recent findings of Berg, Kempton, and Stecyk (1984);
- to explain the stratigraphic nomenclature in more detail;
- to present a formal statement of the changes that have been made since the work of Willman and Frye (1970).

While there are still many unresolved problems in unit definitions and correlations, the nomenclature presented in this report should be continually revised and explained to be useful in future reports. We introduce formal nomenclature to facilitate communication and to update chronostratigrahic and lithostratigraphic concepts.

Location

Most stratigraphic sections discussed in this report are located in Boone and Winnebago Counties, where detailed mapping has recently been completed (Berg, Kempton, and Stecyk, 1984). The total area under consideration, however, includes most of northern Illinois and a small part of southern Wisconsin. The Bloomington Morainic System forms the southern boundary of the study area; Marengo Ridge forms the eastern boundary; and the Winnebago-Stephenson county line forms the western boundary. For practical purposes, the northern boundary is the state line with Wisconsin; however, correlative deposits in Wisconsin will be discussed. In addition to describing new lithostratigraphic units, we suggest changes in the chronostratigraphic classification of the deposits in the area.

Background

Extensive geologic literature on the glacial deposits of northwestern Illinois (Frye, et al, 1969) documents great difficulties in mapping due to changes in stratigraphic concepts and in criteria for determining boundary lines of the major drift units (fig. 1). The development of a substantive geologic framework was hindered by the lack of subsurface data, and until 1958, by the limitations of a single classification system for glacial deposits. The advent of the multiple classification of glacial deposits (Willman, Swann, and Frye, 1958) and detailed investigations of the lithic character of these deposits initiated a new period of stratigraphic study and mapping.

Shaffer (1956) mapped the diamictons of northwestern Illinois partly on the basis of physical characteristics and grain-size distribution. His study combined with the systematic subsurface and regional stratigraphic studies by Horberg (1950, 1953) to provide the impetus for detailed subsurface and stratigraphic work in northern Illinois by Hackett (1960), Kempton (1962), Kempton and Hackett (1968a, 1968b), and Frye et al. (1969). Subsequently,

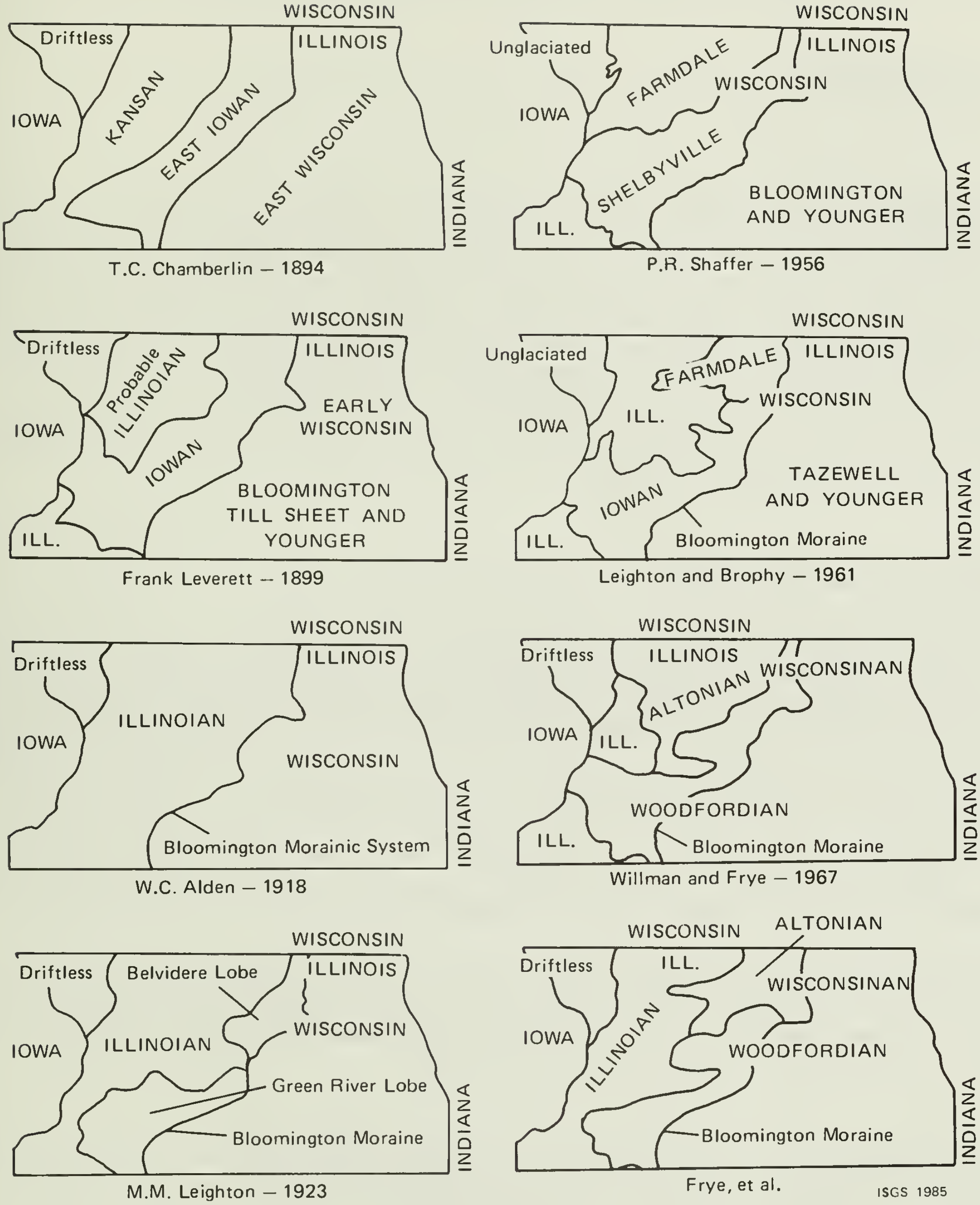


Figure 1 Generalized maps showing major changes in previous mapping and classification of glacial drifts of northwestern Illinois (from Frye et al., 1969).

Willman and Frye (1970) formalized the stratigraphic nomenclature for Illinois. Since 1970, both the nomenclature and stratigraphic framework have been under review. We now present new evidence for revision.

BASES FOR REVISION

Methodology

Over the past three decades, procedures to identify, define, correlate, and map glacial deposits have evolved from the concepts of the multiple classification system (Willman, Swann, and Frye, 1958; American Commission on Stratigraphic Nomenclature, 1970). These methods include determination of the lithic properties (including texture) and mineralogy (including clay-mineral composition and carbonate content) of diamictons; such data are used for regional correlations. For this study, grain-size analyses followed the standard hydrometer procedure; 4-micron clay was determined. X-ray diffraction was made in a manner similar to that reported by Killey (1982) and Hallberg, Lucas, and Goodmen (1978). Carbonate data were determined by X-ray and recorded as counts per second.

Development of the Data Base

Data from outcrops and the subsurface, collected since the Frye et al. study (1969), provide the basis for revising concepts and modifying the stratigraphic framework. Since 1970, much data have been generated by many studies in northern Illinois. These include (1) deep test drilling for water resources; (2) re-evaluation of drift thickness; (3) study of samples from foundation borings along the East-West Tollway extension; (4) soil surveys of Boone, Winnebago, Ogle, and Lee Counties, involving cooperative studies of soil geomorphology and glacial stratigraphy; (5) study of a toxic waste site in Ogle County; (6) several thesis studies; and (7) a comprehensive study of environmental geology in Boone and Winnebago Counties.

Data used for stratigraphic control were derived from test drilling to locate sand-and-gravel aquifers (Reed, 1972, 1974, 1975, 1976). Key borings are listed in the Appendix. A preliminary study of this test drilling in Lee County was prepared by Kempton and Reed (1973).

In addition to the hydrogeologic drilling program, test borings were made along the proposed East-West Tollway, including south-central Kane County, central De Kalb County, the southwestern corner of Ogle County, northern Lee County, and a short distance into east-central Whiteside County. Samples were obtained from borings taken at 80 sites. While not discussed directly in this report, the stratigraphy shown in these borings aided in developing the stratigraphic framework of the region. Private engineering firms have also provided data and samples from numerous scattered locations in Lee, Ogle, and Winnebago Counties. Gilkeson et al. (1977) mapped the geology and studied a toxic industrial waste site in Ogle County. Using the data from this and other recent studies, Follmer, Berg, and Acker (1978) updated existing maps and pointed out inconsistencies in the stratigrahic record. Additional information on glacial geology in northern Illinois was provided by several studies undertaken by Fricke (1976), Wickham (1979), Wickham and Johnson (1981), and Whittecar and Davis (1982). In particular, a study by Fricke (1976) of the stratigraphy of diamictons along the Wisconsin-Illinois border produced information that has been included in our revisions.

Finally, the comprehensive geologic study of Boone and Winnebago Counties (Berg, Kempton, and Stecyk, 1984) provided the data and indicated the need to re-evaluate all elements of the glacial sequence throughout northern Illinois. More than 1800 samples from 308 localities were used to characterize and map the glacial deposits. Data from nearly 5000 water-well logs were evaluated to provide supplementary information on drift thickness, the relationship between major drift units, and the regional correlation of glacial sequences. Detailed stack-unit mapping of Boone and Winnebago Counties interconnected much of the new data and verified the new stratigraphic concepts. It was these data and the mapping, along with the stratigraphic problems recognized from the other recent studies that led to new concepts of regional geomorphic development and stratigraphic modifications.

Regional Interpretations

The continuing study of glacial geology in northern Illinois has not only contributed to the data base, but also provided the basis for understanding the geologic and geomorphic development of the region, including the nature, distribution, and relationships of various glacial deposits (fig. 2). Due to a combination of depositional and erosional circumstances, geologic researchers have had difficulty in differentiating deposits of the region and mapping their distribution.

Several important factors contribute to the complexity of the glacial sequence:

- the bedrock surface, mainly dolomite, is quite irregular with much local relief;
- the drift is generally very thin with few multiple diamicton exposures;
- distinct diamictons are similar in field appearance, making it difficult to distinguish their distribution and depositional characteristics;
- preserved paleosols are relatively rare due to erosion.

A combination of depositional and erosional factors was recognized by Frye et al. (1969) as the principal problem to establishing the glacial sequence. The traditional methods of distinguishing between diamictons (such as, physical characteristics, depth of leaching, and ice-marginal features) provided only conflicting evidence. The scarcity of recognizable multiple diamicton exposures, particularly west of the Rock River, and the generally thin covering of drift on uplands throughout the region, were even more troublesome. The recognition that there were periods of intense erosion provided an explanation for the youthful appearance of landscapes that did not relate to the presence of paleosols.

More detailed field studies and the availability of increasing amounts of subsurface data have gradually provided more evidence of multiple sequences. The classification of diamictons on the basis of physical properties and the use of clay-mineral data have resulted in firmer correlations. This in turn has emphasized that widespread erosion by glacial meltwater possibly had a great impact on some parts of northern Illinois.

Stratigraphic and geomorphic evidence suggests that areas along and adjacent to the Kishwaukee River and its tributaries in southeastern Winnebago, Boone, western McHenry, and possibly portions of northern De Kalb Counties were in part deeply entrenched into a relatively uniform upland surface. Such erosion is reflected in the layer-cake outcrop pattern of diamictons along the northern wall of the Kishwaukee-Piscasaw valleys and the eastern margin of the Rock River valley. The widespread removal of paleosols and loess in southern Boone, northern De Kalb, southeastern Winnebago, and eastern Ogle Counties suggests that rather high-velocity meltwater flowed across the uplands of northern Boone and eastern Winnebago Counties. Solifluction could also have removed this paleosol (Follmer and Kempton: Stop 10). In southeastern Winnebago County, spillways were carved across the bedrock divide separating the Rock Bedrock Valley from the Troy Bedrock Valley; the Kishwaukee now follows the deepest of these spillways.

It has been difficult to identify and map the older till members because of their extensively eroded surfaces. Other factors, however, related to the characteristics, identification, and distribution of the various units have also caused problems. Some of these problems now partially have been resolved: there appears to be a repeating sequence of diamictons with similar characteristics but different ages; exposures of several diamictons with similar characteristics lie within short distances of each other; and it has been demonstrated that one radiocarbon date at the base of the Esmond (once thought to place the Esmond into the Wedron Formation) was misleading.

The following discussion of revisions in the definition and nomenclature of the glacial stratigraphy in northern Illinois centers on three separate, though interrelated categories: classification, stratigraphic succession, and age.

REVISIONS

Glasford Formation

The only Illinoian-age Glasford Formation till members mapped or recognized in central northern Illinois in 1979 (Lineback) were the Ogle and Sterling. Recent geologic mapping (Berg, Kempton, and Stecyk, 1984) expands the areal extent and number of recognized members (fig. 2). The following Glasford Formation till members are now recognized in central northern Illinois: Belvidere, Esmond, Oregon, Fairdale, Herbert, Ogle, and Kellerville.

One radiocarbon date, a youthful appearance, modern-looking soil profiles, and the lack of a paleosol all contributed to the conclusion that

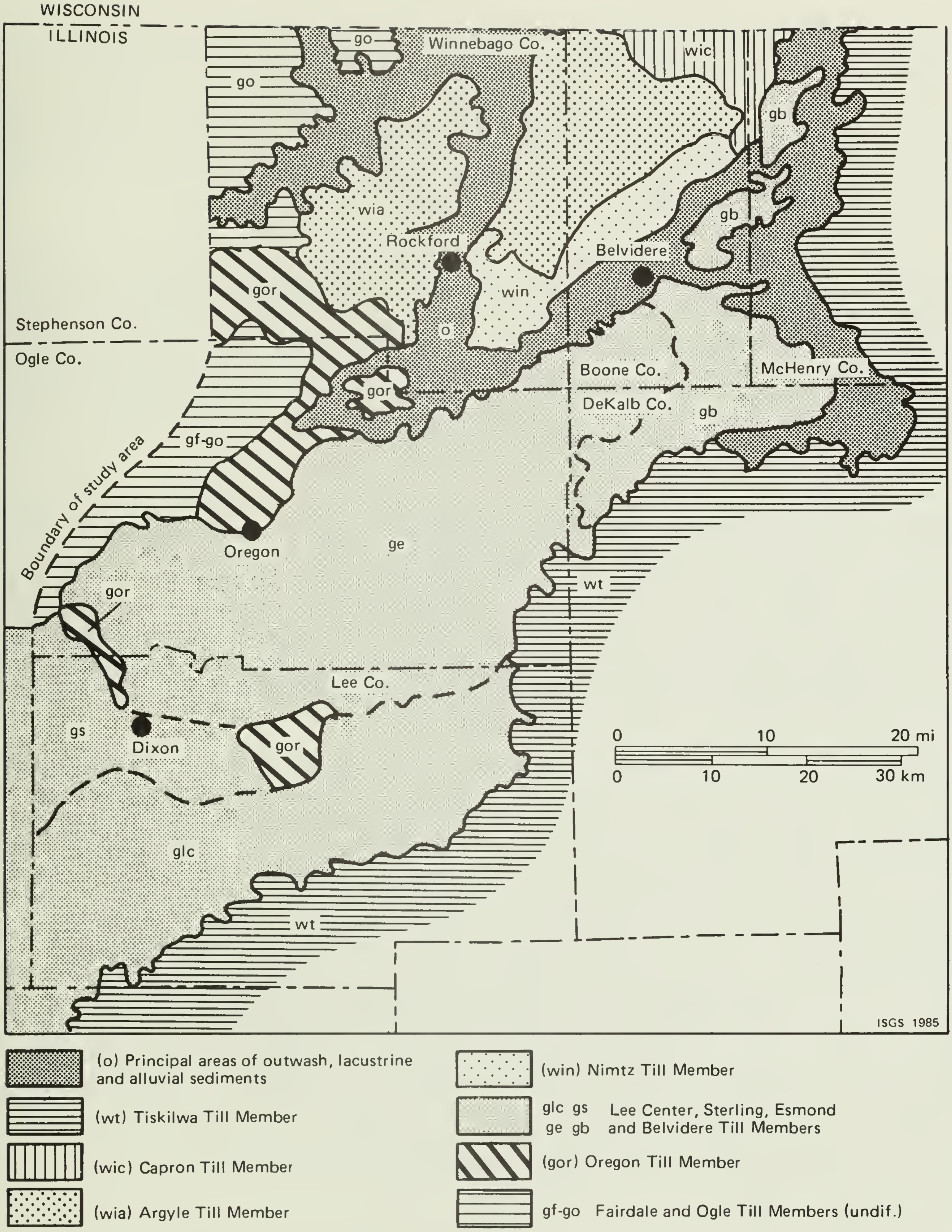


Figure 2 Distribution of uppermost till members and principal areas of waterlaid sediments in central-northern Illinois (modified from Lineback, 1979; Berg, Kempton, and Stecyk, 1984).

the Esmond was the youngest till member in the area (Willman and Frye, 1970; Frye et al., 1969). The Esmond Till and the possibly equivalent Lee Center Till were presumed to be the oldest Woodfordian till members. According to this interpretation, the sandy diamicton of the Altonian-age Winnebago Formation was older than the Esmond. Available data appeared to support the conclusion that the color, stratigraphic succession, texture, and clay-mineral composition of sandy diamictons in northern Boone County were like those underlying the Esmond in Ogle and Lee Counties.

Yet the Esmond Till is late Illinoian (Follmer, Berg and Acker, 1978; Follmer and Kempton: Stop 10). It has diagnostic characteristics similar to the Sterling Till Member, an Illinoian unit in the Glasford Formation exposed in Whiteside and western Lee Counties. Both the Esmond and the Sterling are gray; their textures are clay loam; and their illite contents range between 76 and 80 percent. Only the presence of an accretion-gley Sangamon Soil in the upper part of the Sterling Till distinguishes the two diamictons; the Esmond lacks the paleosol (Willman and Frye, 1970).

The youthful appearance of the Esmond and the general absence of the Sangamon Soil are primarily due to widespread erosion. Although paleosols are generally lacking in southern Boone County, northern De Kalb County, and eastern Ogle County, soil mapping and geologic investigations have recently identified several areas of paleosols in Esmond Till. Moreover, in 1981, Follmer obtained two radiocarbon dates greater than 41,000 BP (ISGS-722 and ISGS-724) from organic-rich silt below the Esmond in northern Ogle County; these dates indicate that the Esmond is older than Woodfordian. The Esmond is now correlated with the Sterling and Radnor Tills.

This new correlation partially solves the Esmond problem. Logically, it would follow that the sandy diamicton below the Esmond fits either of two situations. In the first, the sub-Esmond diamicton would be the Argyle Till of northern Boone County and eastern Winnebago County. If this were the case, then all Winnebago Formation diamictons would be reclassified as being older than Glasford Formation till members. In the second situation, two stratigraphically distinct units would exist. On the basis of field exposures (Berg and Kempton: Stop 5) and borings, the latter case is the favored interpretation because two sandy diamictons can be stratigraphically separated. The upper sandy diamictons are Winnebago Formation units (the Argyle and Nimtz Till Members); whereas the lower sandy diamicton has been assigned to the Glasford Formation and renamed the Oregon Till Member. The texture and clay-mineral composition triangles show that the characteristics of the sandy Oregon and the Argyle Tills overlap--a fact that largely explains the difficulties of previous researchers in separating the units (figs. 3 and 4). This is particularly clear when comparing clay-mineral data from oxidized samples of each diamicton.

The Oregon Till is found in much of Ogle and Lee Counties. In Boone County, it can be found in the subsurface outside the margin of the Esmond Till. The Oregon Till Member silty facies occurs generally in areas east of the sandy Oregon Till. It is widespread in the subsurface throughout southern Boone County, and adjacent portions of the De Kalb County, and eastward. Both textural facies of the Oregon Till are pink and similar in clay-mineral composition (fig. 4, table 1) and stratigraphic position.

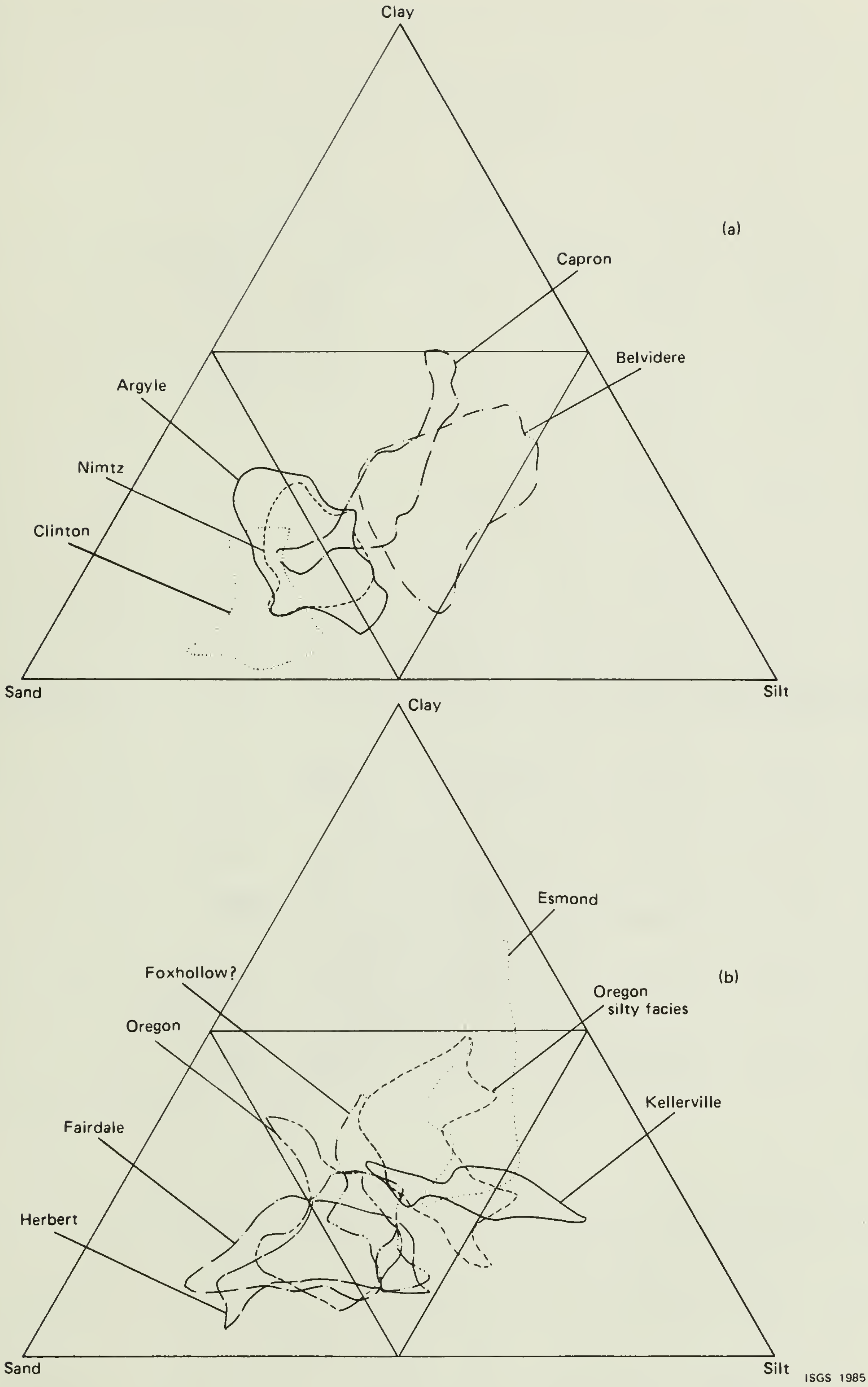


Figure 3 Textural triangles for (a) Capron, Clinton, Argyle, Nimtz, and Belvidere Till Members; and (b) Esmond, Oregon, Oregon silty facies, Fairdale, Herbert, Kellerville, and Foxhollow (of Wisconsin) Till Members.

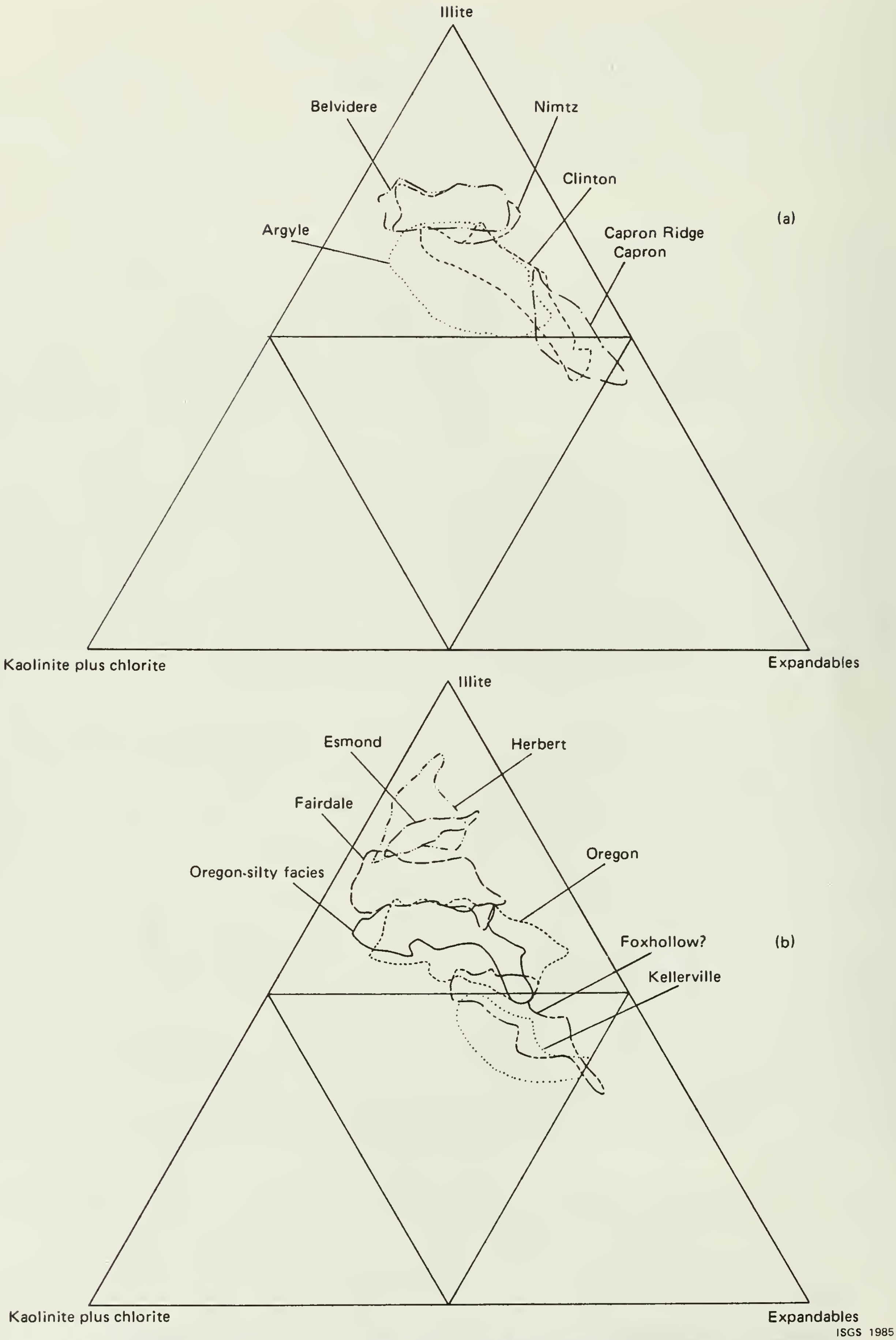


Figure 4 Clay-mineral-composition triangles for the (a) Capron, Clinton, Argyle, Nimtz, and Belvidere Till Members; and (b) Esmond, Oregon, Oregon-silty facies, Fairdale, Herbert, Kellerville, and Foxhollow (of Wisconsin) Till Members.

Table 1 Means and Standard Deviations of Grain size and Clay-Mineral Composition for Till Members in Northern Illinois

Till Member	N	Sand s	Sand $\bar{x}$	Silt s	Silt $\bar{x}$	Clay(<4 μm) s	Clay(<4 μm) $\bar{x}$	N	Ex s	Ex $\bar{x}$	Illite s	Illite $\bar{x}$	K+C s	K+C $\bar{x}$
Capron*	42	7.5	36.5	2.5	36.3	7.1	27.2	42	5.0	40.0	4.4	51.8	1.4	8.2
Clinton**	93	3.9	62.4	4.3	29.0	4.7	8.6	36	9.4	30.2	7.2	57.1	3.6	12.7
Argyle	304	2.8	53.2	4.7	28.8	4.1	18.0	174	6.0	23.6	3.4	60.7	4.8	15.7
Nimtz	186	4.8	50.7	3.9	31.2	3.7	18.1	151	6.9	17.2	2.1	69.3	9.6	13.5
Belvidere	78	9.0	30.1	5.6	41.7	7.5	28.2	54	6.0	12.0	2.9	70.1	6.0	17.9
Esmond	23	10.0	21.2	4.8	40.4	11.4	38.4	14	3.0	10.7	2.1	76.1	5.3	13.2
Oregon	103	8.5	47.2	4.7	34.3	6.5	18.5	84	6.7	21.0	3.9	59.2	6.7	19.8
Oregon silty facies	54	7.5	31.0	6.1	39.1	6.8	29.9	40	8.4	18.8	4.0	60.2	7.1	21.0
Fairdale	78	8.9	48.6	6.8	31.8	5.4	19.6	64	6.3	10.4	2.8	67.2	5.5	22.4
Herbert	33	7.8	48.9	8.2	34.3	5.8	16.8	41	3.2	6.9	3.7	76.9	4.3	16.2
Foxhollow?	31	2.9	43.7	5.5	35.4	5.3	20.9	31	7.3	35.8	5.5	47.7	3.5	16.5
Kellerville	12	7.4	29.8	8.4	43.4	4.1	26.8	9	7.0	41.3	4.1	41.3	4.2	17.4

*Capron Ridge samples only
**Fricke (1976)

The surficial diamictons south of Piscasaw Creek, previously mapped as Capron Till, are now mapped as the Belvidere Till and the silty facies of the Oregon Till, both of the Glasford Formation. The Belvidere Till with its loam to silty clay loam texture (fig. 3) appears to overlie the Esmond Till, in extreme southwestern Boone County. Both the Esmond and the Belvidere may have been deposited by the same ice advance but their relationship is not clear. Their distribution patterns and diagnostic characteristics are similar, although the illite percentage of the Belvidere is less than that of the

Esmond. The silty facies of the Oregon is frequently observed as windows within the area of distribution of the Belvidere and Esmond Tills.

The stratigraphic positions of the Oregon, Fairdale, and Herbert Till Members, all Illinoian-age Glasford Formation units, are documented in borings from southeastern Winnebago and southern Boone Counties, as well as from McHenry, De Kalb and Kane Counties. The Fairdale Till Member is a loam to sandy loam diamicton that lies stratigraphically beneath the Oregon Till Member. The Fairdale-Oregon contact is exposed at the Fairdale Quarry (Kempton and Berg: Stop 9) just south of the village of Fairdale in northern De Kalb County. The clay-mineral composition of the till member (67% illite) distinguishes it from other Glasford Formation diamictons in the area (fig. 4, table 1). The Fairdale Till may correlate to some of the sandy diamictons in western Winnebago County and Ogle County, but a direct relationship has not been established.

Stratigraphically below the Fairdale Till is the sandy Herbert Till Member, which has been identified only in the subsurface. The clay-mineral composition is very similar to the Esmond; however, illite often exceeds 80 percent (fig. 4). The Herbert Till was previously correlated to the Sterling Till. The stratigraphic separation of the Herbert and the Esmond is shown in the Stone Quarry Road Boring (fig. 5), where the high-illite silty clay Esmond Till is the uppermost unit and the high-illite sandy Herbert Till is the lowermost unit. The lower illite Oregon and the Fairdale Tills separate the Esmond from the Herbert. The Herbert appears to have incorporated a large amount of local shale (Maquoketa Shale Group).

The stratigraphic relationships of the Foxhollow till of Wisconsin (Fricke, 1976; Fricke and Johnson, 1983), Ogle, and Kellerville Tills (Frye et al., 1969)--all Glasford Formation units tentatively identified in Boone and Winnebago Counties--are not well understood. The Kellerville Till and perhaps the Foxhollow till are exposed at the Nimtz Quarry Section (Berg and Kempton: Stop 5).

The Ogle Till is perhaps the least understood of the Glasford Formation diamictons. Due to a lack of data on the Ogle in the Boone-Winnebago Counties area, information on the unit is not included on figures 3 and 4 or table 1. It has been described as including three different clay-mineral compositions (Willman and Frye, 1970). Much of the problem is that the unit often rests on bedrock and/or is less than 6 m thick. The Ogle has been retained as a distinct unit because correlation to other units cannot be made at this time.

The lowermost Glasford Formation till member in Illinois, the clay loam to silt loam Kellerville Till, can be observed below organic materials interpreted as the Pike Soil at the Nimtz Quarry Section (Berg and Kempton: Stop 5) and in deep borings in northern Boone, Winnebago, and northwestern McHenry Counties. Where identified in northern Illinois the diamicton is generally less than 3 m thick and illite averages 41 percent. Although it stratigraphically lies below diamictons identified as Oregon and Fairdale, its age relationship to the overlying sequence of Glasford Formation units is not clear.

Stratigraphic unit		Sample	Grain size S-Si-C	Clay Min. Ex-I-K+C	Cal. Dol. counts/sec.	Vermicullite index
Morton-like silt	Esmond Till Member	1	8-39-53	10-78-12	32-70	8<
		2		10-78-12	32-67	2<
		3	14-43-43	12-78-10	41-72	2<
		4, 5, 6	Lacustrine	Sand and Silt		
	Oregon T.M. silty facies	7	22-52-26	27-58-15	26-56	
		8	29-39-32	29-58-13	56-54	
		9	28-38-34	31-56-13	59-73	12>
Glasford Formation	Fairdale Till Member	10	25-35-40	24-64-12	40-59	7>
		11	19-37-44	15-63-22	45-60	1>
		12	21-37-42	13-65-22	52-51	
		13	33-36-31	16-62-22	43-40	2>
		14	34-35-31	13-64-23	50-48	1<
Mixed Fairdale-Herbert		15		9-68-23	35-67	2<
		16	48-38-14	12-68-20	29-81	2<
	Herbert Till Member	17	49-37-14	7-76-17	27-45	6<
		18	48-39-13	9-74-17	20-48	5<
		19	68-23-9	5-88-7	33	15<
		20	48-34-18	6-84-10	12-40	13<

ISGS 1985

Figure 5 Grain-size distribution, clay-mineral composition, and carbonate data for the Stone Quarry Road Boring.

Winnebago Formation

The sandy diamictons of northern Boone County and northeastern Winnebago County have been considered Altonian (75,000 to 28,000 years RCYBP). Recent investigations, however, conclude that the paleosol formed in these diamictons is the Sangamon Soil (McKenna: Stop 4a, McKenna and Follmer: Stop 6 and Follmer, Berg, and Masters: Stop 7); therefore these deposits are Illinoian.

The Capron Till Member has been mapped as the surficial unit in eastern and southeastern portions of Boone, De Kalb, and western McHenry Counties in Illinois, and a small portion of south-central Walworth County in Wisconsin (Frye et al., 1969). The surficial occurrence of the Capron is now restricted to areas north of Piscasaw Creek in Boone County (fig. 2).

Our studies suggest a relationship between the Capron Till and the low-illite portion of the Clinton till of Wisconsin (Krumm and Berg: Stop 3). The Clinton till has been described by Fricke (1976) and Fricke and Johnson (1983). The Capron Till is now known to have an extremely variable texture (fig. 3), in places not unlike that of the Clinton which averages over 60 percent sand. There are other similarities: (1) the Clinton till often has a pink color similar to the Capron; (2) both diamictons are restricted to a similar geomorphic province; and (3) the clay-mineral composition of part of the Clinton is identical to that of the Capron Till (the other part is similar to the Argyle Till). The Clinton till at the Turtle Town Quarry is discussed by Canfield and Mickelson (Stop 2). The time-stratigraphic relationship between the Capron Till and the Clinton till remains unresolved. Weathering horizons between the Capron and Argyle Tills and between the Capron and Oregon Tills on the Capron Ridge suggest an age younger than that of other Winnebago Formation units (Krumm and Berg: Stop 3).

The diamicton beneath the Capron and Clinton Tills is the sandy loam Argyle Till Member (the Allens Grove till in Wisconsin). This till member has been identified in more than 130 exposures and borings in northern Boone County and east-central Winnebago County, where it is the principal surficial unit. It can be observed at the Nimtz Quarry Section (Berg and Kempton: Stop 5), Wempletown Southeast Section (McKenna and Follmer: Stop 6), Simpson Road gravel pit (Follmer, Berg, and Masters: Stop 7) and the State Street Quarry Section (Berg and Kempton: Stop 8).

The lowermost Winnebago Formation diamicton--the Nimtz Till Member--also has a sandy loam texture, however, it is often loamy. Its illite content (69%) differentiates it from the Argyle Till (61% illite) (fig. 4, table 1). The Nimtz Till also appears more compact than that of the Argyle.

The Nimtz Till has been described in 70 exposures and borings; the Argyle overlies it at 28 of these locations. The subsurface occurrence of the Nimtz has been shown in test borings in Boone and northwestern McHenry Counties. Its best exposure is at the Nimtz Quarry Section, where its stratigraphic relationships to the overlying Argyle Till and to underlying diamictons which may be the Oregon and Belvidere Tills are shown.

Although clay-mineral composition, based on illite percentage, separates the Nimtz Till from the Argyle Till, field separation of the units is often difficult. Such is the case at the Nimtz Quarry Section. Possibly the Nimtz was deposited here by the same ice advance that deposited the Argyle. The fact that the illite content is higher in the Nimtz than in the Argyle may be due to an incorporation of higher illite material from the underlying Esmond or Herbert Tills, which average about 76 percent illite.

FORMAL DESCRIPTION OF NEW AND REVISED STRATIGRAPHIC UNITS

The recognition that the Esmond Till is a correlative of the Sterling Till Member of the Glasford Formation (Follmer and Kempton: Stop 10) and the recognition that diamictons of the Winnebago Formation lie stratigraphically above the Esmond, have left three unnamed till members below the Esmond. In addition, two new till members and one sand member above the Esmond have been identified. The complete stratigraphic sequence as now established is given on the back cover. Data for borings mentioned in the following descriptions of members are presented in the Appendix.

Glasford Formation

• Herbert Till Member (new)

The Herbert Till Member of the Glasford Formation was named for the village of Herbert in Boone County, Illinois (Stone Quarry Road Boring 6.4 m northwest of Herbert in the NE NE NE Sec. 22, T 43 N, R 3 E). The Herbert Till Member consists of a gray-brown loam to sandy loam diamicton with a mean grain-size distribution of 49 percent sand, 34 percent silt, and 17 percent clay (table 1). The clay-mineral composition is similar to the Esmond Till Member: average 7 percent expandables, 77 percent illite, and 16 percent kaolinite plus chlorite (table 1). The unit is generally less than 10 m thick. It is bounded at the top by the Fairdale or Oregon Till Members or younger deposits. It often overlies shale of the Maquoketa Group. The Herbert Till Member is principally a subsurface unit in southern Boone, northern De Kalb, eastern Ogle, southern McHenry and Kane Counties. It is described in numerous borings in southern Boone County such as the Stone School, Irene, and Belvidere South Borings. In De Kalb and Ogle Counties it is best described in the Sycamore East and the Greenway School Borings (Follmer and Kempton: Stop 10). It was previously correlated to the Sterling Till Member in northern Illinois.

• Fairdale Till Member (new)

For a formal description of the Fairdale Till Member, see Kempton and Berg: Stop 9.

• Oregon Till Member (new)

The Oregon Till Member of the Glasford Formation was named for its widespread occurrence in the vicinity of Oregon in Ogle County. The Grand Detour Section, designated as the type section, is located about 16 km south of

Oregon (Appendix). The Oregon Till Member typically is a pinkish brown loam to sandy loam diamicton with a mean grain-size distribution of 47 percent sand, 34 percent silt, and 19 percent clay. The mean clay-mineral composition is 21 percent expandables, 59 percent illite, and 20 percent kaolinite plus chlorite; however, the most representative unaltered Oregon Till samples average 55 percent illite. The Oregon Till Member is below the Esmond Till Member and above the Fairdale Till Member. The Oregon Till Member displays a fining downward characteristic. Its siltier component is referred to as the Oregon silty facies and has been defined by Kempton and Berg (Stop 9).

The stratigraphic position of the Oregon Till below the Esmond is shown at Illinois Tollway Boring 3-10-5 (Appendix) as well as at several exposures in Ogle County. The Oregon Till directly underlies the Nimtz Till Member of the Winnebago Formation in the Garden Prairie North Boring, County Farm Landfill Section, and possibly, in Winnebago County Boring W-45-20 (Appendix), and Profiles 11 and 12 of the Nimtz Quarry Section. In the Grand Detour Section it is overlain by silt and the Esmond Till Member.

The original distribution of the Oregon Till is suggested by its subsurface occurrence as a thin band between the Rock River valley and the bedrock upland to the east extending northward almost to the Wisconsin State line; the Oregon also occurs in the deepest portion of the Troy Bedrock Valley in northern Boone County. Apparently, its position on the lee side of a bedrock upland and in the Troy Bedrock Valley protected the unit from ice and water erosion. The Oregon Till Member replaces the Argyle Till Member in parts of western Winnebago County and all of Ogle and Lee Counties.

- **Esmond Till Member (revised)**

The Esmond Till Member was identified on the basis of data from the Greenway School Borings (Frye et al., 1969) and numerous exposures in Ogle, Winnebago, and Boone Counties. It was formally named as a member of the Wedron Formation by Frye and Willman (1970) for the town of Esmond in Ogle County. The till member is gray; its texture is clay loam; the clay-mineral composition averages 76 percent illite. The type section is located in southeastern Winnebago County, NW SW NW Sec. 27, T 43 N, R 2 E. The Esmond Till is now considered a member within the Glasford Formation correlative to the Sterling Till Member of Ogle, Lee, and Whiteside Counties. In portions of Boone County, the lower illite Belvidere Till Member lies above the Esmond. The stratigraphic relationships of the Winnebago Formation diamictons above the Esmond have been established at the Chrysler Railroad Section and the Spartan Store Section. At Illinois Tollway Boring 3-10-5, the Grand Detour Section, and the Greenway School Borings, the Esmond Till directly overlies the Oregon Till. The silt, often underlying the Esmond Till, has been called the Morton Loess (Willman and Frye 1970) and considered a Wisconsinan-age material. Because full stratigraphic implications of the relationship of this silt to overlying materials have not been determined, a formal definition is not being made at this time. The Esmond is now considered to be a rock-stratigraphic equivalent to the Radnor and Sterling Till Members. We are proposing that the name "Radnor" replace the names "Esmond" and "Sterling," on the basis of the Radnor's widespread distribution in Illinois (Follmer and Kempton: Stop 10).

• **Belvidere Till Member** (new)

The Belvidere Till Member of the Glasford Formation has been identified in exposures and borings through much of southern Boone County and parts of northern De Kalb, southwestern McHenry, and Kane Counties. Its formal name derives from the town of Belvidere in Boone County; the type section is a boring near the junction of U.S. Route 20 and Genoa Road, 0.8 km southeast of Belvidere (Belvidere South Boring, NW NW NW Sec. 6, T 43 N, R 4 E).

The Belvidere Till Member is a pinkish to tan brown diamicton with a mean grain-size distribution of 30 percent sand, 42 percent silt, and 28 percent clay; however, its texture ranges from loam to clay loam to silty clay loam. A less common variant, which occurs mostly in extreme southeastern Boone County, has an average grain-size distribution of 16 percent sand, 51 percent silt, and 33 percent clay. This textural range results in its large standard deviation shown on table 1. The average clay-mineral composition is 12 percent expandables, 70 percent illite, and 18 percent kaolinite plus chlorite (table 1). The Belvidere Till overlies the Esmond Till only in a small portion of south-central Boone County (Huber Road Boring, Stone Quarry Road Boring, and Boone County exposure sample HK-95). It also possibly overlies the Esmond in the Capron West Boring. The Belvidere directly overlies older deposits where the Esmond is absent. This is indicated at the Sycamore East, Belvidere South, Irene, and Northwest McHenry County Borings. The Belvidere Till underlies the Nimtz Till (Capron West and the Northwest McHenry County Borings) in deeper portions of the Troy Bedrock Valley. Here a thick sequence of Winnebago Formation diamictons occurs above a sequence (up to 45 m thick) of Belvidere Till and related outwash and lacustrine deposits. Belvidere Till beneath Winnebago Formation diamictons is also described at the Nimtz Quarry Section (Berg and Kempton: Stop 5) and in the Courthouse Boring.

The Belvidere Till Member replaces the Capron Till Member previously mapped in all areas south of Piscasaw Creek in southern Boone County, although the Oregon Till Member silty facies is frequently present where the Belvidere (or Esmond) is missing (fig. 2). It also replaces the previously mapped Capron Till in northern De Kalb and southwestern McHenry Counties. Based on grain size, clay-mineral composition, stratigraphic position, and geographic location, the Belvidere Till Member is a possible stratigraphic equivalent to the Lee Center Till Member in Lee County (fig. 2).

Winnebago Formation

• **Beaver Creek Sand Member (new)**

For formal definition of the Beaver Creek Sand Member, see Berg and Kempton: Stop 8.

• **Nimtz Till Member (new)**

For formal definition of the Nimtz Till Member, see Berg and Kempton: Stop 5.

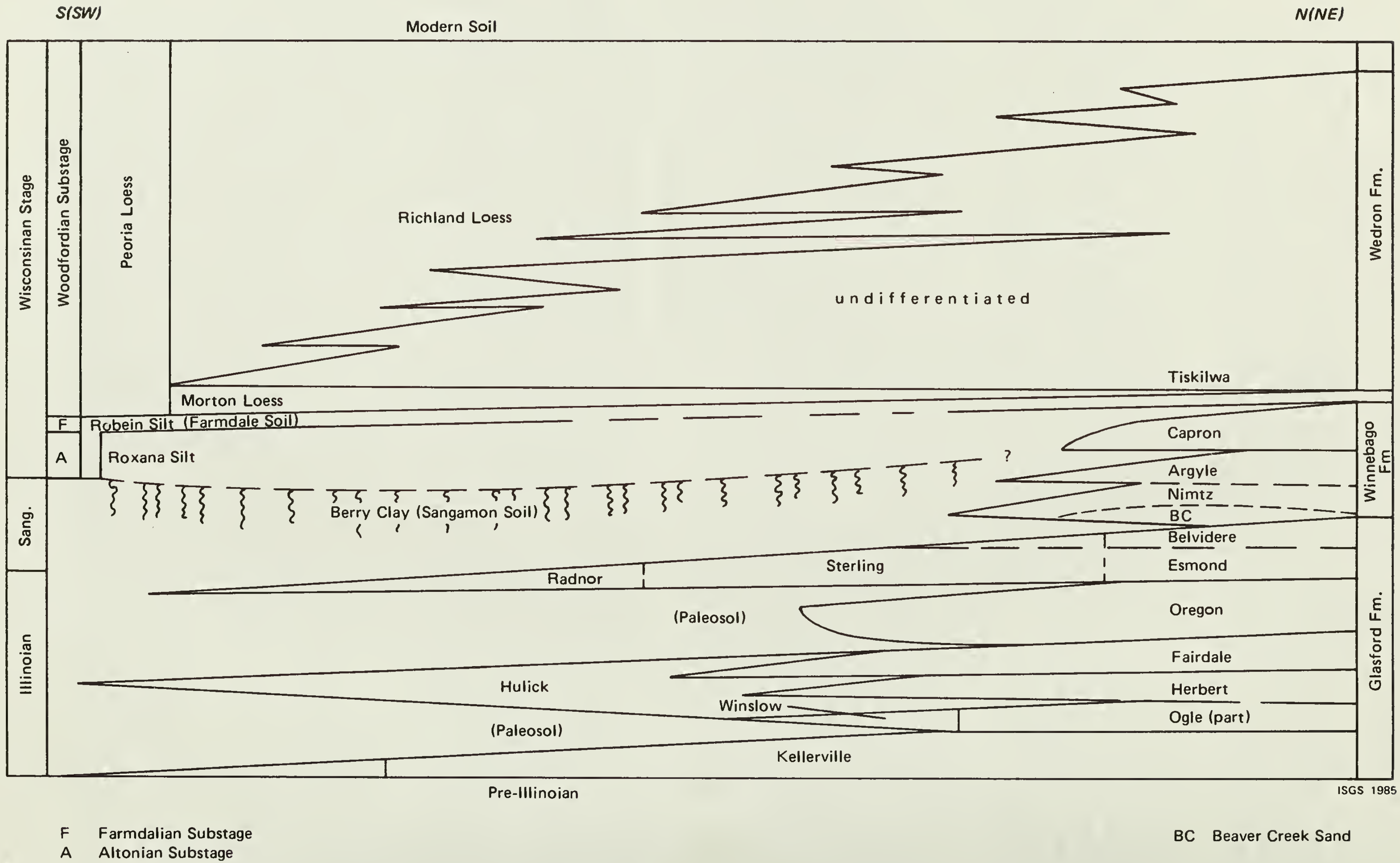


Figure 6 Time-space diagram showing possible relationships of the pre-Woodforidan till members of northern Illinois to those of western Illinois.

Argyle Till Member (revised)

For a formal revision of the Argyle Till, see Berg and Kempton: Stop 5.

Capron Till Member (revised)

For a formal revision of the Capron Till, see Krumm and Berg: Stop 3.

REGIONAL CORRELATIONS

Some diamictons in northern Illinois may directly correlate to those defined in western and southern Illinois. Such potential correlations have not been attempted until recently. The apparent complexity of the sequence of diamictons in northern Illinois has been significantly reduced by having demonstrated the correlation of the Esmond with the Sterling Till Member. By combining the remaining diamictons into groups of materials with similar clay-mineral compositions or with other similar physical characteristics, a less complex picture emerges.

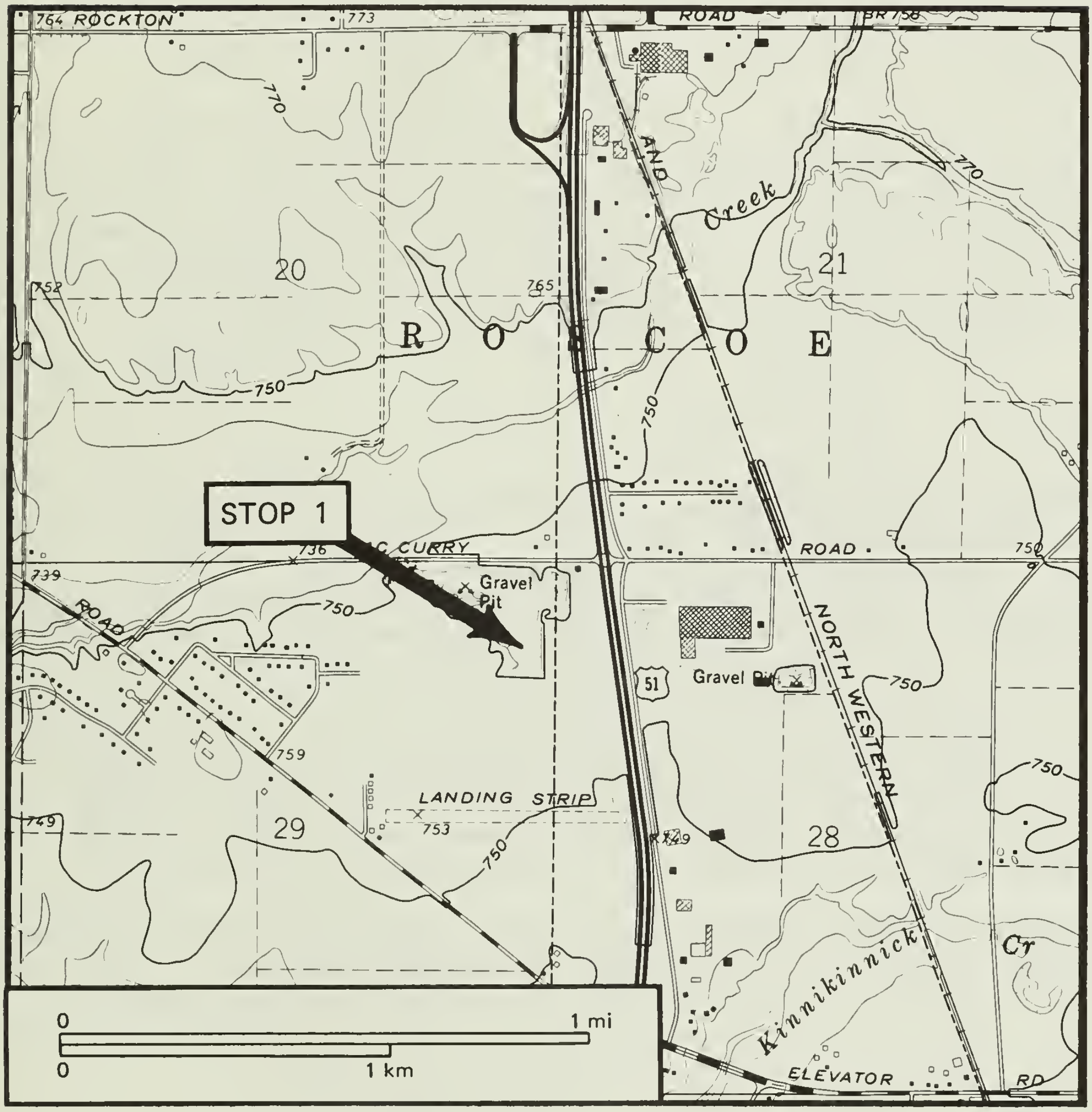
Figure 6 summarizes the groupings of till members, their relationship to paleosols, and suggested correlations to principal till members in western and southern Illinois. The three principal till members described in western Illinois (Willman and Frye, 1970) are the Radnor, Hulick and Kellerville, all members of the Glasford Formation. Frye et al. (1969) suggested that the Sterling Till Member of northwestern Illinois, north of the Green River Lowland, correlates to the Radnor Till Member; this relationship is now formally adopted based on stratigraphic position, color, and clay-mineral composition. Evidence now strongly suggests that the Esmond also correlates with the Sterling. If the Kellerville of northern Illinois has been properly identified and correlated to the Kellerville of western Illinois, the diamictons stratigraphically between the Esmond and the Kellerville can be placed into their proper regional stratigraphic setting.

Because of the relatively high content of illite in the Fairdale and Herbert Till Members, these till members, including parts of the Ogle and Winslow Tills to the west, are correlated with the Hulick. Both the Hulick and the Herbert contain abundant shale. The remaining diamicton between the Esmond and Fairdale is the Oregon; it does not appear to have been deposited much farther south than central Lee County. Its relatively low illite percentage and relatively high calcite content and reddish color contrast with the other three groupings. The source of the Oregon could have been different from that of the other Glasford Formation till members.

The till members of the Winnebago Formation are clearly separated from those of the Glasford Formation on the basis of clay-mineral composition, general color, area of distribution, and stratigraphic relationships. Not totally clear at this point are the age relationships of these till members. The available evidence now places the Argyle and Nimtz Tills into the Illinoian. However, the ages of the Capron and part of the Clinton are not as clear. All appear to lie below the Robein Silt. An Altonian age for the Capron Till is still possible.

Terraces of the Rock River Valley in Southern Wisconsin and Northern Illinois

Richard C. Anderson and John M. Masters



STOP 1
Kelley Sand and Gravel Company Pit
NE 1/2 Sec. 29, T 46 N, R 2 E, Winnebago County

At this site we will observe an exposure of sand and gravel of the Wisconsinan-aged Lake Mills Terrace. We will discuss geomorphic and sedimentologic aspects of the Rock River terraces.

INTRODUCTION

Terraces occur along the Rock River from Watertown, Wisconsin, to the eastern boundary of Rock Island County, Illinois (fig. 1-1). Downstream they were eroded by the Mississippi River during the late Wisconsinan and Holocene. Except for the oldest (highest) terrace remnants and a few remnants upstream from Janesville, Wisconsin (which appear to be bedrock-controlled erosional terraces), the terraces are the result of glaciofluvial deposition and can be traced upstream to correlative moraines. As the elevation decreases, so does the age of each successive terrace; terrace formation resulted from erosional and depositional processes.

In this paper we discuss the geomorphology and sedimentology of terraces in the Rock River valley between Lake Koshkonong in northern Rock County, Wisconsin and the mouth of the Kishwaukee River in southern Winnebago County, Illinois (figs. 1-1, 1-2). From oldest (highest) to youngest (lowest), the terraces are the Rockford, the Johnstown, the Milton, and the Lake Mills. Specific emphasis is placed on the Lake Mills Terrace at the Kelley Sand and Gravel Company pit in northern Winnebago County, Illinois.

METHODS

We mapped and provisionally correlated terraces in the field. We drew cross-valley (transverse) profiles (fig. 1-3) usually at 1.6-km intervals, using 7.5-minute topographic maps having a 3.1 m contour interval. From these cross-valley profiles, we determined the lowest elevation of each uneroded terrace remnant. This value was plotted on a downvalley (longitudinal) profile (fig. 1-2). These plots usually substantiated the field correlations, but in some instances revisions were necessary. The plots were used as the basis for reconstructing the downvalley profiles of the streams that deposited the glaciofluvial sediments. Downvalley profiles of the terraces (fig. 1-2) were drawn. The lines of the profiles represent the lowest points on the terrace surfaces at the time the sediments were being deposited; the profiles give an approximation of the gradient of the depositing stream.

We determined the sedimentology of the terrace deposits in the Rock River valley primarily from our field work. We measured the dips of cross-bedded units and collected samples for identification of rocks and minerals.

RESULTS AND DISCUSSION

Course of the Rock River

Several small tributaries flowing into Horicon Marsh, south of Fond du Lac in east-central Wisconsin, form the source of the Rock River. The river flows generally south and southwest for about 523 km before joining the Mississippi River at Rock Island, Illinois (fig. 1-1). From its source downstream to Watertown, Wisconsin (about 137 km), the river follows a broad lowland underlain by Paleozoic rocks that gently dip eastward. The lowland, formed by the more rapid erosion of the intervening shales of the Maquoketa

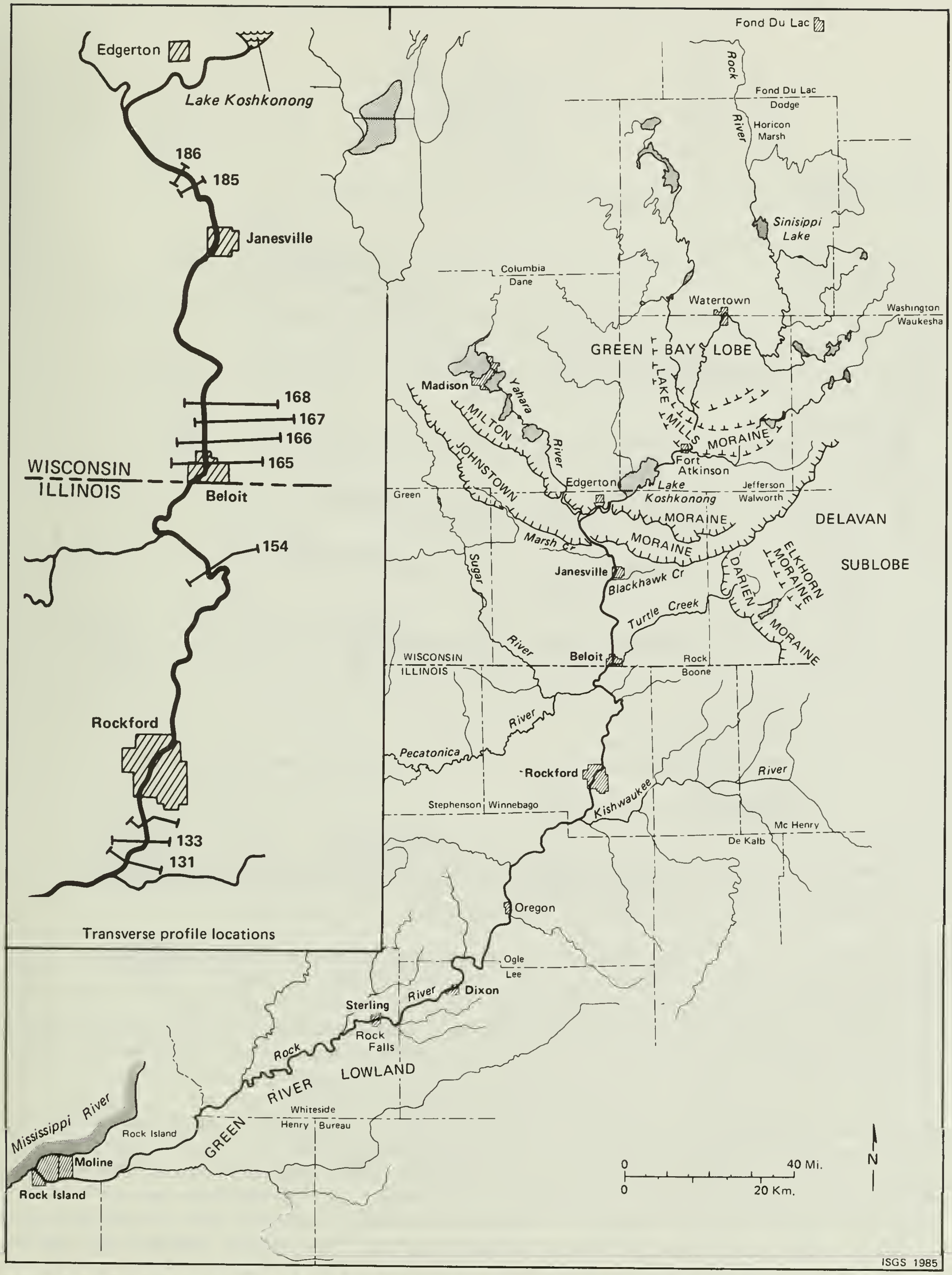


Figure 1-1 Drainage basin of the Rock River. Enlarged inset map shows locations of transverse profiles on figure 1-3.

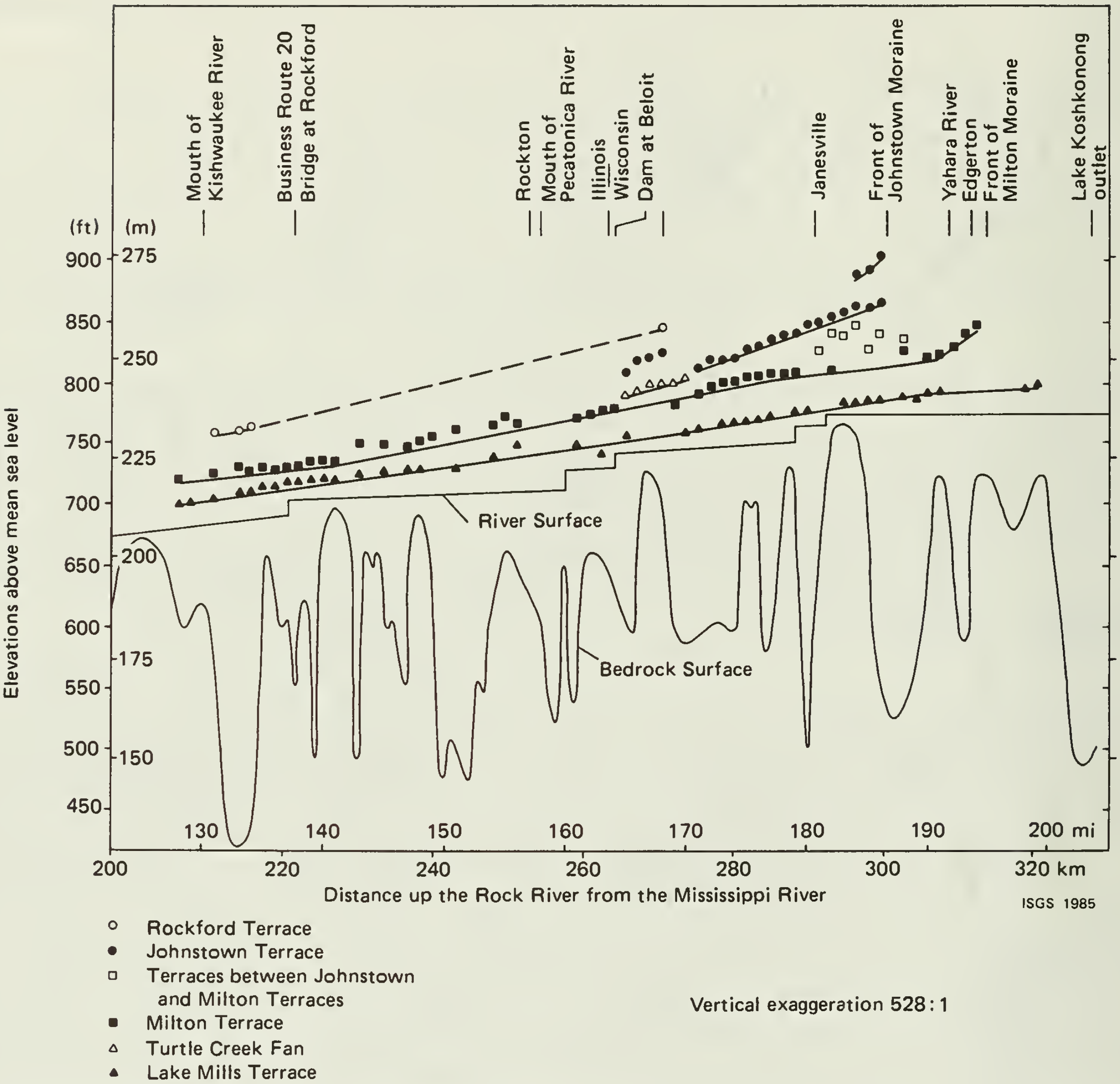


Figure 1-2 Longitudinal profiles of terraces, the river surface, and the bedrock surface along the Rock River between the Lake Koshkonong outlet and the mouth of the Kishwaukee River (bedrock elevations from Alden, 1918; Berg, Kempton, and Stecyk, 1984).

Group (Ordovician), lies between the Niagara Escarpment (Silurian) on the east and the Galena Cuesta (Ordovician) on the west (Martin, 1932). Just downstream from Watertown, the westerly course of the river brings it closer to the axis of the Wisconsin Arch. There, it flows across older Ordovician rocks of the Ancell and Prairie du Chien Groups. Where it crosses more deeply eroded bedrock valleys it flows across Cambrian sandstone formations. From its source downstream to Lake Koshkonong (about 185 km), the river actually encounters bedrock only twice: at Watertown it crosses the Galena Cuesta, and at Jefferson it crosses a bedrock divide capped by the Galena and Platteville Groups. Below Lake Koshkonong (an ice-block depression located in the Rock Bedrock Valley), the Rock River enters a narrow, bedrock-walled valley (Platteville Group) cut through the divide between the Rock and Yahara Bedrock Valleys. The river then follows the west side of the Yahara Bedrock Valley to

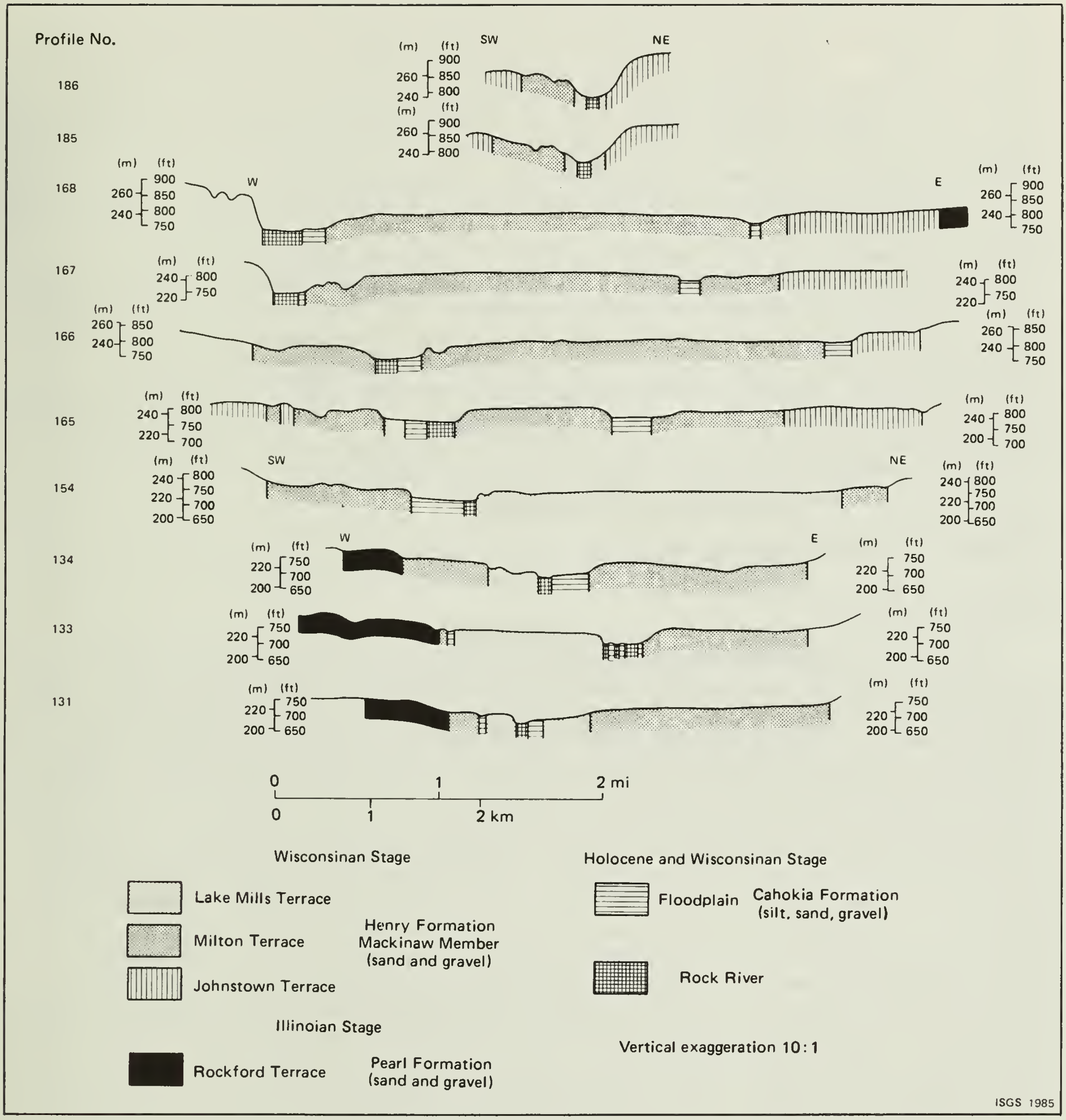


Figure 1-3 Representative transverse profiles across the Rock River valley showing lateral relationships of terraces. Profile locations are shown on figure 1-1.

a few km upstream from Janesville, Wisconsin. Along this reach the river also crosses the Milton and Johnstown Moraines. Throughout this upper reach, the Rock River flows over surficial glacial deposits of the Wisconsinan Green Bay Lobe; the Johnstown moraine is the outermost moraine of this lobe (fig. 1-1). These deposits include moraine remnants, ground moraines, drumlins, and other ice-contact deposits (Alden, 1918).

From Janesville to the mouth of the Kishwaukee River, the river flows along the west side of the Rock Bedrock Valley, where it encounters numerous bedrock highs. These bedrock highs are divides between tributary bedrock valleys that enter the main (deepest) channel in the bedrock valley from the west. As a result, bedrock that has an irregular profile lies below the present course of the stream (fig. 1-2). About 5 km above the mouth of the Kishwaukee River, the Rock River turns to the southwest and flows for the next 150 km roughly perpendicular to the trend of other buried bedrock valleys, the southwesternmost of which is the Princeton Bedrock Valley in southwestern Whiteside County. Downstream to Sterling, Illinois, the Rock River lies within a narrow bedrock valley. From Sterling to eastern Rock Island County, the river flows along the northwestern edge of the Green River Lowland (fig. 1-1), a sandy outwash plain that extends to the outer margin of the Bloomington Ridged Plain 32 km to the southeast (Leighton, Ekblaw, and Horberg, 1948). The Rock River flows on bedrock from the southwestern corner of Whiteside County to its mouth at Rock Island. There it lies within a broad valley formed by glacial diversions of the Mississippi River and by late Wisconsinan and Holocene floods along the Mississippi.

Glaciofluvial Terraces and Deposits

• Rockford Terrace

The areal distribution of the Rockford Terrace is small; it occurs only on the west side of the valley just south of Rockford (figs. 1-2, 1-3; profiles 131, 133, 134). The Rockford Terrace is discussed in detail by Follmer, Berg, and Masters (Stop 7). Other terrace remnants that may be correlative occur northeast of Beloit (figs. 1-2, 1-3; profile 168). The Rockford Terrace is the highest and oldest Rock River terrace. It consists of poorly sorted cobble gravel that has clasts up to 20 cm in diameter and is overlain by about 1 m of silt. Fossil ice wedges containing sand protrude into the gravel. Many of the carbonate and crystalline cobbles are deeply weathered or completely distintegrated. These characteristics contrast with those of the younger Rock River terraces, which often have a very thin cover of silt, contain finer gravel that is less weathered, and cover a greater area. The sedimentary characteristics of the Rockford Terrace indicate that it was deposited close to an ice margin, probably as an outwash plain, or as a kame terrace between the west side of the Rock River valley and an ice margin to the east. Its high elevation and deep weathering indicate that it is significantly older than the lower terraces. The gravel deposit is underlain by the Argyle Till Member of the Winnebago Formation; the weathered zone in the gravel is correlative to the Sangamon Soil. The Rockford Terrace is interpreted as the surface of an Illinoian outwash deposit of the Pearl Formation (Follmer, Berg, and Masters: Stop 7). If we assume that the remnants northeast of Beloit are correlative, the gradient of the Rockford Terrace is about .4 m/km.

• Johnstown Terrace

The Johnstown Terrace begins at the Johnstown Moraine and is traced downstream to the Illinois state line. Although longitudinal profiles (fig. 1-2) indicate that this terrace disappears beneath deposits of the next younger terrace, this relationship is not observable in the landscape.

The Johnstown Terrace, which has a thin cover of silt, is composed generally of moderately well to well sorted, sandy pebble-to-cobble gravel that in places contains boulders. The gravel consists of about 85 percent dolomite, 2 percent chert, 3 percent other sedimentary rocks, and 10 percent igneous and metamorphic rocks. It has the highest percentage of dolomite but the lowest percentage of chert and other sedimentary rocks of any of the terrace deposits in the Rock River valley. Alden (1918) described the outwash plain south of the Johnstown Moraine as deposited by meltwaters discharging from numerous points along the ice front (Green Bay Lobe) at the time the moraine was being deposited. Meltwater converged toward the Rock River valley from a 40-km-wide segment of the ice front, from the Darien Moraine (Delavan Sublobe of the Lake Michigan Lobe) on the east to the head of Marsh Creek on the west. Within about 5 km of the moraine, the outwash of the Johnstown Terrace is a coarse sandy cobble gravel that contains many boulders. The outwash tends to fine southward to a sandy pebble gravel a few kilometers south of Janesville. However, west and south of the area where the Turtle Creek valley joins the Rock River valley, the outwash is again a coarse sandy cobble gravel, probably because of an influx of meltwater down the Turtle Creek valley from ice of the Delavan Sublobe.

Immediately in front of the Johnstown Moraine on the east side of the Rock River lies the Johnstown Terrace. There, it has an elevation of about 274 m, but on the west side of the valley its elevation is 9 to 12 m lower (fig. 1-3, profile 185). These two surfaces can be traced along the front of the Johnstown Moraine for many kilometers. Variations in their elevation reflect the fan-like accumulations of outwash deposited adjacent to or over stagnant ice blocks. The higher elevation of the Johnstown Terrace on the east side of the Rock River is probably the result of a greater influx of outwash-laden meltwater from the ice of the Green Bay Lobe and the Delavan Sublobe. These eastern outwash sources dominated western ones and deflected the Rock River channel westward.

A remnant of the Johnstown Terrace east of Turtle Creek (east and northeast of Beloit) stands at a level distinctly higher than the level projected from upstream (fig. 1-2, Miles 165-168; fig. 1-3, profile 168). This remnant is at the foot of the east bluff, 3 to 5 km east of the Rock River. The cross-valley gradient increases until the terrace is about 6.1 m higher than the Rock River, a vertical interval comparable to the anomalous height of the plain. This remnant may also be related to deposition of an outwash fan by meltwaters that flowed down Turtle Creek and coalesced with outwash of the Johnstown Terrace. The gradient of the Johnstown Terrace is about 0.5 m/km.

In summary, the Johnstown Terrace is an extensive outwash plain consisting of outwash aprons and fans. The shape of the terrace is crudely triagular; its apex points down the Rock River valley. The particle-size range of the gravel, sorting, and bedding structures in this outwash indicate that it was deposited by a complex braided-stream system. The sedimentologic features include proximal to medial facies (longitudinal bars consisting of extensive, crudely horizontal beds of pebble-to-cobble gravel) and medial to distal facies (longitudinal to linguoid bars, dunes, and channel deposits consisting of horizontal and cross-bedded pebble gravel and variously cross-bedded pebbly sand).

• Milton Terrace

Above Janesville, Wisconsin, remnants of terraces occur at intermediate levels between the Johnstown Terrace and Milton Terrace (fig. 1-2; fig.1-3, profile 186). These remnants are interpreted as terraces that were cut in gravel and formed during the period of downcutting between the deposition of the Johnstown Terrace and the Milton Terrace. The Milton Terrace begins at the Milton Moraine near Edgerton, Wisconsin, about 8 km downstream from the mouth of Lake Koshkonong. It is the "upper terrace" described by Anderson (1967); it can be traced downstream to eastern Rock Island County where it has been removed by flood discharge along the Mississippi River. The gradient of the Milton Terrace is slightly variable, but is generally about .32 m/km between Mile 191 (1.6 km downstream from the mouth of the Yahara River) and Mile 128 (3.2 km below the mouth of the Kishwaukee River). The gradient is significantly steeper (fig. 1-2) between the Yahara River and the front of the Milton Moraine.

North and east of Beloit, Turtle Creek has built a fan that lies above the projected level of the Milton Terrace but below the Johnstown Terrace (fig. 1-2, Miles 165 to 168). This fan was deposited by meltwaters that flowed down Turtle Creek, perhaps when ice of the Delavan Sublobe was near the Elkhorn Moraine. The Turtle Creek fan has a higher surface elevation than the main Milton Terrace, which suggests that the Turtle Creek outwash was deposited slightly earlier than the outwash that formed the Milton Terrace.

• Lake Mills Terrace

The Lake Mills Terrace is the "lower terrace" described by Anderson (1967); its upstream limit is not clearly defined. This terrace merges with the outwash deposits that surround the drumlins and moraine tracts in the vicinity of Jefferson, Wisconsin--an area that Alden (1918) delineated as the Lake Mills Moraine (fig. 1-1). Upstream from Watertown, Wisconsin, the Rock River flows directly on outwash; no terrace exists. Alden (1918) recognized four individual, discontinuous "moraine lines" within the Lake Mills Moraine; the Lake Mills Terrace originates within this 10 to 16 km-wide morainic zone. Like the Milton Terrace, it can be traced downstream to Rock Island County where it terminates as a result of erosion by the Mississippi River. In the reach between Lake Koshkonong and the mouth of the Kishwaukee River, the Lake Mills Terrace displays a more uniform gradient than any of the higher terraces (fig.1-2; fig.1-3, profiles 131, 133, 154). The gradient is also lower (.27 m/km) than that of other terraces (fig.1-2). The sediments of the Lake Mills Terrace are well exposed at the Kelley Sand and Gravel Company pit.

• Sedimentologic Aspects of the Milton and Lake Mills Terrace Deposits

The deposits of the Milton (upper) and Lake Mills (lower) Terraces between Beloit and the mouth of the Kishwaukee River consist of 0.5 to 1.5 m

Figure 1-4 Imbricate slabs of dolomite in a horizontal bed of gravel, overlain by a bed of fine pebbles. This bed contains climbing ripples. Exposure in a south-southeast face of the Rockford Sand and Gravel Airport pit (November, 1984). Scale contains 10 cm divisions.

of silty sand, which overlie thick sequences of variable mixtures of medium-to coarse-grained sand and pebble to fine cobble gravel. Clasts 4 to 8 cm in diameter are common. The sand and gravel usually exceeds 8 m in thickness except immediately adjacent to the valley sides. The sand and gravel deposits are much less weathered than those of the Rockford Terrace. The Milton and Lake Mills Terraces contain 10 to 20 percent less dolomite and 10 to 18 percent more chert than the Rockford or Johnstown Terraces.

Gravel particles are moderately well rounded, indicating that they travelled a relatively long distance prior to deposition and probably were eroded and redeposited many times. However, in one area angular slabs of dolomite occupy imbricate positions within a horizontal bed of well-rounded gravel (fig. 1-4). The dolomite slabs extend downvalley (southwest) from the top of a bedrock high that was eroded during the formation of the Milton Terrace.

At any given point in the valley, the Milton Terrace is composed of slightly coarser material than the Lake Mills Terrace. The ratio of sand to gravel (<2mm in diameter) is approximately 1:1, tending to be lower (more gravel) upvalley and higher (more sand) downvalley. The gravel exposed in pits in both terraces is finer, better sorted, and more well-rounded than the gravel in the Rockford Terrace (Follmer, Berg and Masters: Stop 7). As depth increases the material generally becomes more gravelly and contains abundant coarse cobbles and some boulders. In the deepest portion of the bedrock valley, these deposits may reach thicknesses of 60 to 75 m. However, sand and gravel below depths of 15 m may represent several other periods of outwash deposition (Hackett, 1960; Berg, Kempton, and Stecyk, 1984) that occurred before the Milton or Lake Mills Terraces formed. These older outwash sands and gravels often contain diamictons and lacustrine sand, silt, and clay. The depositional history of these fine-grained deposits can usually be determined from correlations of their clay-mineral compositions with deposits on the adjacent uplands (Berg and Kempton: Stop 8). In places where the section is entirely composed of sand and gravel, it is difficult to identify the contacts between younger and older outwash deposits.

The terrace surfaces often extend into tributary valleys, where they are underlain by well-bedded silt and clay (Berg, Kempton, and Stecyk, 1984). These deposits accumulated in slackwater lakes that were formed as outwash-laden braided streams across the valley-train surface. The meltwater deposited sand and gravel bars across the mouths of these tributary valleys and temporarily formed lakes in which silt and clay were deposited.

Gravel pit exposures in the Milton and Lake Mills Terraces show that their deposits are well sorted and contain similar bedding structures. Both terraces are interpreted to be valley trains that were deposited as aggrading, braided streams.

• Lake Mills Terrace Exposure at the Kelley Sand and Gravel Company Pit

Perhaps the best exposure of the deposits of the Lake Mills Terrace is at the Kelley Sand and Gravel Company pit, located at the southwest corner of the intersection of McCurry Road and US 251 (NE Sec. 29, T 46 N, R 2 E, Winnebago County, Illinois) where about 8 m of sandy pebbly gravel is being extracted. The gravel is overlain by 0.5 to 1.0 m of silty sand. Gravel up to 5 cm in median diameter is common. Pebble identifications indicate that the gravel consists of about 60 percent dolomite, 20 percent chert, 10 percent other sedimentary rocks, and 10 percent igneous and metamorphic rocks. Most of the gravel is well rounded and unweathered. The material consists primarily of laterally persistent, thin (less than 0.5 m), horizontal beds of closed framework gravel; sand fills the interstitial spaces (fig. 1-5). Internally, these beds contain discontinuous horizontal and cross-stratification features; however, disc-shaped clasts often have an imbricate orientation.

The gravel was probably deposited in extensive, low amplitude, longitudinal bars during peak flood conditions on the braided surface of the valley train. The sand was deposited under declining or low flow conditions; it probably filtered into each layer of gravel shortly after its deposition.

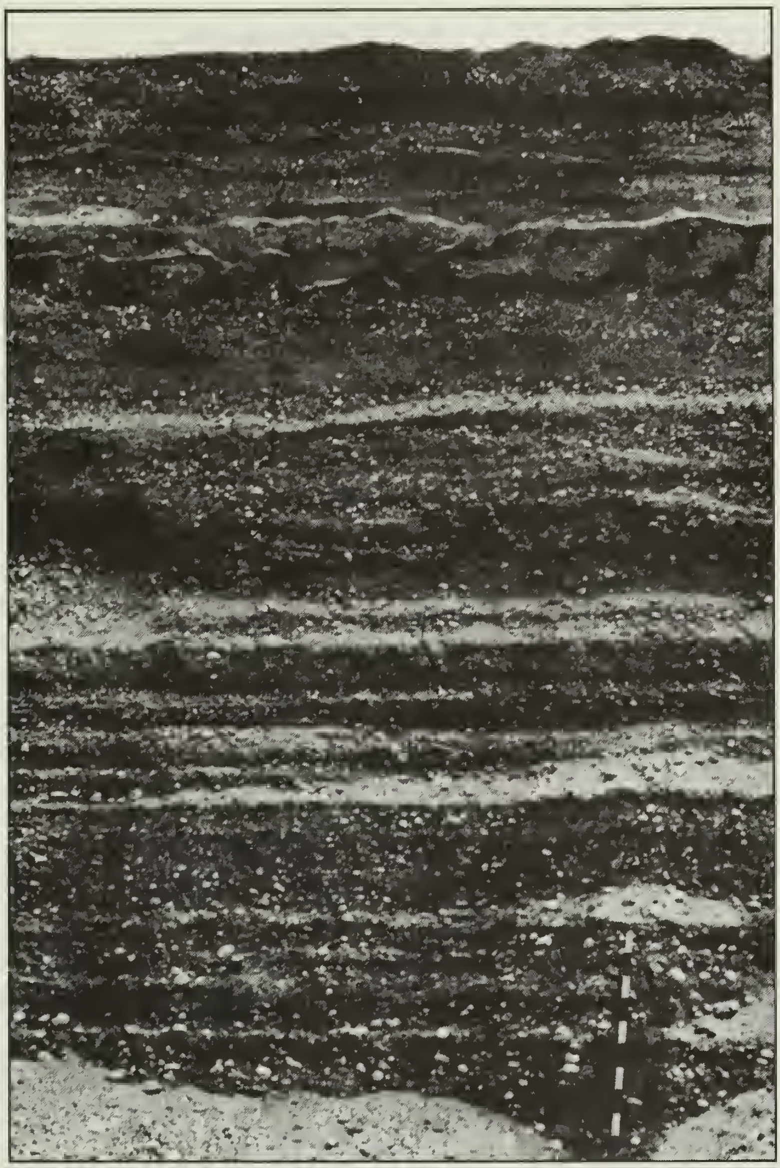


Figure 1-5 Horizontally bedded, sandy pebble gravel exposed in the south face of the Kelley Sand and Gravel Company's pit in July, 1980. Scale contains 10 cm divisions.

This section also contains layers of trough cross-bedded pebbly sand about 0.3 m thick; they may represent liguoid bars or sand waves that migrated over the longitudinal gravel bars during declining meltwater flow just after peak flood events. These sand and pebbly sand layers are up to 1 m thick. Elsewhere in the pit open framework gravel is present, mostly in size-graded cross-strata lenses that are 1 to 2 m thick. These deposits probably represent channel-fill deposits or prograding deltaic bar growth into deeper channels (Miall, 1977).

A contorted layer of fine-grained material, continuously exposed over about 10 m of the pit face, is about 1 m below the top of the gravel deposit (figs. 1-5, 1-6). It is a form of soft sediment deformation. Toward the

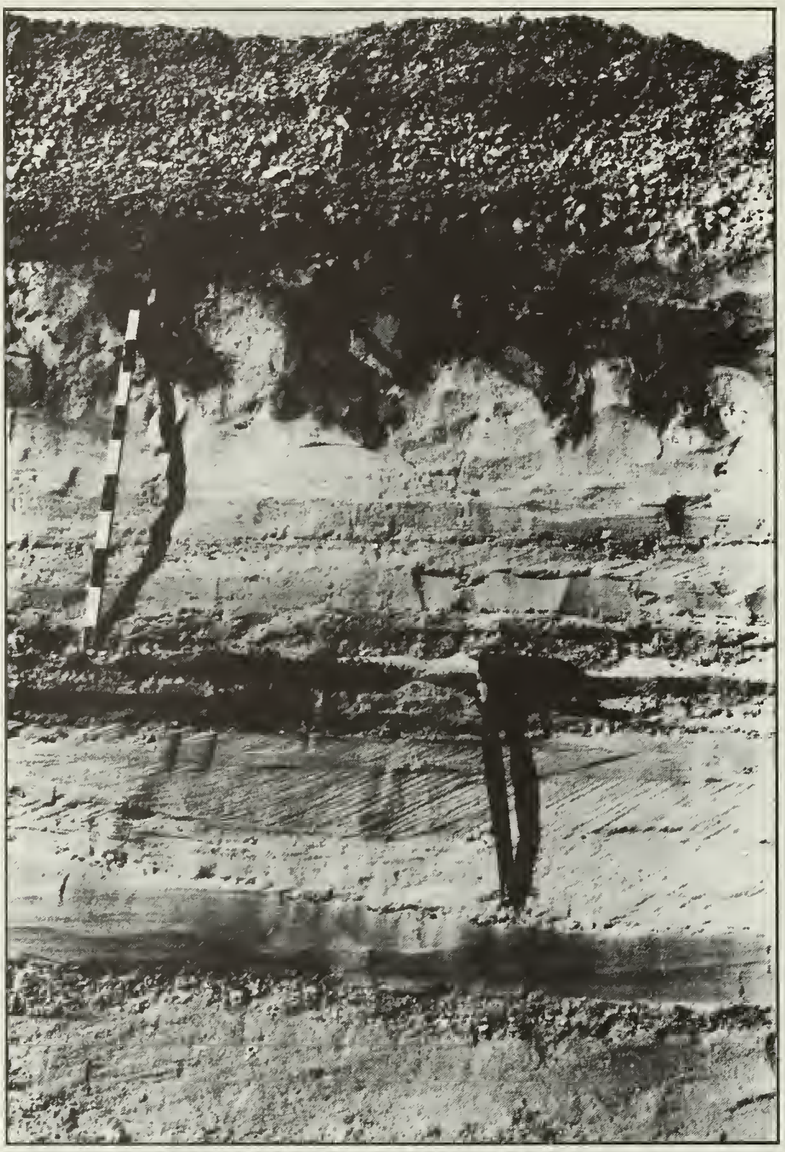


Figure 1-6 West face of the Kelley Sand and Gravel Company's pit, November, 1984. The soft sediment deformation at the top of the meter stick is also shown near the top of the exposure in figure 1-5.

east, deformation gradually decreases upwards as the contorted layer grades into a layer of about 20 cm of laminated clayey silt. The photograph (fig. 1-6) of the deformed material shows its downward injection into a fine sand. One possible explanation for this feature includes the following three-step process: (1) deposition of the silty clay in standing or slow-moving water in a depression or abandoned channel on the valley-train surface; (2) rapid migration of a longitudinal gravel bar over the undercompacted silty clay; and (3) deformation of the mud injected into undercompacted sediments below, incorporating some pebbles from above and probably undergoing simultaneous loss of excess water. Injected lobes of clayey silt apparently dip upvalley (fig. 1-6). This may represent a slight shift of the material downvalley as it was deforming. The shift may have resulted from gravity and shear stress transmitted through the overlying longitudinal gravel bar by the high-velocity overloaded meltwater flood.

Below the deformed unit, the section consists of about 2 m of sand interbedded with thin, sometimes pebbly lenses (generally < 10 cm thick) of clayey silt to silty sand. The sand units contain planar crossbedding (fig. 1-6, at shovel handle) and low- to high-angle trough crossbedding (above and below the shovel). This portion of the section may represent a large partly abandoned channel. The velocity of the water flowing into the channel may have been too low to transport material coarser than sand. Several flow regimes producing dunes and channel fills probably resulted in sand deposition (Miall, 1977).

Sedimentary features exposed in the valley-train deposit at the Kelley Sand and Gravel Company and other pits in the Milton and Lake Mills Terraces are very similar to the medial facies of proglacial, braided outwash fans in Alaska and Iceland (Boothroyd and Nummedal, 1978). Although facies of the Rock River valley trains have lower gradients and extend farther downslope than facies in Alaska and Iceland, perhaps the Green Bay Lobe episodically supplied high volumes of meltwater over long periods. If the Rock River valley constrained the meltwater and the gravel bars migrated down the valley, the medial-braided outwash facies would have spread a long distance down the valley.

In the Milton and Lake Mills Terraces between Beloit and the mouth of the Kishwaukee River, the horizontal beds of gravel were probably deposited in extensive, low-amplitude longitudinal bars as meltwater spread across the valley during periods of high flow. Thick cross-stratified lenses of gravel may represent channel fills, linguoid bars, or deltaic bar growth from older bar remnants. Beds of silt, sand, and pebbly sand probably represent a variety of deposits including dunes, linguoid bars, planar beds, ripples, and slackwater deposits. These finer grained deposits represent deposition under moderate to low flow conditions, which would have occurred in areas of low current velocity away from active gravel bars. This situation occurred in abandoned channels as well as in other topographically low areas on the valley-train surface during waning flood stages and other periods of low flow (Miall, 1977).

SUMMARY

In Winnebago County, Illinois, and Rock County, Wisconsin, the Rock River valley contains extensive terraces that consist of Wisconsinan and Illinoian sand and gravel. The terraces record a complex history of outwash plain and valley-train deposition. Sediments of the Rockford and Johnstown Terraces were deposited in outwash plains, fans, and aprons. Their internal bedding structures, sorting, and the particle-size range of the gravel indicate that deposition occurred in proximal to distal braided-stream facies. Erosion probably reworked some materials from the older, higher terraces as well as from older materials deeper in the valley.

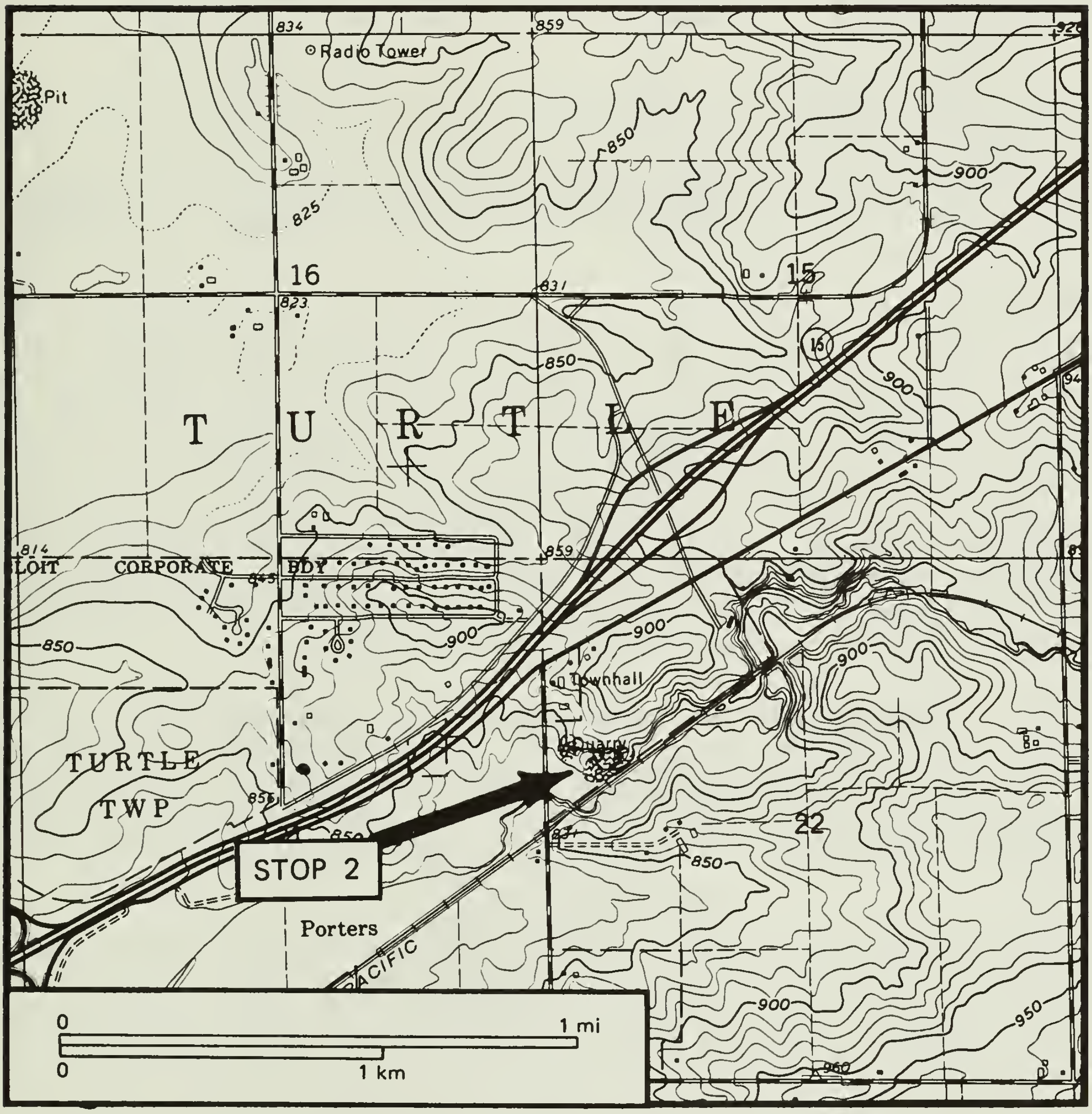
The sediments that form the Milton and Lake Mills Terraces mainly consist of materials washed in by meltwaters from the Green Bay Lobe. The meltwaters that deposited the younger outwash did not parallel the thalweg of the Rock Bedrock Valley, but sometimes eroded bedrock highs between its tributaries. Sediments of the Milton and Lake Mills Terraces were deposited in valley trains. Deposition occurred in medial to distal braided-stream facies.

Soft sediment deformation resulting from deposition of a gravel bar on underconsolidated fine-grained sediments can be seen at the Kelley Sand and Gravel Company pit.

The Milton and Lake Mills Terraces dominate the surface of the Rock River valley in Winnebago County. The underlying sand and gravel deposits are important economic sources of construction aggregate; however, the flat, well drained terrace surfaces are attractive sites for industrial, residential, and agricultural use. Such development on the terraces restricts the areas available for sand and gravel extraction.

An Outline of the Quaternary History of South-Central Wisconsin

Howard E. Canfield and David M. Mickelson



STOP 2
Turtle Town Quarry Section
SW NW Sec. 22, T 1 N, R 13 E, Rock County, Wisconsin

The Turtle Town Quarry section provides an exposure of the Clinton till, a very sandy light yellowish brown or pinkish brown diamicton. This section is the largest exposure of the Clinton till. The Clinton has significant implications for regional stratigraphy because of its relationship to the Argyle and Capron Tills in Illinois.

INTRODUCTION AND BACKGROUND

Study of the Quaternary history of south-central Wisconsin began with Alden's reconnaissance mapping of the glacial deposits in 1918. Later, Bleuer (1971) and more recently, Fricke (1976) and Fricke and Johnson (1983) mapped the area in more detail and developed the stratigraphy of glacial deposits. In this paper we review the history of study in the area, present an overview of the glacial succession in south-central Wisconsin, and discuss the stratigraphy and glacial history of the Turtle Town Quarry section.

On the basis of his reconnaissance mapping, Alden (1918) concluded that all of the surficial upland drift outside the area of the late Wisconsinan end moraine resulted from the same Illinoian glacial advance. However, he noted differences in the degree of soil development and landscape dissection across the area. Alden also suggested the possibility of an underlying older drift.

The first detailed stratigraphy of south-central Wisconsin was developed by Bleuer (1971). He recognized five tills in the area outside the late Wisconsinan end moraine. Bleuer assigned the surface tills east of the Rock River to the Altonian Substage of the Wisconsinan Stage and those in the more dissected region west of the Rock River to the Illinoian Stage. In the area underlain by Altonian tills, the surface morphology consists of a series of east-west trending, gently sloping, elongate hills separated by imperfectly to poorly drained lowlands. These linear landforms (including drumlins) as well as the microfabric, macrofabric, striae, and flow lines established by tracing dolomite lithologies of diamictons suggested to Bleuer that all Altonian tills were deposited by ice flowing from the east-northeast.

Bleuer observed ice-wedge casts in the area outside the late Wisconsinan end moraine; he attributed their formation to the development of permafrost conditions during the late Wisconsinan return of ice to southern Wisconsin. Because the ice-wedge casts were truncated and covered by colluvium, Bleuer concluded that substantial erosion of the uplands had also occurred during this time.

Bleuer was the first to describe the exposure at Turtle Town Quarry. In a small section, probably south of the present one, he reported 0.6 m of loess containing a zone of basal mixing over about 0.5 m of light yellowish brown sandy till. Beneath the sandy till was 0.5 m of a siltier till of the same color. Bleuer tentatively correlated this silty till with the Janesville till to the northwest. Pebble fabrics from this unit indicated flow from the northeast. He interpreted the upper till as the Argyle Till Member of Illinois. On the basis of fabric diagrams and flow lines established by the distribution of Niagaran dolomite, Bleuer concluded that the surface till in Wisconsin had been deposited by southwestward-flowing Lake Michigan Lobe ice. This interpretation contrasted with that of Frye et al. (1969), who concluded (on the basis of shale pebble distributions) that the Argyle Till had been deposited by southward flowing Green Bay Lobe ice.

Fricke (1976) and Fricke and Johnson (1983) mapped part of south-central Wisconsin and re-examined and revised the stratigraphic correlation of the glacial units. Fricke's interpretation of the distribution of surficial units

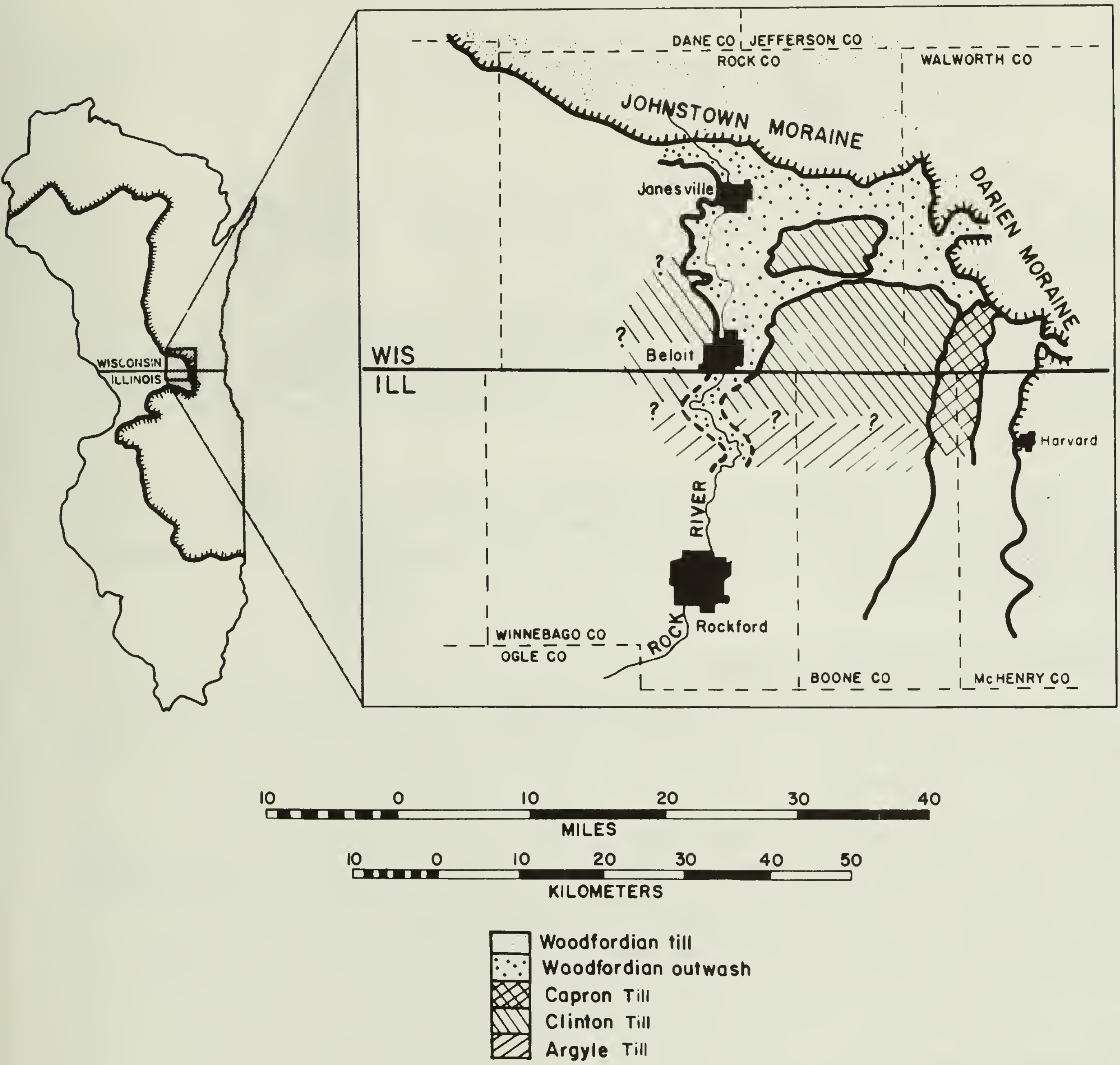


Figure 2-1 Map showing Pleistocene stratigraphic units in south-central Wisconsin (from Fricke and Johnson, 1983).

is shown in figure 2-1. He concluded that the surficial till (which Bleuer (1971) had interpreted as Argyle) was distinctly different from the Argyle Till in Illinois: the unit in Wisconsin was sandier and browner and had been deposited by ice flowing from the east rather than the north. Fricke informally named this unit the Clinton till and designated a type section about 5 km northeast of Turtle Town.

Beneath the Clinton till lies a unit that Fricke correlated with the Argyle Till Member of Illinois; he informally named it the Allen's Grove till. This unit is redder and not as sandy as the Clinton till. Fricke interpreted the Allen's Grove and the Clinton as Altonian, although he did not eliminate the possibility that they might be pre-Wisconsinan because of well developed soils at several locations.

Beneath the two tills, Fricke recognized a siltier till that he informally named the Foxhollow till. He designated a type section 3.2 km southeast of Turtle Town. Fricke concluded that this unit was Illinoian, but did not correlate it to a unit in Illinois.

Fricke also noted several soil-geomorphic relationships. He observed a thick, red (5YR), B horizon of a paleosol that was present on stable uplands, but not on slopes. He concluded that the landscape was relatively old and had undergone a period of erosion, during which the thick B horizon was stripped from the slopes.

Pleistocene lithostratigraphic units of Wisconsin were formally defined by Mickelson et al. (1984). At that time the till units proposed by Fricke (1976) were designated as the Foxhollow, Allen's Grove, and Clinton Members of the Walworth Formation.

THE TURTLE TOWN QUARRY EXPOSURE

Although the Turtle Town exposure (fig. 2-2) is much larger than it was when Bleuer described it in 1968, the units now exposed are not significantly different. In places the section has a thin cover of fill from quarry operations, but it is generally well exposed. A thin (0.3 m) layer of Wisconsinan loess grades downward into 0.8 to 1 m of pedisediment on a stone line that is several centimeters thick (fig. 2-2). Beneath the pedisediment lies about 8.3 m of Clinton till. A complex zone of sediment about 1 m thick occurs within the Clinton till about 1.3 m below the contact with the pedisediment. A siltier till that may be the Foxhollow till is exposed in a karst filling at the base of the section.

Wisconsinan Loess

A thin layer of loess mantles the exposure at Turtle Town Quarry, but has been stripped in many places, presumably by quarry operations. Although loess is typically about 0.3 m thick in this region (Bleuer, 1971), we did not recognize loess in either of the textural logs (figs. 2-3, 2-4).

Pedisediment and Stone Line

Beneath the loess is a loamy slope sediment deposited over a weak stone line. Ruhe (1959) interpreted stone lines as erosional lags that formed after a period of stripping. The erosion was interpreted as a time-transgressive process in which the hillslope retreats, leaving the stone line lag deposit that armors the slope at its base. As the slope continues to retreat,

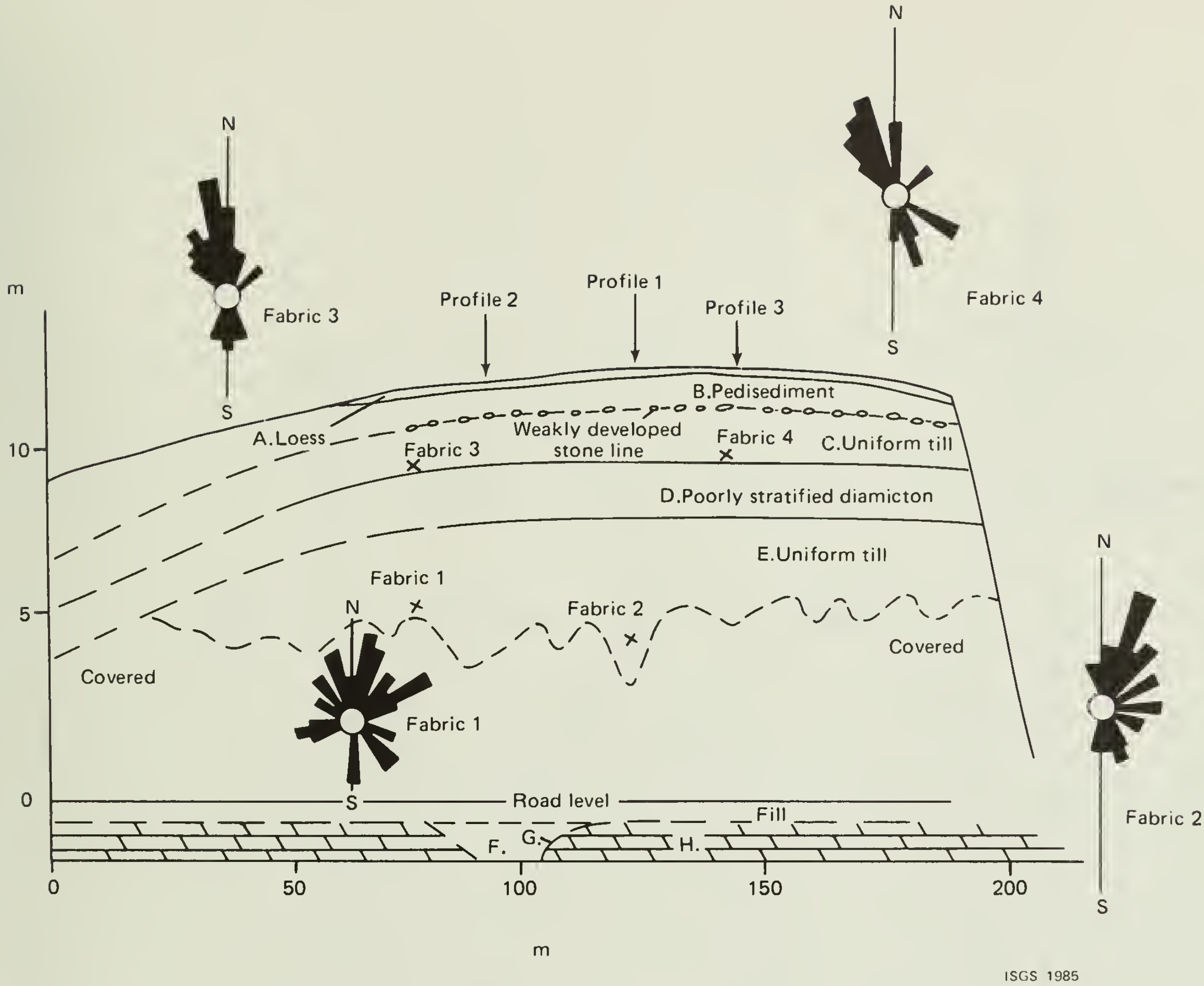


Figure 2-2 Diagrammatic sketch of the Turtle Town Quarry section showing geologic units, fabrics, and sampling profile locations. Section is oriented east (right) to west (left), and scale is in meters. Fabrics measured on 30 pebbles with long-to-intermediate axis ratios of more than 1.5:1. Units from top to bottom: A. Loess up to 0.5 m thick. B. Pebbly, sandy, silty diamicton that is interpreted to be pedisediment derived from underlying till and loess. Poorly developed stone line underlies unit in places and is presumably an erosional lag on the underlying till. C. Uniform, gravelly sandy till of the Clinton Member of the Walworth Formation. D. Poorly stratified, poorly sorted diamicton of the Clinton Member of the Walworth Formation, including lenses and thin beds of sand and gravel. (Unit may be ice-marginal deposit indicating fluctuating ice margin, or may be subglacial). E. Uniform gravelly sandy till of the Clinton Member of the Walworth Formation. F. Gravelly sandy silty Foxhollow till (Fricke, 1976). G. Reddish, clayey diamicton interpreted to be weathering product from the surface of the dolomite. H. Dolomite of the Sinnipee Group (Ordovician).

sediment is deposited over the stone line. The sediment deposited on an erosional surface or pediment is called pedisediment. At this exposure the pedisediment is loamy; however, the material is sandier at its base and fines upward. The sand is evidently derived from the underlying till: at the Turtle Town Quarry exposure, the sand content of samples taken directly above and below the stone line is almost identical. The high silt content in the upper portion of the pedisediment might have resulted from the incorporation of loess into the pedisediment. However, pedisediment formation and loess deposition may not have been contemporaneous.

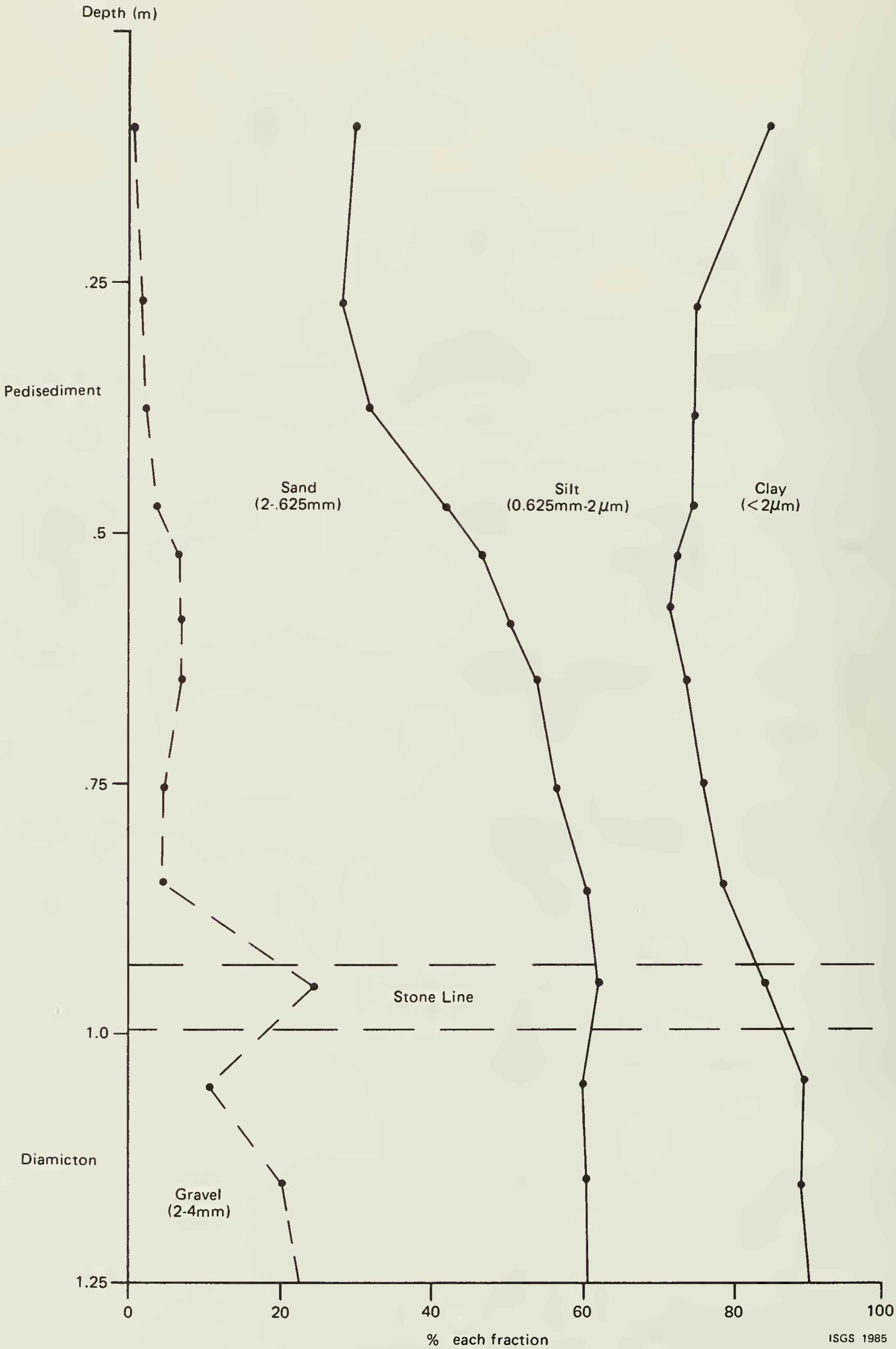


Figure 2-3 Gravel, sand, silt, and clay expressed as percentages of the <4-mm fraction from the top of Profile 1.

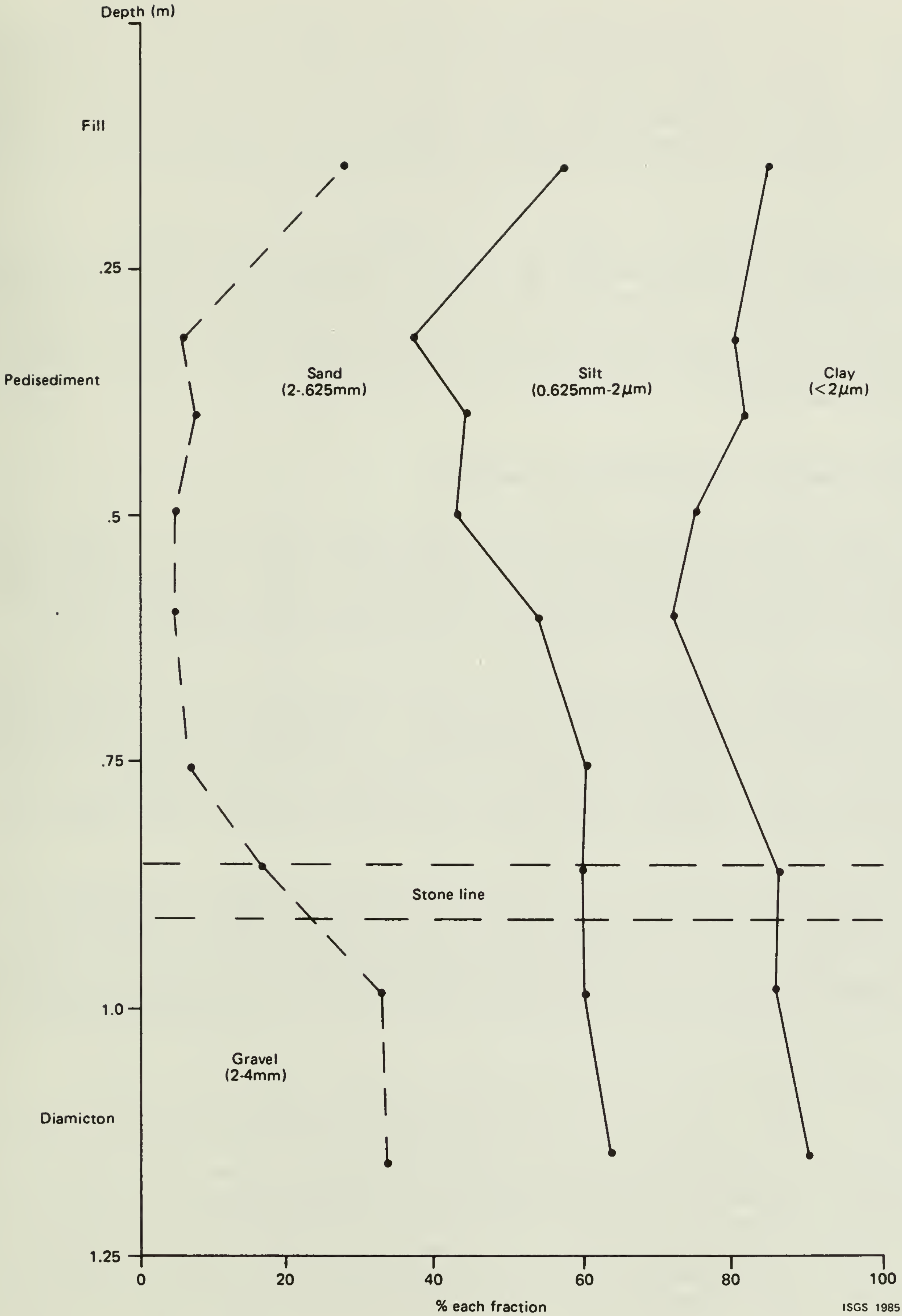


Figure 2-4 Gravel, sand, silt, and clay expressed as percentages of the <4-mm fraction from the top of Profile 3.

The stone line at the Turtle Town Quarry exposure is recognizable in the textural logs as a zone containing more gravel than other parts of the profile (figs. 2-3, 2-4). Although this stone line is weakly expressed, its presence becomes apparent after scraping the outcrop with a shovel. The weak development of the stone line, slight dissection of the landscape, and the preservation of a paleosol on uplands suggest that stripping of the landscape was not great. More erosion would have resulted in a prominent erosional lag.

The modern soil at Turtle Town Quarry extends through the loess into the pedisediment. Although we did not observe a paleosolic B, a well developed argillic horizon of the modern soil is present. The modern profile is leached to a depth of about 1.2 m. The actual depth of leaching is difficult to measure because quarry operations have disturbed the top of the soil profile and because the matrix is often leached deeper than larger clasts in sandy, gravelly material.

Clinton Member of the Walworth Formation

The Clinton till is a light yellowish brown (10YR 6/4), uniform, gravelly and sandy loam that generally contains about 60 percent illite, although some samples contain less (about 45%) (Fricke, 1976). Small inclusions of pink diamicton are common in the Clinton till at Turtle Town Quarry. Fricke interpreted these as inclusions of the underlying Allen's Grove till.

We measured the orientation of long axes of pebbles in the upper unit of the Clinton till at two places (fig. 2-2). The fabrics (fig. 2-2, fabrics 3, 4) indicated flow from the north-northwest, in contrast to the northeast flow indicated by the landscape lineations and Bleuer's (1971) fabrics. Although all fabrics are downslope (possibly as a result of a post-depositional mechanism), the strength of the fabric and the uniformity of the diamicton suggest that this material is basal till.

Within the Clinton till is a zone of complex sediment consisting of poorly stratified diamicton that contains massive to poorly bedded and contorted sand and silt, pebbly sand, pink diamicton that we interpreted as Allen's Grove till, and some highly weathered material that may be inclusions of paleosol. This unit may have been deposited in an ice-marginal environment or it may have been moved en masse to this location by basal transport.

Uniform Clinton till is also present beneath the zone of complex sediment. This till is fissile and contains some sandy inclusions; it is similar in grain size and clay-mineral composition to the upper till unit (figs. 2-5, 2-6). The pebble fabrics we measured in this lower unit are shown in figure 2-2. Fabric 2 is strong and indicates flow from the north-northeast; fabric 1 is weak and indicates flow generally from the north or northeast. Fabric 2 is similar to a fabric Bleuer (1971) measured; both indicate flow from the northeast. The weakness of fabric 1 may be due to the effects of frost heave and other surficial processes on pebble orientation. The well developed fabric within this uniform unit suggests that this material is basal till.

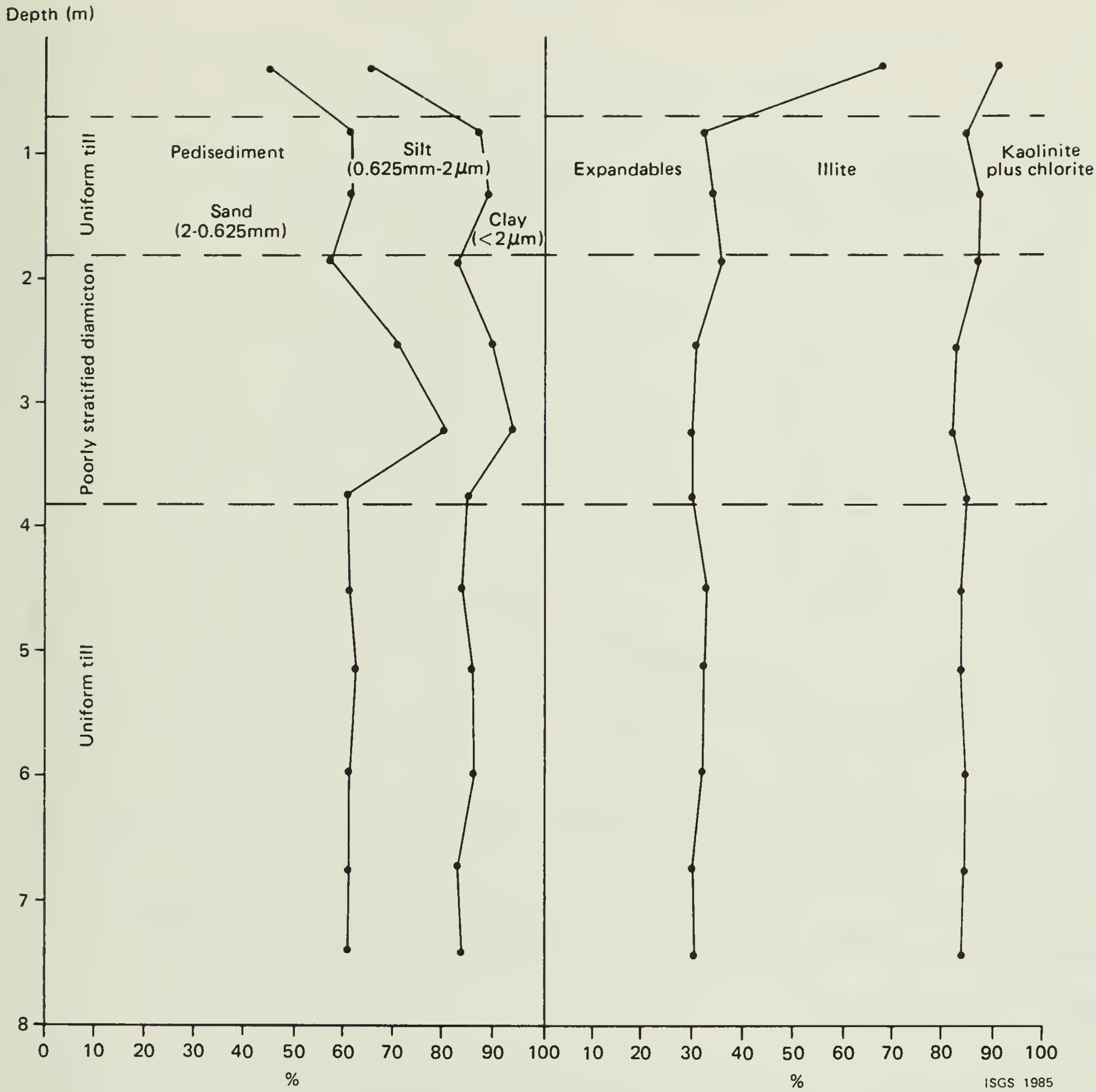


Figure 2-5 Grain-size distribution and clay-mineral composition for Profile 1. Grain-size percentages based on <2-mm fraction.

Foxhollow Member of the Walworth Formation

Within a karst depression in the bedrock surface (fig. 2-2) is till containing more silt than the overlying Clinton till. The section is poorly exposed and the original thickness of the unit is unclear because road construction destroyed the upper contact. One sample of the till contained 39 percent sand, 43 percent silt, and 18 percent clay in the less-than-2-mm fraction. This grain-size distribution is similar to the mean for the Foxhollow till (44% sand, 37% silt, 19% clay) (Fricke, 1976). This unit may correlate with the Foxhollow till in other areas.

Figure 2-6 Grain-size distribution and clay-mineral composition for Profile 2. Percentages based on <2-mm fraction.

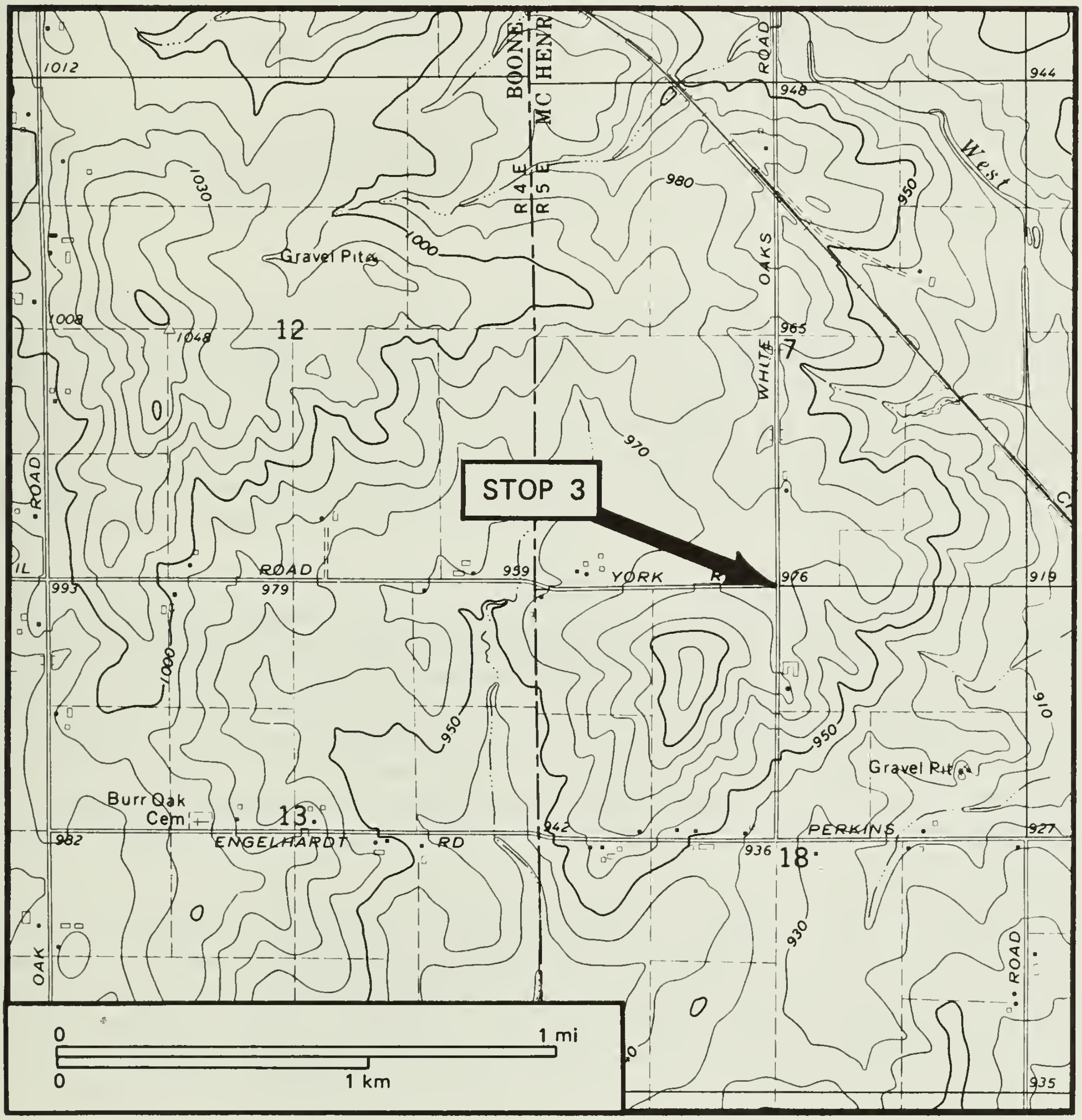
SUMMARY AND CONCLUSIONS

Three till units are now recognized in south-central Wisconsin. The silty Foxhollow till, presumably present at the base of the Turtle Town Quarry section, is pre-Wisconsinan. Above the Foxhollow is the sandy Allen's Grove till, equivalent to the Argyle Till Member of northern Illinois; the Allen's Grove and the Argyle are pre-Wisconsinan. This unit is absent in the Turtle Town Quarry exposure, except as possible inclusions in the stratigraphically higher clinton till.

The Clinton is the prevalent surficial unit in south-central Wisconsin. This till and other diamicton units of the Clinton Member of the Walworth Formation compose most of the exposure at the Turtle Town Quarry. The Clinton extends a few kilometers into Illinois and was probably deposited by southwestward-moving ice. The meaning of the varying illite content in samples is unclear; however, studies by Krumm and Berg (Stop 3) suggest that a portion of the Clinton may be a facies of or interbedded with the Capron Till to the east. Evidence supporting this interpretation has not been discovered in Wisconsin.

Stratigraphic Relationships of the Capron Till Member of the Winnebago Formation

Robert J. Krumm and Richard C. Berg



STOP 3
Capron Ridge
SE SE SW Sec. 7, T 46 N, R 5 E, McHenry County

At this site we will observe and discuss borings of the Capron Till taken from Capron Ridge. From this stop we can view the Wisconsinan-aged Marengo Ridge. This vantage point is critical to our discussion of the age of the Capron.

INTRODUCTION

The Capron Till Member of the Winnebago Formation was described and named as an informal stratigraphic unit by Frye et al. (1969) from its occurrence in the prominent ridge that trends north-south through the town of Capron in Boone County. In 1970, Willman and Frye formally named the unit. The type section, the Capron North Section (NE SE SE Sec. 23, T 46 N, R 4 E), consists of 0.3 m of leached diamicton over 0.6 m of pink calcareous diamicton and 1.1 m of calcareous sand.

As defined by Willman and Frye (1970), the Capron overlies the Plano Silt Member of the Winnebago Formation and is overlain by the Robein Silt. The Capron Till Member was designated as being within the youngest part of the Altonian Substage of the Wisconsinan Stage.

Frye et al. (1969) described the Capron as pinkish gray to reddish brown, moderately compact and blocky, and containing some cobbles and pebbles. They also characterized it as having two distinct textural compositions: an upper sandy facies and a lower silty facies. The representative grain-size compositions (sand-silt-clay) reported were 43-33-24 for the upper sandy facies and 25-43-32 for the lower silty facies (Frye et al., 1969; Willman and Frye, 1970). The clay-mineral compositions (expandables-illite-kaolinite plus chlorite) reported by Frye et al. (1969) were 37-50-13 (upper sandy) and 29-58-13 (lower silty).

Recent studies (Berg, Kempton and Stecyk, 1984; Kempton and Berg: Stop 5) indicate that many diamictons in northern Illinois are similar in color and texture; some are similar in clay-mineral composition. These studies suggest that the stratigraphic relationships of some units be revised. Within the Winnebago Formation, the Argyle and Nimtz Till Members are now considered Illinoian rather than Altonian (Kempton, Berg, and Follmer, this report; Berg and Kempton: Stop 5). Revising the stratigraphic interpretations has directed attention to how the Capron Till Member relates to the newly defined Quaternary sequence.

The purpose of this paper is to revise the concept and regional distribution of the Capron Till Member. This revision is largely based on the results of a detailed sampling program; we will present data from seven holes drilled on and close to Capron Ridge. Also, we will present data concerning the relationship of the Capron Till Member to the Clinton Member of Wisconsin, as well as information concerning the time-stratigraphic placement of the Capron.

Although the Capron was given member status by Willman and Frye (1970), the unit was characterized on the basis of relatively few samples. Although no specific number of samples was reported by Frye et al. (1969) or Willman and Frye (1970), a review of Capron samples on file at the Illinois State Geological Survey suggests that 11 samples were tested for grain size and 4 samples were tested for clay-mineral composition. To better characterize the grain size and clay-mineral composition of the Capron, we collected many samples. The drilling program also enabled us to further investigate the stratigraphic relationships of the Capron to other units.

METHODS

Ten holes were drilled (fig. 3-1): four holes on Capron Ridge and six in nearby areas. Samples were taken with a split-spoon sampler (0.6 m long x 5.1 cm O.D.) driven through hollow-stem augers. The cores were wrapped in the field and returned to the laboratory for description as well as grain-size and clay-mineral analysis. The hydrometer technique (ASTM D-422) was used for grain-size analysis (sand 0.062 to 2.0 mm, silt 0.004 to 0.062 mm, clay < 0.004 mm). The clay-mineral composition was determined using the X-ray diffraction procedure of Glass described in Hallberg, Lucas, and Goodmen (1978). Calcite and dolomite compositions reported in this study are based on X-ray diffraction counts per second.

RESULTS

The Capron Till Member diamicton sampled in this study was generally silty loam to sandy loam in texture, fairly massive, and highly calcareous. It was usually brown (7.5YR 5/4); however, it ranged from light brown (7.5YR 6/4) to yellowish brown (9YR 5/4). The Capron generally has a pinkish or reddish cast, and previous workers have described the Capron as red, pink, pinkish brown, and pinkish gray (Kempton and Hackett, 1968b; Frye et al., 1969; Willman and Frye, 1970; Fricke, 1976).

Forty-two Capron samples from the four borings (CP-1, CP-3, CP-4, CP-8) drilled on Capron Ridge were analyzed for grain size and clay-mineral composition (table 3-1). The high variability in the texture of the Capron was immediately apparent. Vertical variability in texture is shown on figure 3-2, which is a plot of data for boring CP-3. Although the sand fraction averaged 41 percent for the boring (20 samples), the range was 27 to 57 percent.

Lateral variability in texture is indicated by a comparison of grain size data from borings CP-1 and CP-4 (figs. 3-3, 3-4). For CP-1, the average grain size is 49-29-22 (6 samples); for CP-4, it is 27-33-40 (11 samples). The samples from these borings are similar in color and clay-mineral composition to samples from the other Capron Ridge borings. Samples from these two borings (CP-1, CP-4), however, represent the highest average sand content (49% for CP-1) and the highest average clay content (40% for CP-4) for any Capron diamicton analyzed for this study. The average grain size from the other Capron Ridge boring (CP-8) is 34-35-31, which is intermediate between the textures for CP-1 and CP-4.

These textural data do not indicate an upper sandy and a lower silty facies in the Capron. This concept, proposed by Frye et al. (1969) and Willman and Frye (1970), was based on limited sampling of the Capron Till Member. Although the grain-size distribution for boring CP-3 (41-33-26) is nearly the same as that of the upper sandy facies of Willman and Frye (43-33-24), the relationship of sandy diamicton overlying silty diamicton was not observed in any Capron Ridge boring.

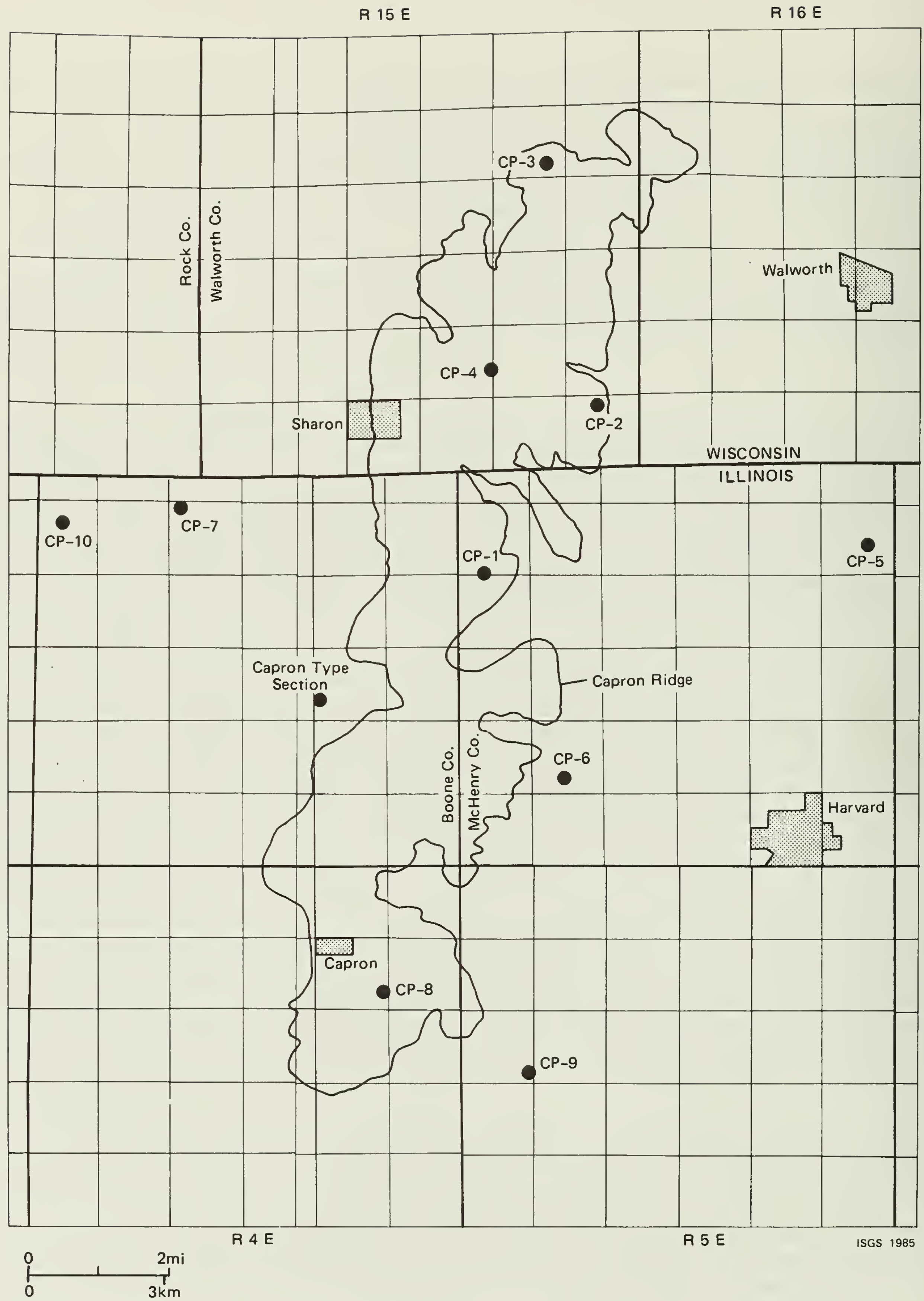


Figure 3-1 Location map of borings on and adjacent to Capron Ridge.

Table 3-1 Average grain-size distributions and clay-mineral compositions for borings.

		Sand		Silt		Clay		Expandables		Illite		Kaolinite & Chlorite		N
		$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	
Capron Samples	CP-1	49	5	29	2	22	4	45	2	47	2	8	1	6
Capron Samples	CP-3	41	9	33	5	26	6	39	9	52	3	9	1	20
Capron Samples	CP-4	27	9	33	2	40	9	41	8	53	6	6	1	11
Capron Samples	CP-8	34	1	35	2	31	2	36	2	55	1	9	1	5
Capron Samples	CP-7	60	2	26	1	14	1	34	3	56	3	10	1	4
Average from Capron Ridge borings		38	11	33	4	29	9	40	5	52	2	8	1	42
Argyle	CP-2	67	1	25	1	8	1	34	4	59	5	7	1	4
Tiskilwa	CP-5	40	3	33	4	27	3	28	3	64	3	8	2	17
Oregon	CP-9	58	4	25	1	17	3	43	2	49	3	8	1	7

The average clay-mineral composition for the Capron (42 samples from the four Capron Ridge borings) is 40-52-8 (table 1). This is equivalent to the clay-mineral composition of the upper sandy facies (37-50-13) of Willman and Frye (1970). In the four Capron Ridge borings, the average percentage of illite ranges from 47 percent (boring CP-1) to 55 percent (boring CP-8). The overall percentage of illite for 42 samples ranges from 42 percent (1 sample from CP-4) to 61 percent (1 sample from CP-4). The average percentage of illite in the Capron sampled for this study is less than that reported by Fricke and Johnson (1983) for the Capron in southern Wisconsin (61% illite); however, their determination was based on five samples (Fricke and Johnson, 1983).

Weathered Zones Below the Capron

Two of the four borings (CP-1 and CP-8) drilled on Capron Ridge penetrated the entire thickness of the Capron Till Member. In both borings, weathered horizons were encountered in materials immediately below the Capron.

In boring CP-1, a weathered zone was found in the top of a sandy loam diamicton at a depth of 5.0 m (fig. 3-3). This sandy loam unit (grain size 57-38-5) beneath the Capron has been correlated to the Argyle Till Member. No strong evidence of a paleosol was observed, however, the occurrence of this weathered zone is supported by analytical data that show a sharp drop of carbonate minerals (particularly calcite) at 5.0 m. The data also indicate a change in clay-mineral composition: illite decreases from 50 to 33 percent and the expandables increase from 42 to 60 percent.

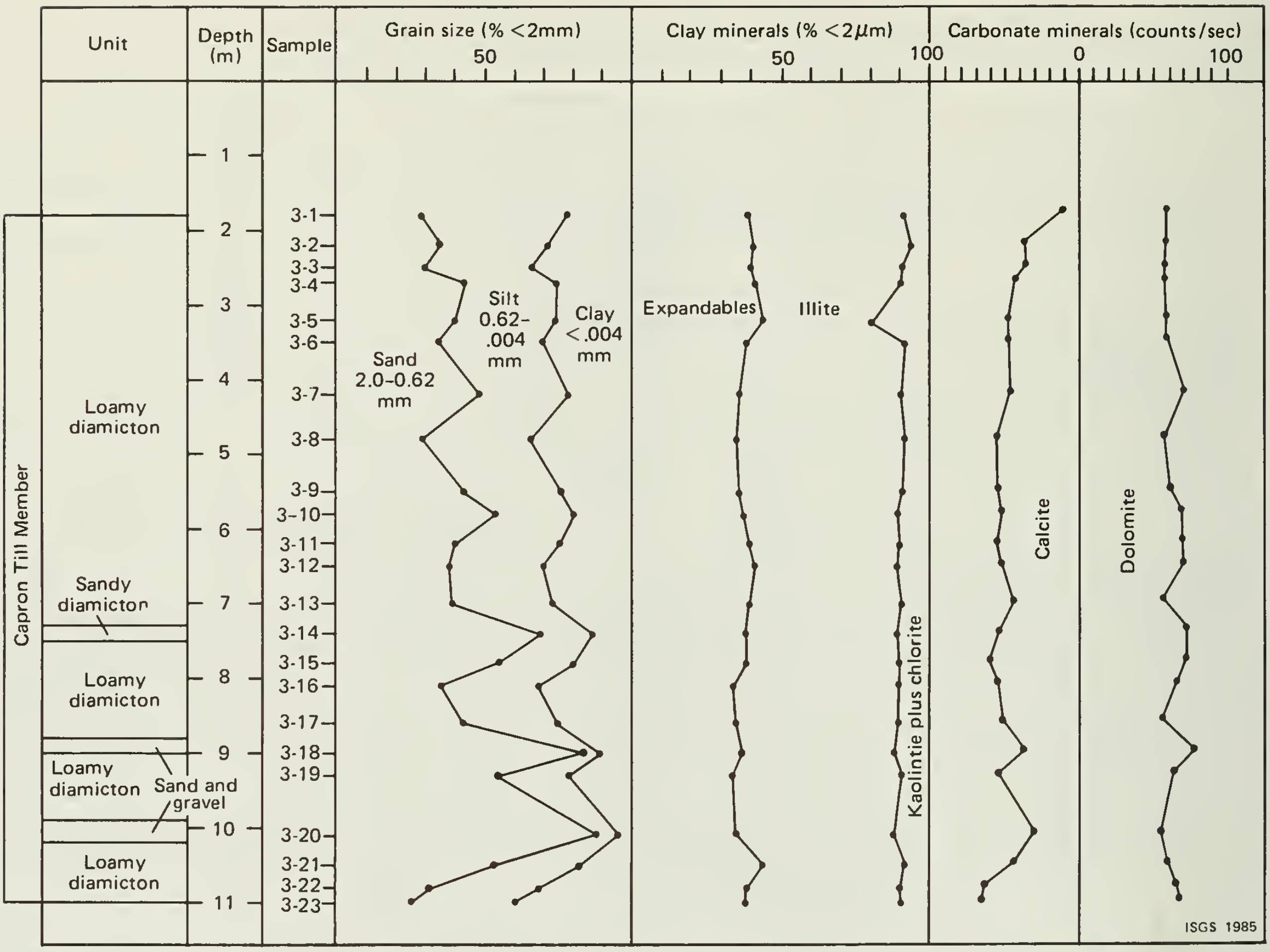


Figure 3-2 Grain-size distribution, clay-mineral composition, and carbonate data for Boring CP-3.

In boring CP-8, a weathered zone was encountered at a depth of 4.3 m at the top of a 0.4-m-thick silt deposit directly beneath the Capron Till Member. A C1g soil horizon has developed in this silt; it had brown and gray clay skins (10YR 3/3), and appeared gleyed, bleached and deoxidized. This weathered zone is also characterized by a partial leaching of carbonates (fig 3-5). The underlying diamicton, the Oregon Till Member of the Glasford Formation, was also partially leached in its upper part; and iron staining suggested a C2 soil horizon, which would be pedogenically compatible with an overlying C1g horizon in the silt (Follmer, personal communication, 1985).

DISCUSSION

Clinton-Capron Relationship

The Clinton Member of the Walworth Formation was formally named by Fricke and Johnson (1983) for the surficial diamicton which occurs on all the uplands west of Capron Ridge in southern Wisconsin and part of northern Illinois (Canfield and Mickelson: Stop 2). The Clinton till has been described as a light yellowish brown (10YR 6/4), sandy, pebbly diamicton. Fricke and Johnson (1983) reported average grain size and clay-mineral compositions

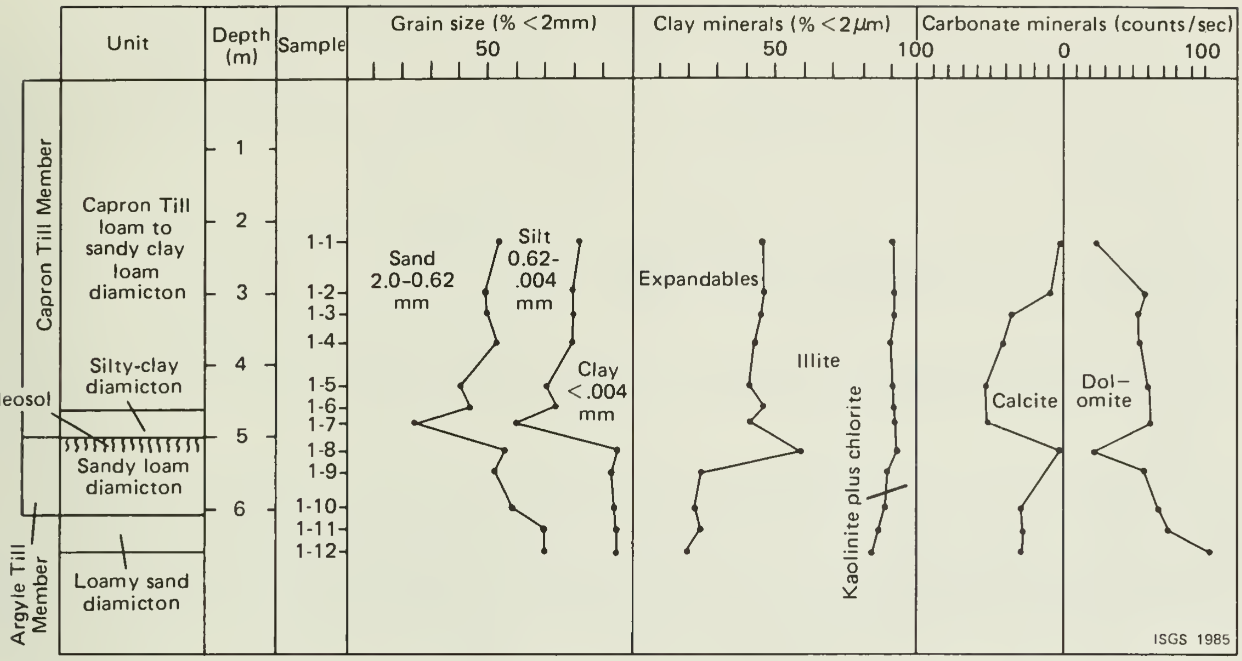


Figure 3-3 Grain-size distribution, clay-mineral composition, and carbonate data for Boring CP-1.

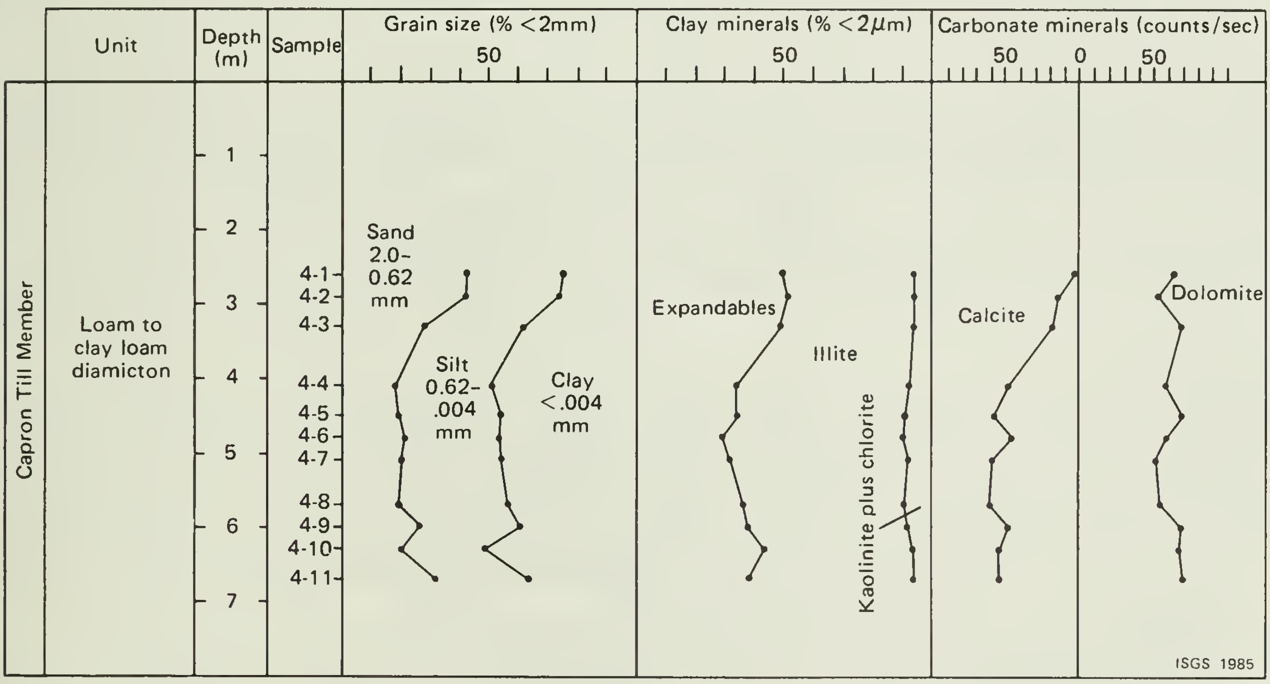


Figure 3-4 Grain-size distribution, clay-mineral composition, and carbonate data for Boring CP-4.

as 61-27-12 and 26-60-14 (n=85). Fricke and Johnson (1983) defined the Clinton Member in Illinois as part of the Winnebago Formation based on its stratigraphic position below the Capron Till Member and above the Argyle Till Member. At its type section (NE NE SW Sec. 3, T 1 N, R 14 E) near Clinton, Wisconsin, a highly weathered, sandy paleosol was observed in the upper part of the unit (Fricke, 1976).

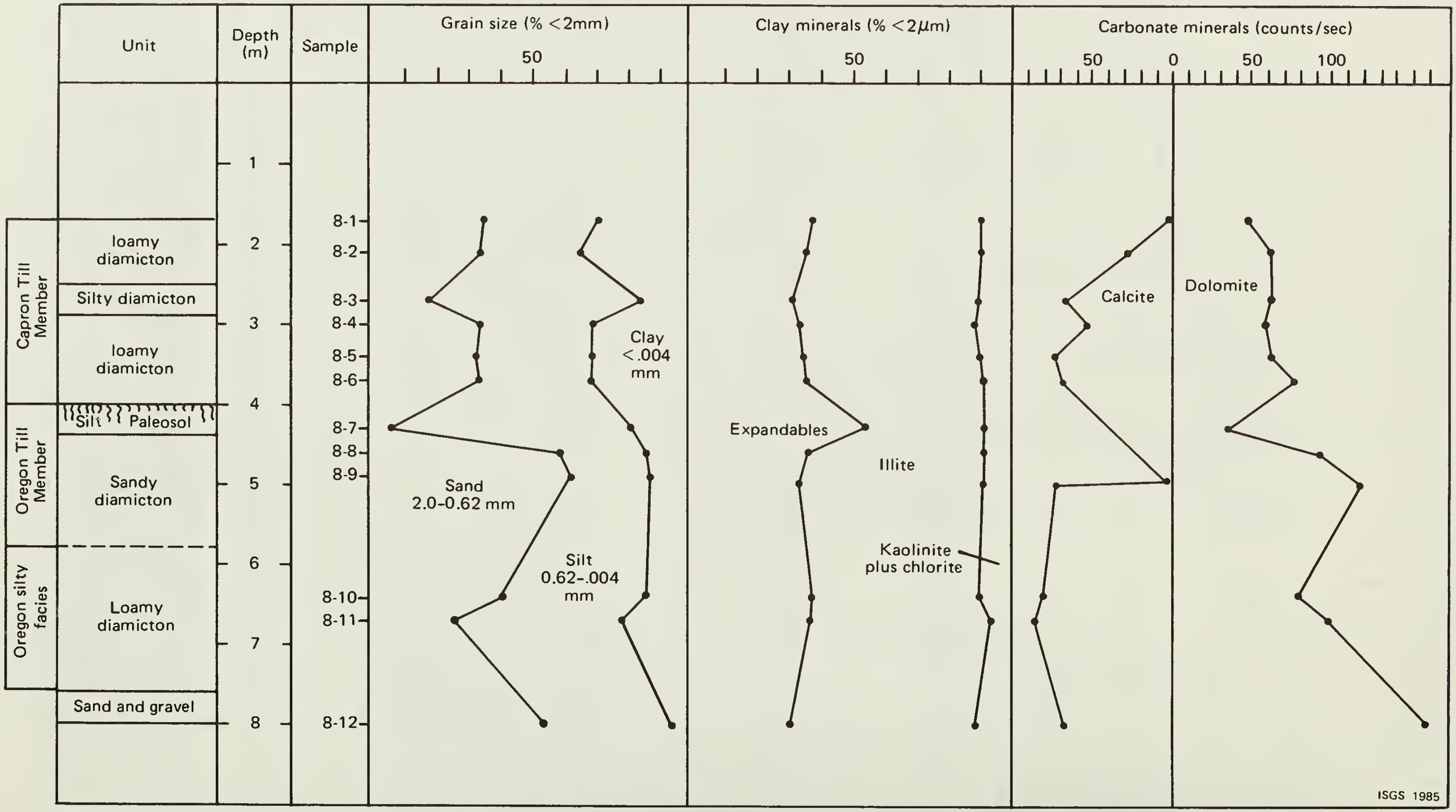


Figure 3-5 Grain-size distribution, clay-mineral composition, and carbonate data for Boring CP-8.

Several questions concerning the stratigraphic position of the Capron and the Clinton have arisen as a result of this study and the studies of Fricke (1976) and Fricke and Johnson (1983). It is suggested here that the Capron and at least a portion of the Clinton may be genetically related based on

1) the textural variability of the Capron Till and textural overlap between the Capron and the Clinton;
2) the percentage of illite in the clay-mineral composition of the Capron, which is similar to the percentage of illite for part of what Fricke (1976) classified as Clinton;
3) the color of the Capron Till, which is similar to part of the Clinton till.

Our data indicate that the grain-size distribution of the Capron on Capron Ridge is highly variable; the range in the averages of percent sand in the four borings is 27 to 49 percent (table 1). Because textural variability appears characteristic of Capron diamicton, the Capron cannot be differentiated from other units in the area solely on the basis of average grain size (fig. 3-6).

The Clinton Member has been described as sandier (61% sand) than the Capron (Fricke and Johnson, 1983). Although silty Capron has not been identified west of the type section, samples of sandy Capron collected for this study on the Capron Ridge and to the west of it are texturally similar to samples interpreted as Clinton by Fricke (1976) in other locations.

The Clinton has also been characterized as having a larger percentage of illite than the Capron: 60 percent for the Clinton (Fricke and Johnson, 1983) and 52 percent for the Capron. Fricke (1976) noted two distinct clay-mineral compositions for the Clinton Member: one of 26-60-14 and another he referred to as 'a less common clay mineral type' of 45-45-10. He also stated that it is not uncommon for the clay-mineral composition of a till unit to vary, and that the Clinton differences could not be explained on the basis of data available at that time.

Our review of data published by Fricke (1976) for the Clinton till also suggests bimodal distribution of clay-mineral data with two distinct groups based on illite composition: less than or equal to 56 percent illite, and greater than or equal to 58 percent illite. Of the 36 samples identified by Fricke as Clinton till, 15 samples ranged between 42 and 56 percent and 21 samples ranged between 58 and 68 percent.

The average Capron clay-mineral composition is 40-52-8; whereas the Clinton containing less illite averages 40-49-11. This suggests that the low-illite Clinton is similar to the Capron. This overlap is diagrammed in figure 3-6 (Kempton, Berg, and Follmer: this report). The high-illite Clinton may correlate to the Argyle Till Member in Illinois. The average Argyle clay-mineral composition is 24-61-15 (n=174, Kempton, Berg, and Follmer, this report); whereas that for the high-illite Clinton is 24-62-14.

The type section for the Capron Till Member, the Capron North Section (Willman and Frye, 1970), is located west of Capron Ridge proper. Evidence from a boring west of Capron Ridge (CP-7) suggests that the Capron may

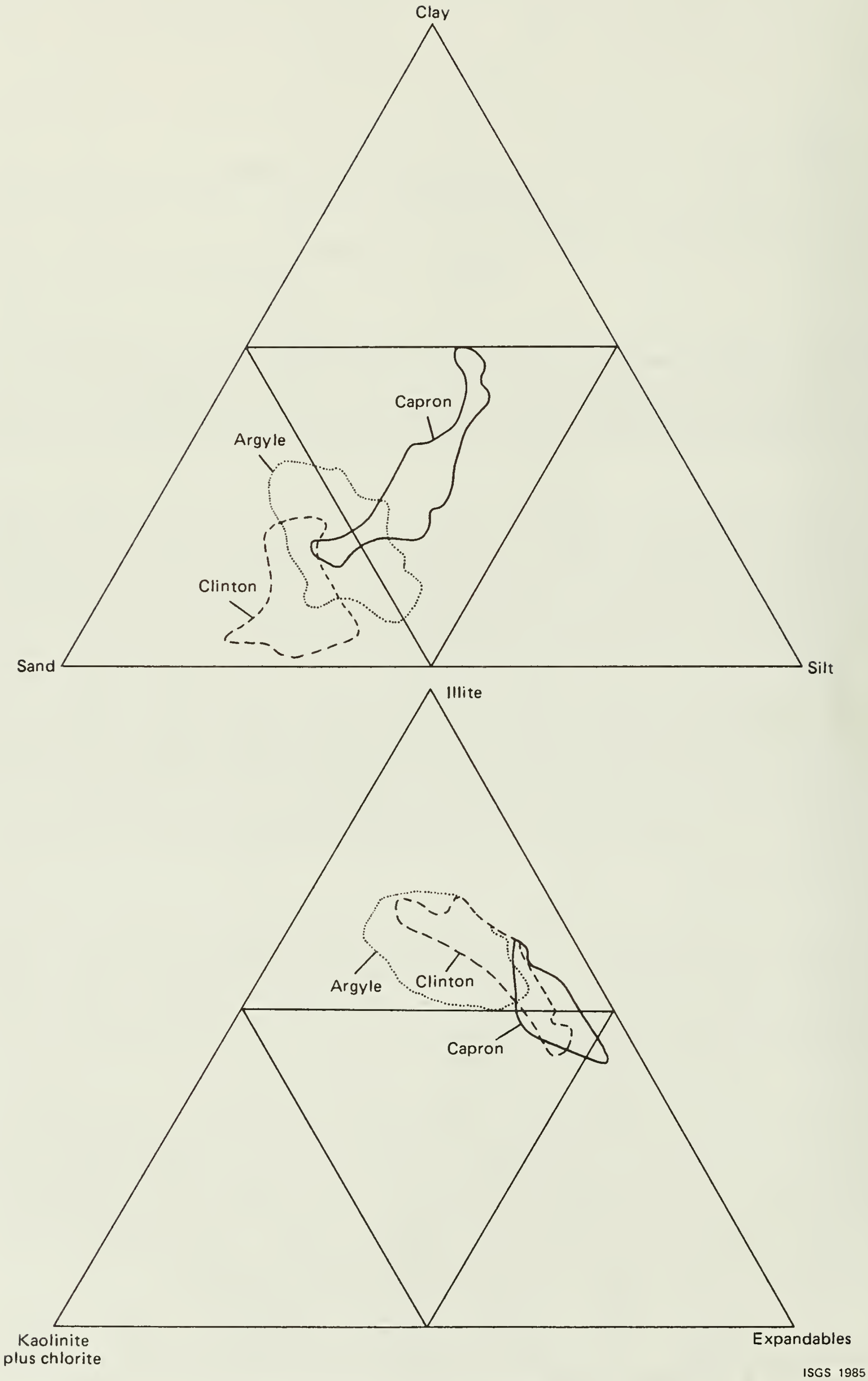


Figure 3-6 Grain-size distribution and clay-mineral composition for the Capron, Clinton, and Argyle Tills.

extend westward. At the CP-7 drill site, located on a topographic high 4.5 km west of Capron Ridge, approximately 4.0 m of a brown (7.5YR 5/4) diamicton resembling the Capron Till Member was penetrated. The texture was sandier, however, than the diamicton from the four Capron Ridge borings: a sandy loam averaging 60-26-14 (n=4). The clay-mineral composition for the samples averages 34-56-10, which is very similar to that observed for the Capron in boring CP-8 (36-55-9). This similarity suggests that the Capron diamicton was deposited west of the ridge. Erosion may have removed much of the unit west of the ridge leaving outliers that occur as caps on the topographic highs.

The distribution of the Capron and Clinton is shown on figure 3-7. The low-illite Clinton (illite <56%) occupies a specific geographic area extending westward from Capron Ridge, suggesting a possible relationship with the Capron. Several samples of high-illite Clinton (illite >58%) have been collected from the same area where low-illite Clinton is distributed; extensive erosion may be responsible for these occurrences. The low-illite Clinton (which may correlate with the Capron) overlies the high-illite Clinton as indicated in boring CP-7.

South of the area of low-illite Clinton, the surficial unit correlates to the Argyle Till Member of the Winnebago Formation, in terms of both texture and clay-mineral composition. Topography in this area exhibits strong northeast-southwest lineations; whereas in the low-illite Clinton area to the north, the topography trends more to the east and west.

Color may be used to differentiate the Capron from the Clinton. The Capron usually has a pinkish or reddish cast (brown, 7.5YR 5/4) and the Clinton is usually yellowish brown (10YR 6/4); however, several Clinton samples have been described as being reddish or pinkish (Fricke, 1976).

Texture, clay-mineral composition, and color similarities all indicate that part of the Clinton may correlate to the Capron and/or the Argyle Till Members; however, the stratigraphic relationships of these units remain unresolved.

Areal Extent Of The Capron

Previous workers (Kempton and Hackett, 1968b; Frye et al., 1969; Willman and Frye, 1970) suggested that the Capron extended from Capron Ridge to areas well south of Piscasaw Creek and the Kishwaukee River. On the map, Quaternary Deposits of Illinois (Lineback, 1979), the unit extends from the Wisconsin-Illinois state line to southern Boone, southwestern McHenry, and northern De Kalb Counties.

The glacial deposits south of Piscasaw Creek have recently been correlated to Glasford Formation (Illinoian) units (the Creston and Fairdale Till Members, Kempton and Berg: Stop 9), thus limiting the distribution of the Capron to areas north of Piscasaw Creek. In light of the results from boring CP-7 (west of Capron Ridge), it is suggested that the distribution of the unit is not limited to the Capron Ridge but extends to areas west of the ridge.

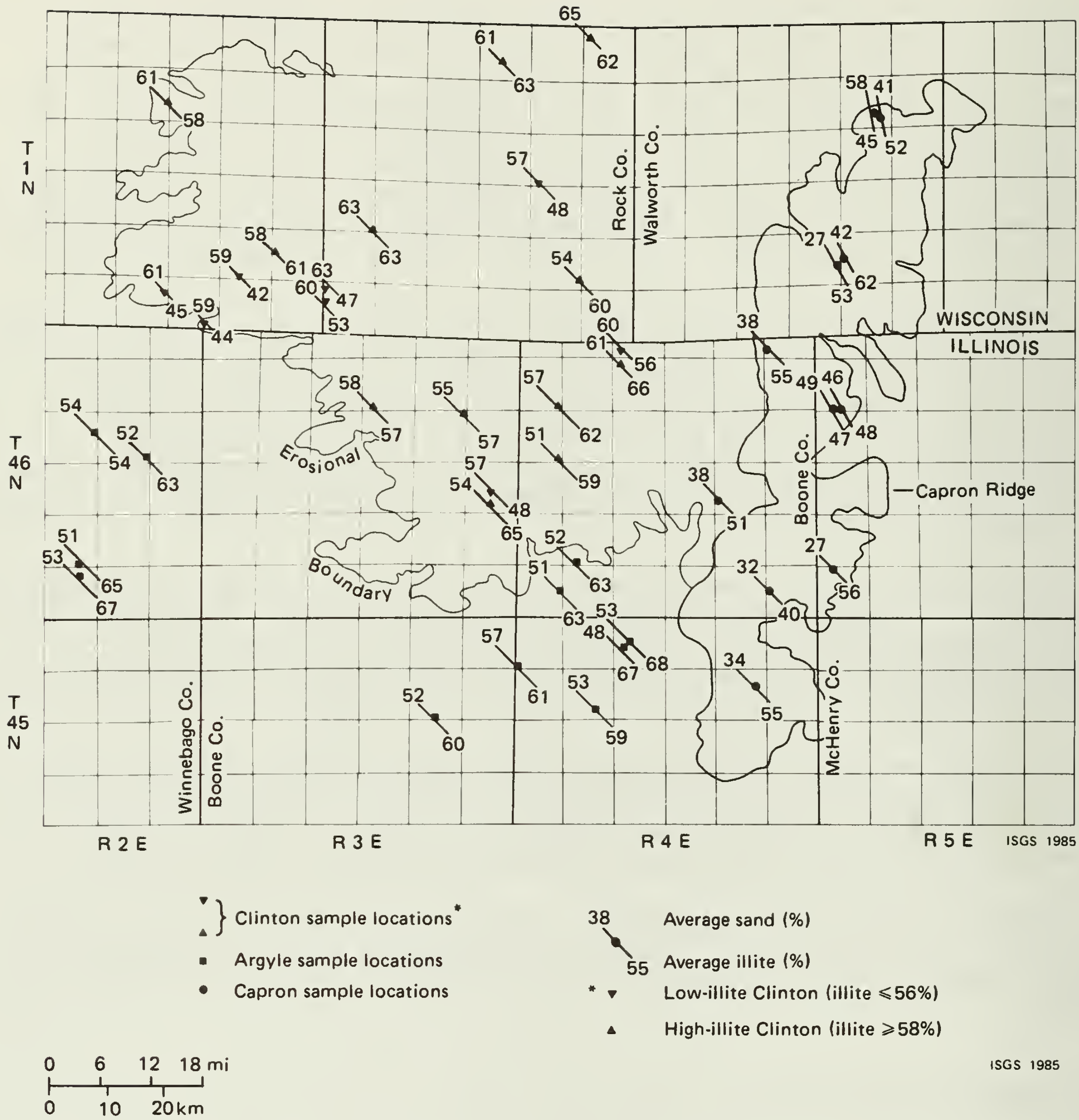


Figure 3-7 Distribution of average grain-sizes and clay-mineral compositions for till members in state line area; central-northern Illinois and central-southern Wisconsin.

Time-Stratigraphic Placement of the Capron Member

Willman and Frye (1970) suggested that the Capron Till Member was the youngest Altonian deposit in northern Illinois. This was based, in part, on the de-scription of a Farmdale Soil developed in the Capron at the Capron North Section (Frye et al., 1969). Radiocarbon dates for the Capron of older than 27,000 years BP and younger than 35,000 years BP were reported by Frye et al. (1969). Previous dates for the Capron are not valid because these dates were from materials that are not related to the Capron as it is now defined. There has been no dating of either the Capron or materials directly above or below the Capron.

According to the evidence presented here, it is possible that the Capron is either Altonian or Woodfordian.

• Evidence Favoring an Altonian or Woodfordian Age

Primary evidence supporting an Altonian or Woodfordian age for the Capron consists of paleosol formation beneath the Capron. Secondary evidence consists of widespread erosion west of Capron Ridge associated with either Altonian or Woodfordian deglaciation.

The presence of weathered horizons beneath the Capron and above Illinoian diamictons supports an Altonian or Woodfordian age for the Capron--if the underlying soil is the Sangamon Soil. Conversely, this soil could be the Farmdale Soil if the Capron were deposited during the early Woodfordian. The truncated paleosol, which occurs between the Capron and the Oregon (boring CP-8), indicates substantial erosion after deposition of the silt.

Although weak paleosols have been described (Willman and Frye, 1970) and mapped (Grantham, 1980) on the surface of the Capron, it is not possible to separate modern soils from remnants of paleosols. Slightly clay-rich horizons may be partly derived from the Farmdale, but are most likely modern. Surface soil information merely suggests an age younger than Illinoian.

Erosion by meltwater from an ice margin at the Capron Ridge during Woodfordian or Altonian time could have produced the fluted topography and eroded landscape in northern Boone and eastern Winnebago Counties. An ice margin at Capron Ridge would also explain the origin of Beaver Creek and surficial ice-contact deposits just west of Capron Ridge. Ekblaw (1929) postulated that Beaver Creek was an ice-marginal stream that formed during the early Wisconsinan. Although his basic conclusions were perhaps correct, the supporting data were morphological. The Capron ice margin was recognized by Ekblaw, but he extended the ice margin southwestward toward Belvidere, beyond the distribution of Capron Till.

• Evidence Favoring an Altonian Age

Since the Argyle is now considered Illinoian rather than Altonian in age (Kempton, Berg, and Follmer, this report), the overlying Capron Member is the only unit in northern Illinois that is still possibly Altonian. There are several factors favoring an Altonian age for the Capron Till Member: dissimilarities between the Capron and the Tiskilwa Till Member of the Wedron Formation (differences in clay mineral composition), pollen data from the Oak Crest Bog (Meyers and King: Stop 4b), the loess record in southern Illinois, and geomorphic differences between the Capron Ridge and Marengo Ridge.

Although the Capron and the Tiskilwa are sometimes similar in color, the clay-mineral compositions of each differs markedly. The clay-mineral composition of the Capron averages 40-52-8, whereas for the Tiskilwa (17 samples from boring CP-5) it averages 28-64-8. This difference suggests to us that the Capron and the Tiskilwa were deposited during separate glacial events. Despite some textural similarities between the Capron and the Tiskilwa, the overall textural variability of the Capron makes correlation with the Tiskilwa tenuous.

Pollen analysis of samples from the Oak Crest Bog (Meyers and King: Stop 4b) suggests glacial activity in the region between about 38,000 and 33,000 RCYBP. A glacial advance during this time could have deposited the Capron; these dates are in agreement with the Altonian age given by Kempton and Hackett, 1968a, 1968b).

The loess record in southern Illinois is also evidence for active glaciation to the north during the Altonian. The Roxana Silt Member is a thick loess that is considered Altonian (Willman and Frye, 1970; McKay, 1977, 1979). McKay (1977) divided the Roxana into four zones; from oldest to youngest these are r-1, r-2, r-3 and r-4. Radiocarbon dates from the r-2/r-3 contact (40,200 ± 1,500) and from the upper part of r-3 (30,980 ± 400) indicate an outwash source at that time. McKay (1977) suggested that Roxana zone r-3 was derived from an outwash that had its major source in the Lake Michigan Lobe of northeastern Illinois between about 30,000 and 40,000 years RCYBP.

Finally, a comparison of the geomorphic features of the Capron Ridge and the Marengo Ridge suggests a relatively older age for the Capron Ridge. The Marengo Ridge is not as well drained nor nearly as dissected as Capron Ridge. Capron Ridge appears to have been subjected to considerably more erosion than the Marengo Ridge, and thus, a relatively older age is inferred for Capron Ridge.

• Evidence Favoring an Illinoian Age

Perhaps the most tenuous time-stratigraphic placement for the Capron is within the Illinoian because it depends upon a definite correlation with that portion of the Clinton Member containing a recognizable Sangamon Soil. Although two clay-mineral compositions of Clinton have been recognized (one similar to the Capron and one similar to the Argyle), it is not clear from available information (Fricke, 1976) which of the two facies contains the Sangamon Soil.

CONCLUSIONS

Based on recent information from several borings in and adjacent to the Capron Ridge, the time-stratigraphic and rock-stratigraphic relationships and areal distribution of the Capron Till Member of the Winnebago Formation are being reconsidered and partially revised. Once thought to consist of an upper sandy facies and a lower silty facies, the Capron is now known to be extremely variable in texture both vertically (within individual borings) as well as areally (between different borings); however, its clay-mineral composition is fairly uniform, averaging 52 percent illite (range of 42% to 61%). Till members south of Piscasaw Creek have been correlated to older Illinoian units limiting the regional distribution of the Capron to areas north of Piscasaw Creek. Similarities in clay-mineral composition and to some extent grain size indicate that the Capron may correlate to part of the Clinton of south-central Wisconsin. Additional field work will be required to substantiate this correlation.

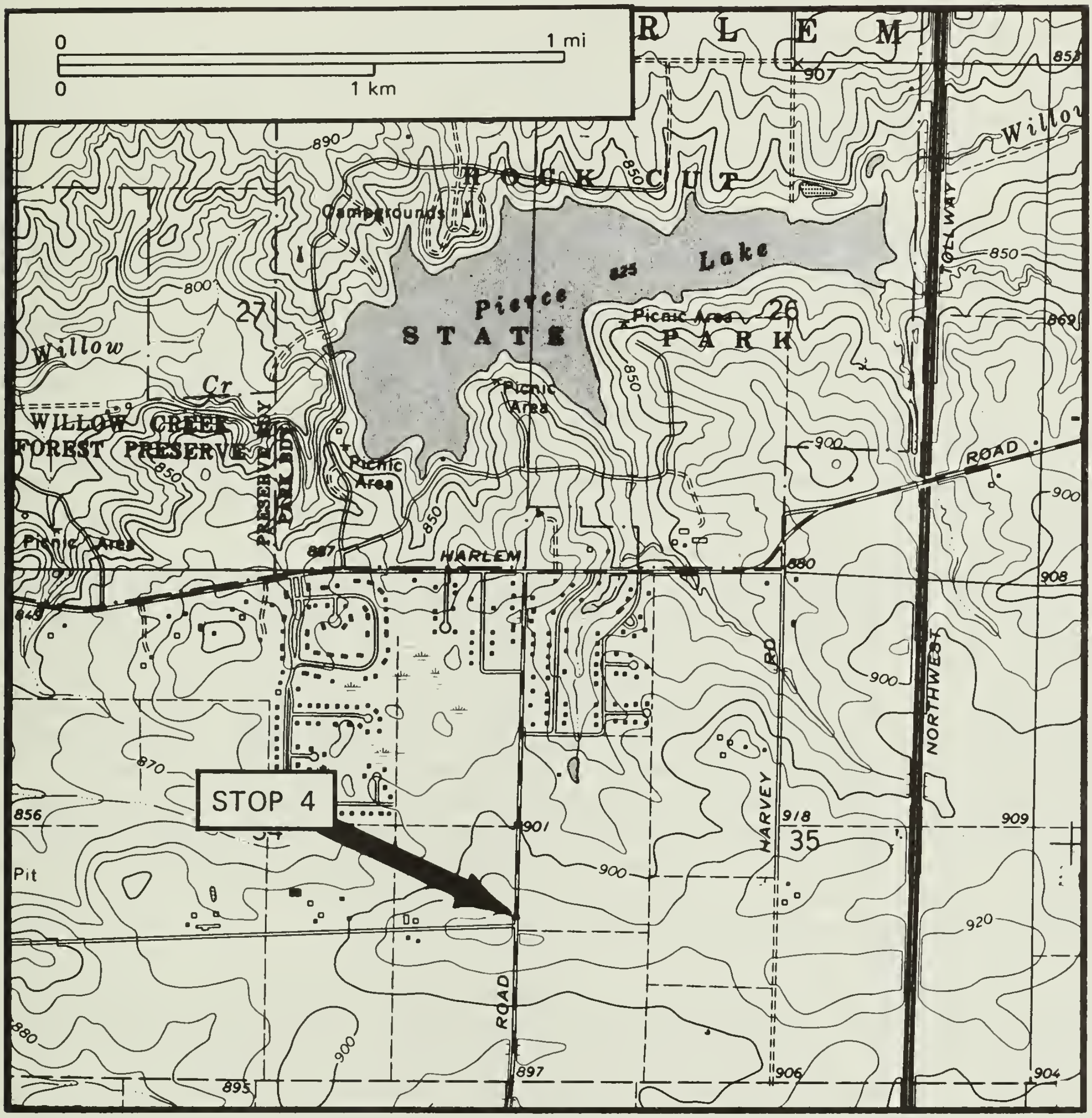
Several alternatives have been suggested related to the time-stratigraphic placement of the Capron Till Member. We favor an Altonian age for the Capron based on the following:

1) soil formation beneath the Capron Till Member,
2) lack of an apparent Sangamon Soil formed into the surface of the Capron,
3) clay-mineral dissimilarities between the Capron and the Tiskilwa,
4) pollen data suggesting a glacial advance in the region 38,000 to 33,000 RCYBP,
5) the loess record in southern Illinois,
6) geomorphic differences indicating that Capron Ridge is an older landform than Marengo Ridge, and
7) the erosional topography and drainage west of Capron Ridge.

Additional work should focus on establishing a definite age for the Capron. The possibility of a Capron-Tiskilwa relationship could be investigated. To determine the genesis of these deposits, fabric analysis would be useful, possibly indicating that these deposits may have resulted from the same major ice event. Given the textural variability of the Capron, the unit may be supraglacial in origin and possibly related to the same ice event that deposited the Tiskilwa.

Geology and Geomorphology of the Oak Crest Bog

Dennis P. McKenna



STOP 4A
Oak Crest Bog
NE Sec. 34, T 45 N, R 2 E, Winnebago County

From a roadside location, we can see the entire site of the buried Oak Crest Bog. This bog is the farthest north of any sequence of organic deposits with a dated age range of 24,000 to 47,400 RCYBP. We will display borings from the bog and discuss the soil-geomorphic, geologic, and palynologic aspects of this relict feature.

INTRODUCTION

The glacial deposits of northern Illinois west of the Woodfordian moraines have been studied for more than 100 years. Nevertheless, the interpretations of their distribution and time-stratigraphic position have been "more diverse and contradictory than in any other part of Illinois" (Frye et al., 1969) with the deposits being assigned ages from Kansan to Wisconsinan. Later workers agreed that the surficial tills of central-northern Illinois represented an Altonian (early Wisconsinan) glacial interval (Frye and Willman, 1960; Willman, Glass, and Frye, 1966; Kempton; 1963, Frye et al., 1969); however, the areal distribution of the Altonian deposits (the Winnebago Formation) was further limited in each subsequent study.

Recently, the assignment of the Argyle and Nimtz Till Members of the Winnebago Formation to the Altonian Substage has been questioned (Berg, Kempton, and Stecyk, 1984). Detailed soil survey (Grantham, 1980) and geologic mapping (Berg, Kempton, and Stecyk, 1984) in Boone and Winnebago Counties have indicated that the paleosols formed in the Argyle and Nimtz Tills are similar to Sangamon Soil profiles in adjacent Glasford Formation deposits of Illinoian age. Although most previous workers had recognized weathering profiles in the tills that they considered early Wisconsinan in age, they viewed the weathering as minimal and there was apparently limited recognition of the effects of landscape position on soil morphology.

The often conflicting age assignments made by past workers can be attributed to two major factors: the lack of stratigraphic control on Winnebago Formation deposits, and the confusing relationships of these deposits to the time-transgressive Sangamon Soil. While to many observers the gross morphology of a buried soil provides sufficient evidence to assign an age to a paleosol and the deposits in which it formed, the lack of additional stratigraphic evidence often leads to continued controversy. Finite radiocarbon dates within the Winnebago Formation deposits were not older than 41,000 RCYBP (Kempton, 1963) and provided only minimum dates for estimating the age of these deposits. Moreover, the organic sediments from which these dates were obtained were not placed within a geomorphic setting or directly related to weathering profiles on adjacent uplands.

Recently a buried bog dated at 24,830 ± 350 (ISGS-1039) to 47,400 ± 2400 (ISGS-744) RCYBP was discovered (McKenna, 1984); it is nearly encircled by a strongly developed well drained paleosol formed in the Argyle Till. This unique situation has provided the opportunity to more clearly demonstrate the relationship between the paleosol formed in the Winnebago Formation drift and dated organic sediments.

Through an application of the principles of hillslope analysis and a comparison of the paleosol in the Argyle Till Member to the modern soil and recognized interstadial soils, this study attempts to resolve the contradictory interpretations of the age of the paleosol and the underlying diamictons.

The bog has been informally called the Oak Crest Bog after the residential subdivision that was developed over it. The bog is located (fig. 4a-1)

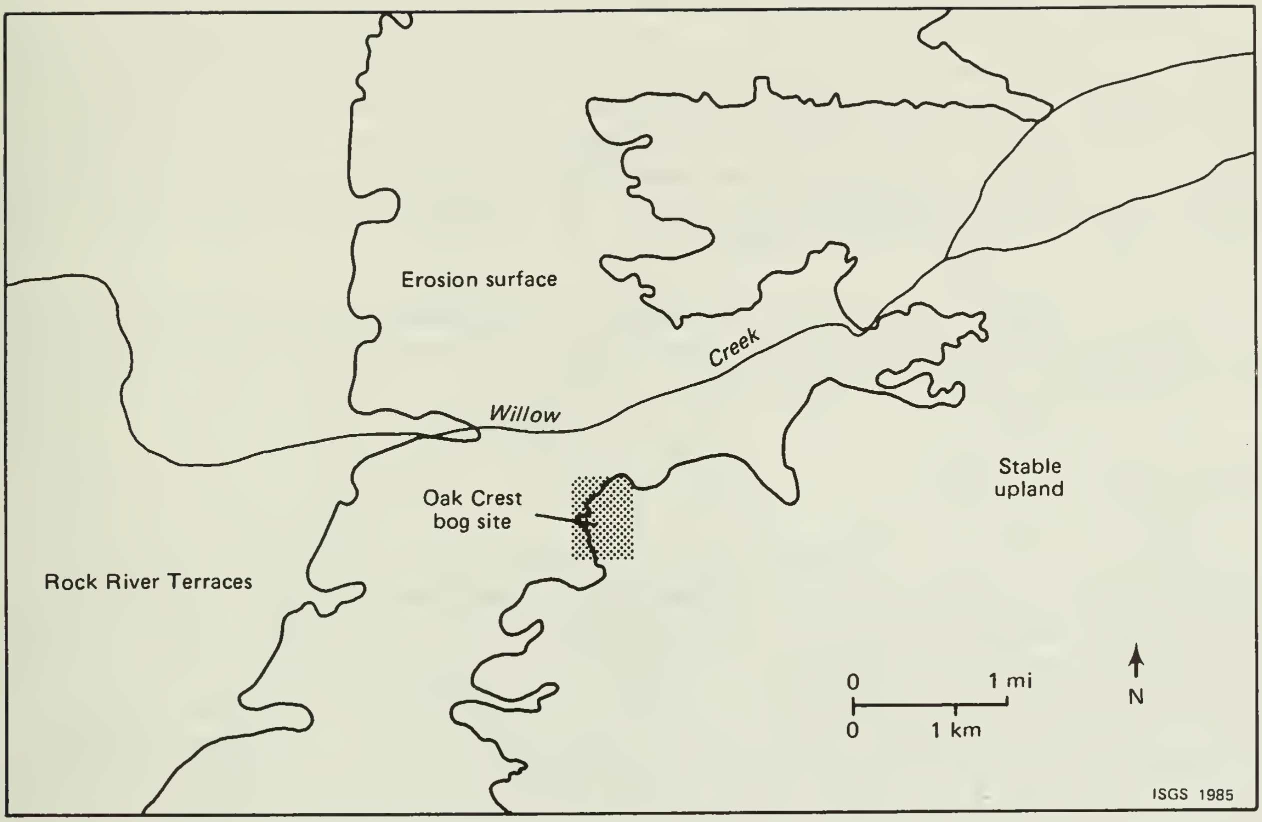


Figure 4a-1 Map view showing Oak Crest Bog relative to Rock River terraces, erosion surface, and stable uplands.

on the east side of the Rock River (NE Sec. 34, T 45 N, R 2 E) on the edge of a stable upland, dominated by loess overlying a well developed paleosol; it lies above an erosion surface sloping down to the Milton Terrace, the upper terrace of the Rock River (Anderson and Masters: Stop 1). This erosional surface is correlated to the Iowan erosion surface.

The uplands south and east of the study area are composed of 1 to 1.5 m of Peoria Loess over a well drained paleosol formed in the Argyle Till. To the north and west, the overlying sand and loess were eroded following the downcutting of Willow Creek; consequently, modern soils have formed in the Argyle Till, in scattered remnants of the paleosol, and in bedrock. The bedrock (Galena-Platteville Dolomite) is within 1 m of the surface immediately north and west of the study area and occurs as a regional topographic high beneath the study area (Berg, Kempton, and Stecyk, 1984).

METHODS

Sixteen borings were made with a truck-mounted power auger. In most holes, continuous undisturbed split-spoon samples were taken every .5 m to the top of the diamicton; additional split-spoon samples of the diamicton were collected every 1.5 m until reaching the bedrock surface. Each core sampled was measured and described using nomenclature from the Soil Survey Manual. Colors of moist samples were compared to Munsell Soil Color Charts.

An additional 204 hand borings to depths of 1.5 to 4.2 m were made with a 2-cm-diameter soil-sampling tube. The borings were made in a modified grid pattern to determine the areal extent of the buried bog and the distribution and thickness of the overlying eolain and colluvial sediments. Field descriptions were recorded on the thickness, color, and texture of each horizon or material. Sedimentary structures and significant inclusions (pebbles, sand lenses) were also noted. All borings were plotted on a 1:2400, 2-foot contour-interval base map.

Palynological analysis of the organic sediments was conducted by Dr. James King of the Illinois State Museum. Radiocarbon dating was provided by the Illinois State Geological Survey.

RESULTS

The distribution and stratigraphic sequence of the materials are illustrated in a stack-unit map format (fig. 4a-2). Informal letter designations have been assigned to the material units, treated here as rock-stratigraphic units. The dominant features of the study area are the surficial sand (Unit B), which is continuous across the landscape (fig. 4a-3), and the nearly continuous, well drained paleosol (Unit F) on the uplands surrounding the buried organic sediments of Unit D (fig. 4a-2). The cross section in figure 4a-3 more clearly illustrates the thickness and relationships of the various units.

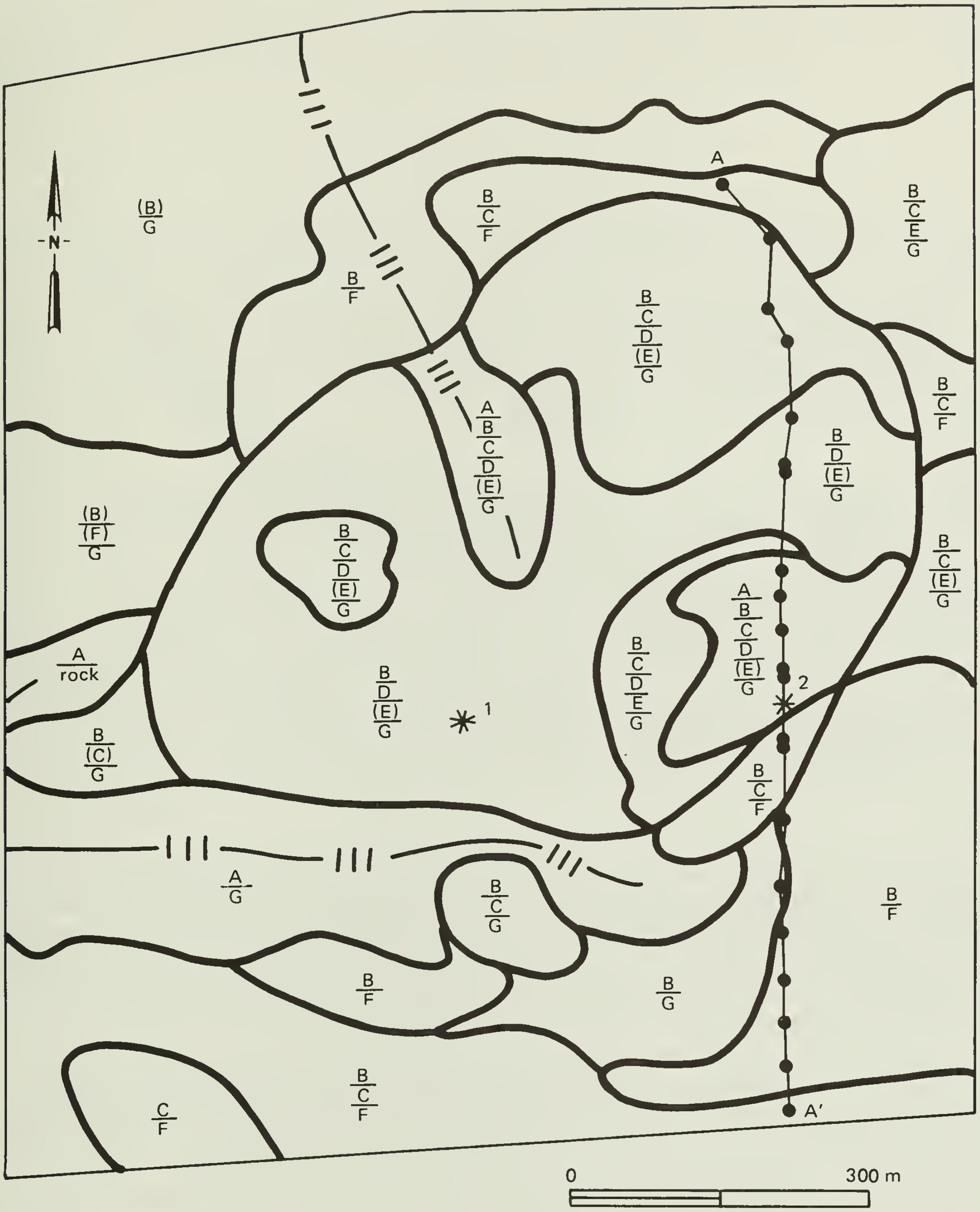
Due to scale limitations, figure 4a-2 does not show all variations in the sequence of materials resulting from small-scale topographic features or localized erosion. A unit is shown in parentheses if it is thin and irregularly distributed, or if field information is insufficient to draw boundaries with confidence.

Unit A

Unit A consists primarily of unsorted deposits of sand and silt in toe-slope positions, within the intermittent drainageway, and along the edges of the bog area (fig. 4a-3). Although occurring primarily above Units B and C, Unit A is also found lying unconformably over organic sediments and diamicton. Within the drainageway on the south edge of the bog area, Unit A exceeds 2 m in thickness. Because it contains thin lenses of stratified materials, it may be partially alluvial in origin.

Generally, however, Unit A is less than 75 cm thick. Where Unit B is the dominant surficial material, Unit A is extremely sandy and difficult to distinguish from the underlying eolian sand in soil profiles. Below severely eroded areas, Unit A is more variable in texture and appears to be derived from a combination of loess, paleosol or Argyle Till.

Due to the limited extent of the deposits, which may be alluvial, Unit A is considered to be a single unit. It is interpreted to be Peyton Colluvium or Cahokia Alluvium.



Radiocarbon sampling sites

Intermittent drainageway

Line of cross section in figure 4-3

ISGS 1985

A — Cahokia Alluvium/Peyton Colluvium
B — Parkland Sand
C — Peoria Loess
D — Organic Sediments
E — Silty Diamicton
F — Paleosol
G — Argyle Till

Figure 4a-2 Stack-unit map of Oak Crest Bog area.

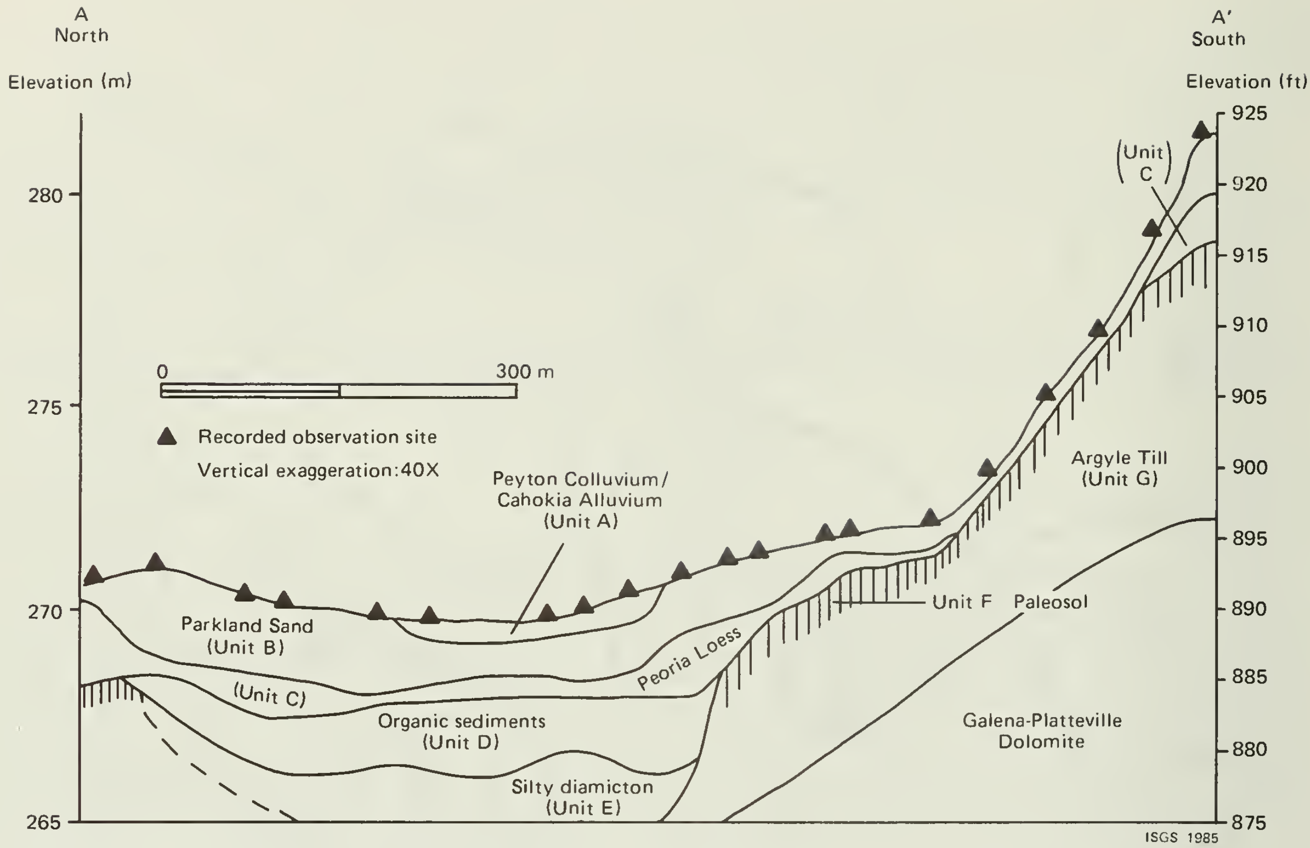


Figure 4a-3 North-south cross section through Oak Crest Bog.

Unit B

Overlying most of the study area is a well sorted medium-grained sand (Unit B), which is interpreted to be Parkland Sand. An eolian origin of the deposit is suggested by its high degree of sorting, occurrence on topographic highs as well as in the bog basin, and a 3-m-high transverse dune on the east side of the area. Apparently the sand migrated onto the uplands along stream channels from the Rock River valley.

In the nearly level bog area, the sand is 150 to 200 cm thick and overlies either silts or organic sediments. Although over 100 cm of sand caps the higher landscape positions, the thickness is generally less than 50 cm on the sideslopes. To the north and west of the bog, the sand is found only as isolated remnants on more level areas. Within the surface-water drainageways, the sand is absent as a surficial deposit, although it may occur as thin lenses within the lower portion of the colluviated sediments.

Unit C

On the more stable uplands, nonlaminated, leached, yellowish brown silt (Unit C) underlies the sand of Unit B (fig. 4a-2). In the low-lying area, Unit C is generally gleyed; locally, its upper portion shows some evidence of stratification. Unit C is interpreted to be the Peoria Loess based on its lithologic characteristics and its position above the organic sediments of Unit D, which are dated at 24,830 RCYBP.

The loess is up to 2 m thick where it occurs below the sand on the stable upland positions, but is generally absent on the hillslopes (fig. 4a-3). In the bog area, Unit C loess rarely exceeds 50 cm in thickness.

Unit D

Unit D consists of organic-rich silts, muck, and a very fibrous peat occasionally interbedded with silts. The unit underlies Units B and C (Parkland Sand and Peoria Loess); in the area of Unit A south of the bog (fig. 4a-2), it was apparently removed by erosion before deposition of the surficial colluvium or alluvium. The organic sediments range in thickness from less than 50 cm to more than 3 m; they occupy a generally circular basin of approximately 36 hectares and overlie the diamicton of Units E or G (fig 4a-2).

Cores were collected near the south edge of the bog (fig. 4a-2) at two locations spaced approximately 320 m apart. A sample taken from the organic silt at the top of core 1 was dated at 33,220 ± 710 RCYBP (ISGS-779). The bottom date from a sapric material was 47,400 ± 2,400 RCYBP (ISGS-744; fig 4a-4). Core 2, which contained 155 cm of organic sediments, was sampled at four depths for radiocarbon age determination (fig. 4a-4). The dates on these materials ranged from 24,830 ± 350 RCYBP (ISGS-1039) at the top of the organic silt to 37,900 ± 1,300 RCYBP (ISGS-1073) in the upper peat. Samples were collected from the top and bottom of the lower fibrous peat with radiocarbon dates of 43,800 ± 2,700 (ISGS-1069) and 43,100 ± 1,100 (ISGS-1045), respectively. It appears that the date of the bottom sample is wrong (Meyers and King: Stop 4b).

The divergent dates at the top of the organic silts in the two cores appear to be paradoxical. However, the organic-rich silt layers in the two cores appear to be the same deposit. Core 1 with the date of 33,220 RCYBP is within 50 m of a major drainageway (fig. 4a-2). Therefore, it could be hypothesized that the upper organic sediments had been eroded by sheetwash after downcutting of the drainageway. Also, in this core the eolian sand lies over the peat with no loess present. The 24,830 radiocarbon date from core 2 closely corresponds to the 25,000 RCYBP reported for inception of Peoria Loess deposition (McKay, 1979) and the 26,000 ± 200 RCYBP reported by Whittecar and Davis (1982) from a bog 70 km to the northwest.

It appears that Unit D can be divided into two subunits. The upper organic silt may be correlative to the Robein Silt, which formed by the accumulation of organic debris and silt from sheetwash and eolian deposition (Willman and Frye, 1970). The lower portion of Unit D appears to be about the same age as the Plano Silt described by Kempton (1968a) in northern Illinois. If this correlation is valid, the 47,400 radiocarbon date at the base of the unit is an additional 6,000 radiocarbon years older than previous findings.

A pollen profile from core 2 is dominated by high values for pine (average >50%) and sharp peaks in spruce values (Meyers and King: Stop 4b).

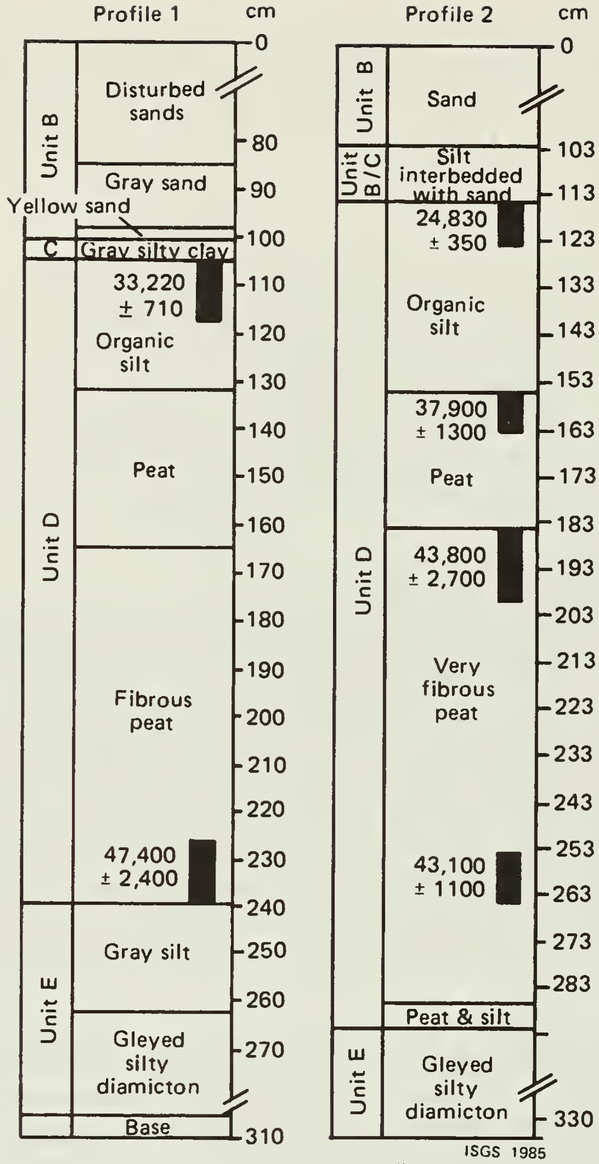


Figure 4a-4 Stratigraphy and radiocarbon chronology of Profiles 1 and 2, Oak Crest Bog. (See figure 4a-2 for locations.)

This may represent a decrease in temperature associated with a glacial advance. It generally agrees with previous reports indicating a pine-spruce boreal forest (Whittecar and Davis, 1982; Frye and Willman, 1973; Gruger, 1972).

Unit E

Unit E is primarily a nonstratified, pebbly, silty and sandy diamicton that overlies either the paleosol, the unoxidized diamicton of Unit G, or bedrock. This unit appears to be derived from slopewash or solifluction from the paleosol or Argyle Till surface. It underlies the Peoria Loess (Unit C), the Parkland Sand (Unit B), and the organic sediments of Unit D. The maximum thickness of Unit E is 1.4 m.

Where Unit E overlies the paleosol in well drained landscape positions, it is oxidized and distinguished from the paleosol by its browner hues (10YR) and greater silt content. Below the organic sediments, it is generally gleyed, leached, and lacks stratification. Its high silt content distinguishes it from the underlying diamicton (Argyle Till), and its sand and pebble content separates it from the overlying nonorganic silts.

Unit F

Unit F is a strongly developed paleosol that formed in sandy loam diamicton (Argyle Till). It has reddish hues (5YR to 7.5YR), a clay loam argillic horizon and a maximum B-horizon thickness greater than 1.2 m. The B horizon frequently contains Mn-Fe concretions and staining. For mapping purposes, the paleosol was treated as a material unit.

A and E horizons were not observed above the Bt horizon of the paleosol in any boring. The high clay content in the upper portion of the paleosol suggests that the upper B horizon has been removed by erosion. Because of the severe truncation of the paleosol and the lateral variation of soils on the paleo-landscape, it is difficult to discern which part of the paleosol has been preserved, particularly where the paleosol may have been affected by modern soil-forming processes.

On the basis of its stratigraphic relationships to the 47,400-year-old organic sediments of Unit D and its degree of development, the Unit F paleosol is interpreted to be the Sangamon Soil.

Unit G

Unit G underlies all of the other units within the study area and overlies bedrock. It is a sandy loam diamicton containing an average of 53 percent sand, 32 percent silt, and 15 percent clay; it has a clay-mineral composition of 22 percent expandables, 63 percent illite and 15 percent kaolinite plus chlorite. This unit is interpreted to be the Argyle Till Member of the Winnebago Formation described by Berg, Kempton and Stecyk (1984) and Berg and Kempton (Stop 5).

On stable upland positions, the diamicton of Unit G exceeds 6 m in thickness but thins rapidly to the west and north of the study area. Unit G is missing where tributary streams of the Rock River have downcut through overlying deposits and removed it. It appears that the Argyle Till is generally very thin within the bog basin.

Because the paleosol that formed in this unit correlates to the Sangamon Soil, the Argyle Till is considered to be Illinoian in age.

DISCUSSION

Geomorphic Surfaces

Each material unit in the study area was a geomorphic surface at the end of its depositional period. According to Ruhe (1969), a geomorphic surface is "a portion of the landscape specifically defined in space and time." It may be erosional, depositional, or both; and it may be limited to one rock type or sediment, or may cut across several types. It may be buried without being destroyed; but once eroded, the geomorphic surface is destroyed. The erosion creates a new surface (Daniels et al., 1971).

The age of a geomophic surface is defined as the duration of its exposure at land surface. By use of the principles of superposition and hillslope ascendancy (Ruhe, 1969; Daniels et al., 1971), the relative age of the various surfaces were determined. Where supplemented by radiocarbon dates or direct correlation to dated surfaces in other similar locations, absolute age or time can also be estimated.

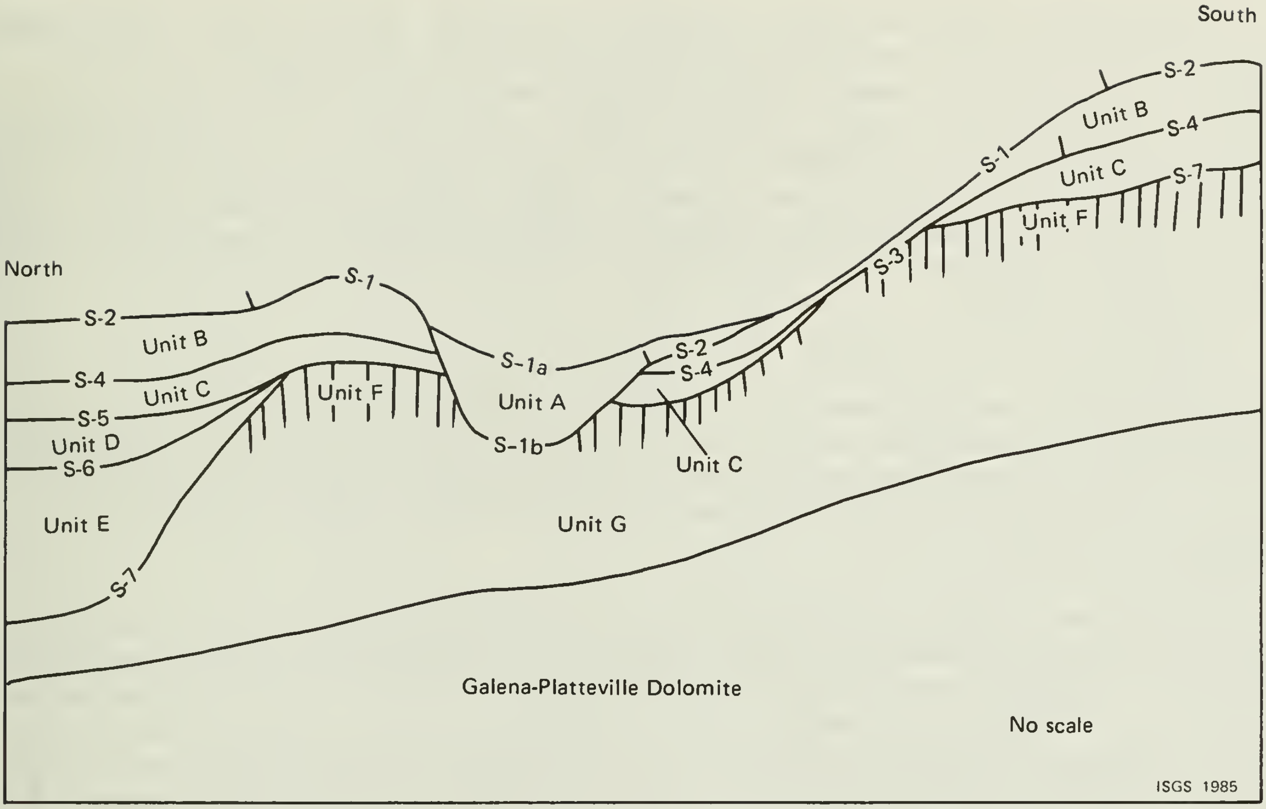
The Oak Crest Bog area is composed of many geomorphic surfaces representing the depositional and erosional history of the area (fig. 4a-5). The present land surface includes both stable and erosional/depositional surfaces. The age of the present surface at any particular point ranges from the most recent erosive rainfall back to the time of eolian deposition of the sand or subsequent reworking of those deposits by the wind.

The Peyton Colluvium and Cahokia Alluvium are the same age as the hillslopes from which they were eroded. The present surface also includes an older geomorphic surface on the stable uplands; it is mantled by Parkland Sand, but is not eroded (fig. 4a-5). In some places this older surface is buried by Peyton Colluvium. These two surfaces are identified as surface 1 (S-1, erosional and depositional) and surface 2 (S-2, stable upland) in figure 4a-5.

S-1 can be further subdivided to reflect the entire erosional interval since deposition of the Parkland Sand. Within the modern surface-water drainageway, which is filled with colluvium, the upper surface (S-1a) is the same age as S-1 on the hillslopes. S-1b represents the initiation of the erosion that is forming S-1. The correlative hillslope surface no longer exists.

Another pair of geomorphic surfaces, which are similar with respect to erosional and depositional processes and age relationships, are related to the Peoria Loess. S-3 is primarily erosional. The depositional phase of the surface was mostly eroded during downcutting of the small valley in which the Peyton Colluvium was deposited. As with the eolian sands, the stable upland and toeslope positions probably reflect a surface that was formed at the time of loess deposition (S-4).

The top of the organic sediments (S-5) defines another geomorphic surface, which is dated at 24,830 ± 350 RCYBP. Since both the bog and the Sangamon Soil are buried by Peoria Loess, we can conclude that the eroded surface of the Sangamon was exposed until approximately 25,000 RCYBP. The development of the erosional surface on the Sangamon Soil must have begun before 25,000 years ago. The 47,400 radiocarbon date toward the base of the organic sediments provides a minimum date for estimating the age of the bog.



A — Cahokia Alluvium/Peyton Colluvium
B — Parkland Sand
C — Peoria Loess
D — Organic Sediments
E — Silty Diamicton
F — Paleosol
G — Argyle Till

Figure 4a-5 Relationship of geologic materials to geomorphic surfaces in the Oak Crest Bog area.

The steep-sided valley cut into the Sangamon Soil and the Argyle Till (S-7) is filled with the alluvium and colluvium of Unit E, which is overlain by the bog or by younger sediments. Unit E provides a means to relatively date the Sangamon Soil (fig. 4a-5). An erosional surface is older than the valleys cut below it, yet is the same age as the depositional surface to which it grades (Daniels et al., 1971). Therefore, the Unit E fill represents the time during which the Sangamon Soil was being eroded. The end of this erosional interval (S-6) was 47,400 RCYBP--or possibly older. Erosion would have begun at some time before 47,400 RCYPB (S-7) but after the paleosol had formed.

The Sangamon Soil

A primary reason cited by previous workers for the assignment of lower Winnebago Formation till members to Altonian (early Wisconsinan) time was a purported lack of weathering of the surficial diamictons. In cases where a buried soil was recognized it was considered to be weakly developed and as further confirmation of the early Wisconsinan age assigned to the tills (Shaffer, 1956; Leighton and Brohpy, 1966).

The Sangamon Soil has been severely truncated, which limits any attempt to reconstruct the thickness and characteristics of the original solum; however, its degree of development exceeds that of recognized interstadial soils. Throughout the study area and other areas where it is preserved, the paleosol on the Argyle and Nimtz Tills is more strongly developed than the modern soils formed in the same deposits. The paleosol has redder hues (2.5YR to 7.5YR) than the modern soil (7.5YR to 10YR), a thicker solum, and thicker lower horizons (25 to 60 cm, B3 horizons) compared to the modern soil (0 to 15 cm) (Grantham, 1980).

McKenna and Follmer (Stop 6) discuss an exposure 15 km west of the Oak Crest Bog where the Sangamon Soil, formed in Argyle Till, is overlain by a Farmdale Soil in the Roxana Silt and an organic horizon (20,150 ± 500 RCYBP) within Peoria Loess. The sequences of materials both here and at Stop 6 clearly place the soil as the Sangamon Soil and the underlying diamicton as Illinoian or older.

The several degrees of latitudinal difference between central northern Illinois and the Sangamon Soil type area can be expected to influence climatic conditions and the duration of a soil-forming interval. If, as proposed here, the Argyle and Nimtz Till Members are Illinoian in age, their stratigraphic position above all other Illinoian drift, including thick outwash units (Berg, Kempton and Steyck, 1984), would indicate advances of Illinoian glaciers into northern Illinois later than into central Illinois. Under these conditions, the Sangamon Soil would have begun forming earlier in central Illinois than in northern Illinois. Similarly, the Sangamonian Interglacial may have ended much earlier in northern Illinois.

Post-Sangamonian Erosion

The general climatic cooling reflected in the pollen record (Meyers and King: Stop 4b) and the deposits of Roxana Silt (McKenna and Follmer: Stop 6) indicate an early Wisconsinan glacial advance. Although there is no unequivocal evidence that the ice front reached northern Illinois, there are several reports suggesting widespread erosion of the Sangamon surface prior to 40,000 RCYBP.

Origin of the Basin

The roughly circular shape of the Oak Crest Bog (fig. 4a-2) suggests that it was a depression on the surface of the Argyle Till, possibly a kettle. However, the sediments of Unit E, which occur below the organic sediments, are apparently the result of colluvial or fluvial processes. A fluvial origin for the basin is supported by the steep-sided valley cut into the surface of the Argyle Till (fig. 4a-3). The presence or location of a paleostream cannot be determined because of the limited number of deep borings in the bog area. However, sand and gravel were reported in well logs drilled to the northeast of the study area, and Unit E sediments were observed in a gap in the paleosol-mantled slopes. Possibly a stream flowed northeastward into the deep bedrock valley of Willow Creek. Mass wasting, solifluction, or some other mechanism may have blocked the channel and produced the basin.

CONCLUSIONS

The significant results of this study are

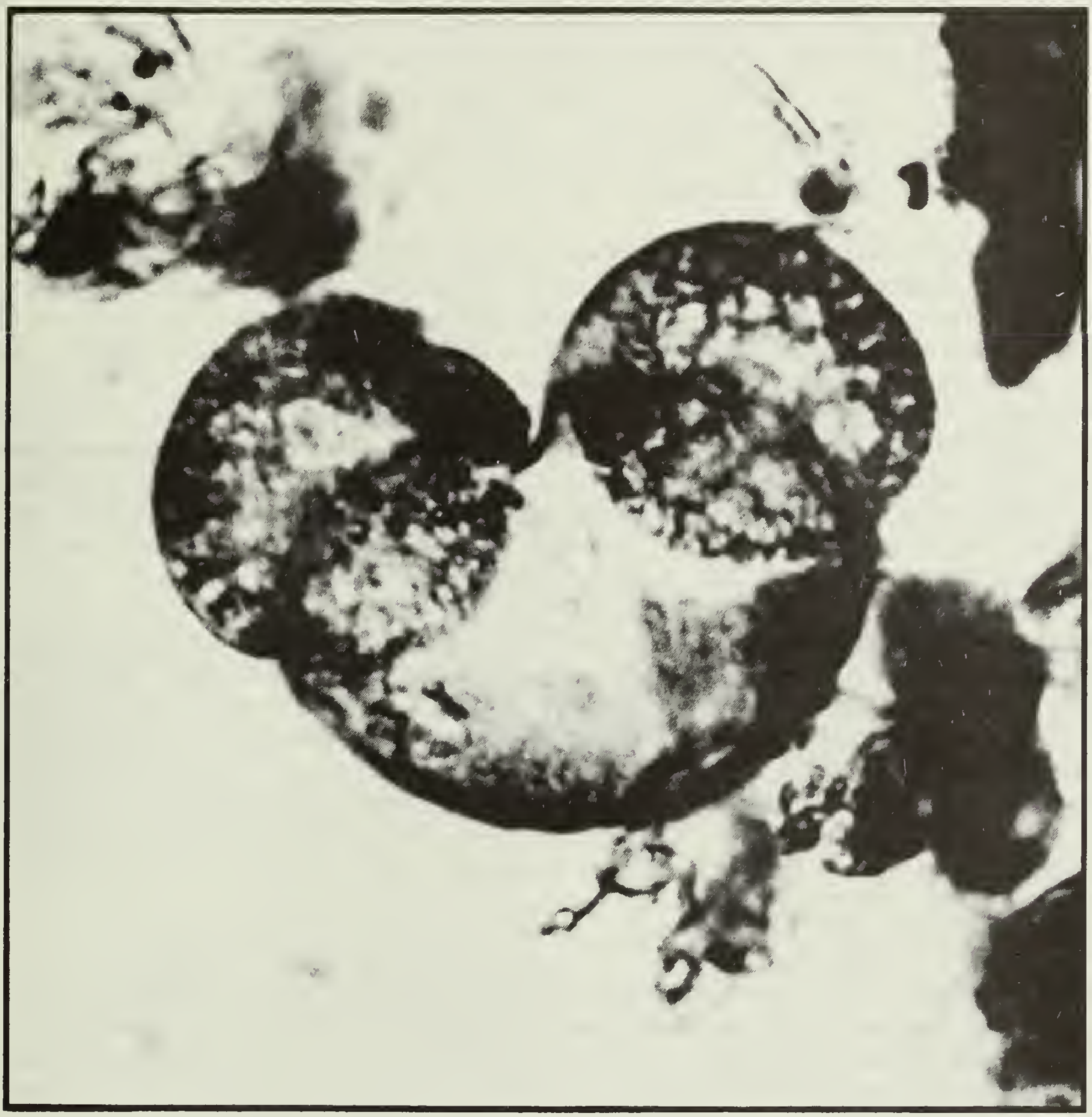
(1) extension of the age of the organic sediments above the Argyle Till Member to 47,400 ± 2,400 RCYBP;
(2) evidence for a major erosional episode prior to 47,000 RCYBP;
(3) correlation of the paleosol in the Argyle Till Member of the Winnebago Formation to the Sangamon Soil;
(4) assignment of the Argyle and Nimtz Till Members of the Winnebago Formation to the Illinoian Stage.

Paleosols and the radiocarbon dating of organic sediments are primary tools used by Quaternary scientists to establish the age of glacial deposits. However, the selection of study sites is frequently more opportunistic than scientific. In many instances, studies of single exposures or borings have allowed Quaternary workers to make significant contributions to the understanding of glacial history. Yet paleosols and organic sediments are elements of multi-dimensional landscapes and should be studied within the temporal and spatial context of the landscape in which they occur.

This investigation has reaffirmed the value of detailed mapping of soils, geologic materials, and geomorphic surfaces as a supplement to regional mapping in stratigraphic studies of complex areas. By establishing the geomorphic relationships between dated organic sediments and soils on the adjacent hillslopes, the value of each in establishing a time-stratigraphic framework is increased.

Wisconsinan Interstadial Vegetation of Northern Illinois

Rebecca L. Meyers and James E. King



STOP 4B
Oak Crest Bog
NE Sec. 34, T 45 N, R 2 E, Winnebago County

Fossil pine pollen grain (42 microns across).

INTRODUCTION

Interpretations of Wisconsinan interstadial vegetation of eastern North America have been derived primarily from sites located some distance south of the limit of maximum Wisconsinan glaciation. With little exception, interstadial paleovegetation data from near or within the glaciated region has consisted of scattered macrofossils and isolated pollen spectra. Long palynological sequences have not been available. Recently, a buried bog dated between 24,830 ± 350 and 47,400 ± 2,400 RCYBP was discovered in the Oak Crest Subdivision, north of Rockford, Winnebago County, Illinois (NE Sec. 34 T 45 N R 2 E) (McKenna, 1984; also Stop 4a). Sediments from this bog indicate that the interstadial vegetation of the area may also relate to ice-margin fluctuations described from regions to the north and east.

Pollen data throughout the midwest have indicated that mid-Wisconsinan interstadial vegetation was dominated by Pinus (pine) with mixtures of herbaceous species and grass. Generally, Picea (spruce) and other taxa characteristic of more severe glacial conditions were absent or scarce. The general environment portrayed was of cool uniform conditions with temperatures decreasing at the end of the interstade as the late Wisconsinan glaciation began. Data from western Missouri (King, 1973) Iowa (Mundt and Baker, 1979), central Illinois (Gruger, 1972), and northwestern Illinois (Whittecar and Davis, 1982) support this interpretation. The vegetational record of the region has not supported interpretations of the rock-stratigraphic record which indicate mid-Wisconsinan glacial activity.

Picea and Pinus dominate the pollen in a peat from a bog in Stephenson County, Illinois, radiocarbon dated between 26,800 BP to 40,500 BP (Whittecar and Davis, 1982). The pollen data from this site, 70 km west of Oak Crest, are divided into two assemblage zones: Pinus is more abundant than Picea in the lower zone, while in the upper zone Picea dominates together with a herb and shrub component. This sequence was interpreted as indicating a stable environment with slow cooling toward the top. The record does not show variability suggestive of climatic or glacial fluctuations.

Based on geological evidence, Dreimanis and Goldthwait (1973) have characterized the mid-Wisconsinan interval as being an interstadial interrupted by at least two glacial advances, giving rise to three shorter interstadials rather than one long one. These are (oldest to youngest) Port Talbot I, Port Talbot II, and Plum Point. Pollen evidence from the eastern Great Lakes suggests that Port Talbot I was dominated by Pinus and Picea with smaller amounts of Betula (birch), Salix (willow), and Alnus (alder); Quercus (oak) pollen was also present (Berti, 1975a; Dreimanis et al., 1966). Pollen data from the Port Talbot II are similar, except for much lower Quercus percentages. Data from Pennsylvania suggest that during Port Talbot II, treeless areas were expanding (Berti, 1975b); similar open-ground conditions prevailed during the Plum Point. Climatic variation is also indicated in the marine oxygen-isotope record where stage 3 (61,000 to 29,000 RCYBP) is composed of a series of temperature fluctuations leading to colder conditions in stage 2, the classic late-Wisconsinan (Shackleton and Opdyke, 1973).

Although the question of mid-Wisconsinan ice-contact deposits in Illinois is still open (Krumm and Berg: Stop 3), perhaps the best regional evidence for mid-Wisconsinan glacial activity is the Roxana Silt, a prominent loess deposit along the ancient Mississippi Valley in Illinois. The Roxana was deposited during an interval about 30,000 to 45,000 RCYBP (McKay, 1979). Its character and distribution suggest that its source material was deposited by meltwater from the Lake Michigan and/or Lake Superior regions. This glacial activity apparently took place in areas to the north of Illinois with the resulting outwash bringing the source material into Illinois via the river systems for ultimate deflation and eolian redeposition.

Oak Crest Bog

The Oak Crest Bog is approximately 30 km west of the Woodfordian glacial boundary (Lineback, 1979). The site, on the edge of the gently rolling uplands bordering the Rock River, is underlain by a sequence of organic silts and peats buried beneath late Wisconsinan eolian sands and silts, which in turn are underlain by the Illinoian-age Argyle Till (McKenna: Stop 4a). The bog deposits occupy a shallow basin of probable fluvial origin and cover an area of approximately 36 hectares. Due to the overlying eolian sediments, there is little topographic indication of the subsurface bog. At present the basin is occupied partly by a housing development and partly by second-growth woods or farmland.

The detailed stratigraphy of the Oak Crest Bog and the surrounding area is presented by McKenna (Stop 4a). The overlying sand ranges from 50 to more than 300 cm in thickness throughout the basin and is often interspersed with bands of silt and clay. These sediments, however, are uniform throughout the basin and appear to occupy the same stratigraphic position regardless of the complexity of the overlying deposits. Clearly the stratigraphy above the organic sediments portays a complex late-Wisconsinan geologic and environmental history.

METHODS

In June 1980, a core of the organic sediments was taken from the south-central portion of the basin in a vacant subdivision lot. Radiocarbon analysis of this original core 16 indicated the organic sediments ranged in age from 47,000 to 33,000 BP. In September 1982 another core was collected at the original site. Also, two cores were taken from deeper deposits in the center of the basin about 320 m to the northeast of the first site; these duplicate cores, designated 4a and 4b, were collected 1 m apart for pollen analysis, radiocarbon dating, and stratigraphic control.

After stratigraphically matching the duplicate cores, palynological samples, 2 cm thick, were removed at 10-cm intervals from core 4a, and radiocarbon samples were cut from core 4b. Additional pollen samples were collected at 5-cm intervals from the organic silt unit in core 4b. Because of the location of a radiocarbon sample at the base of the organic silt, there is a 20-cm interval between the lowest pollen sample in this unit and those in the underlying peat.

Before processing, each pollen sample was volumetrically measured and a known quantity of Eucalyptus pollen (a southern hemisphere tree that is not native to North America) was added to each as a check on efficiency of the extraction technique and so that pollen concentrations per cm^3 could later be determined. The samples were then processed with standard methods (Gray, 1965): hydrochloric acid to remove carbonates, hydrofluoric acid to remove silicates, and a brief acid hydrolysis. Clay particles were dispersed by washing several times with sodium pyrophosphate and sieving through a 7-micron screen (Bates et al., 1978; Cwynar et al., 1979). The remaining humic acids were removed with a brief sodium hydroxide treatment; the residue was then stained with basic fuchsin and mounted with glycerol on slides. A minimum of 300 pollen grains, excluding obligate aquatic species, was counted from each sample. The numbers of Eucalyptus grains were tabulated separately from the pollen sum (N). The remaining sections of core 4 were screened for plant macrofossils.

RESULTS

The organic sediments in core 4 were overlain by 110 cm of sand and sandy clay containing the Modern Soil.The pollen-bearing sequence of organic-rich silt, peat, fibrous peat, and silty peat is 180 cm thick (fig. 4b-1). Fossil pollen is well preserved and abundant in the peats, but sparse and poorly preserved in the silt. Underlying the fibrous peat is a gleyed nonstratified silty peat that appears transitional to the lower gleyed sediments. Fossil pollen was poorly preserved in this silty peat.

Sedimentation Rates

Five radiocarbon dates were obtained from boring 4; these augment the two dates previously determined from the boring 16 site.

		Core 4	
114-124 cm	clay	24,830 ± 350 BP	ISGS-1039
155-163 cm	peat	37,900 ± 1300 BP	ISGS-1073
185-198 cm	peat	43,800 ± 2700 BP	ISGS-1069
234-243 cm	peat	38,210 ± 930 BP	ISGS-1156
254-264 cm	peat	43,100 ± 1100 BP	ISGS-1045
		Core 16	
108-138 cm	clay	33,220 ± 710 BP	ISGS-749
260-264 cm	peat	47,400 ± 2400 BP	ISGS-744

Note: the boring 16 depths have been recalculated from stratigraphic contacts and are approximate.

The sedimentation rate in the upper organic silt is determined by two radiocarbon dates of 24,830 ± 350 BP and 33, 220 ± 710 BP from that unit, and one date of 37,900 ± 1300 BP from the top of the peat. Plotting these dates against depth (fig. 4b-2) indicates a slow uniform sedimentation rate of

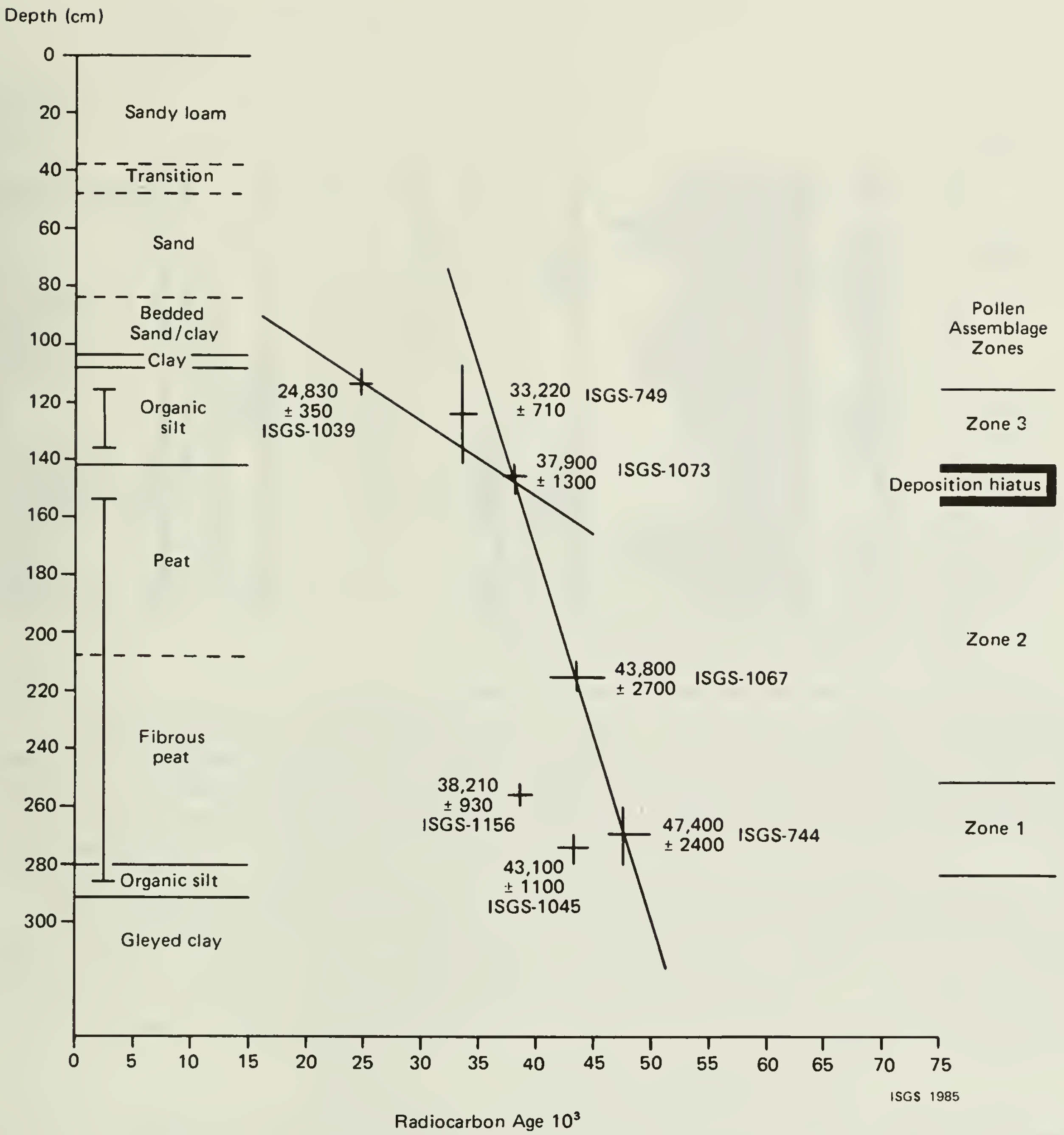
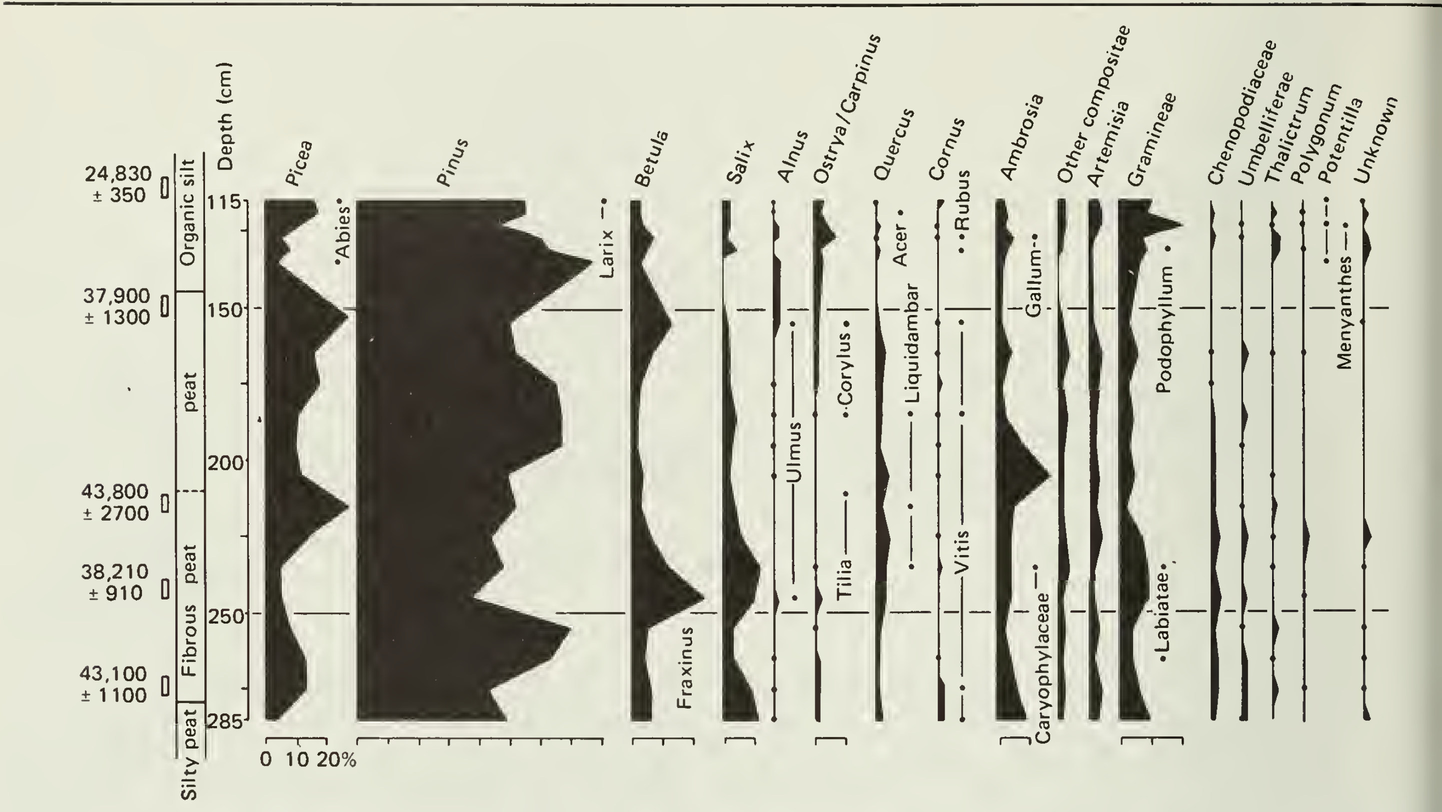


Figure 4b-1 Stratigraphy of core 4, pollen assemblage zones, radiocarbon dates, and calculated sedimentation rates for Oak Crest Bog.

approximately 0.028 mm/yr for the organic silt, suggesting that this portion of the pollen record accumulated between about 33,000 and 25,000 RCYBP.

The radiocarbon analyses from the lower portion of the boring indicate a considerably faster sedimentation rate, especially in the lower fibrous peat section. The dates also present conflicting information. Based on the upper two dates from the peats in core 4 (ISGS-1073 and 1069) and the basal peat date from core 16 (ISGS-744), the two stratigraphically lowest radiocarbon dates from boring 4 (ISGS-1156 and 1045) are younger than expected. If these dates are correct, then the dates of ISGS-1069 and 744 are inaccurate: they are much too old and would indicate that a large portion of the peat



accumulated within an extremely short time. The pollen evidence does not support such an interpretation. Considering all radiocarbon dates from the peat units in both cores, we suggest that this unit accumulated between 48,000 and 30,000 BP, an interval that overlaps with the ages for the organic silt above. If ISGS-1156 and -1045 are excluded, however, then the ages on this unit are from 46,000 to 38,000 RCYBP--a range that appears more consistent with the pollen and sedimentological data. The age estimates are little changed if ISGS-749 from the overlying organic silt is also included. Thus it appears that ISGS-1156 and -1045 were contaminated with younger carbon during field collecting. They were both cut from the same core section recovered on the final drive into the uncased hole. These young dates do, however, provide a minimum age for the base.

Three dates (ISGS-1073, -1069, and -744) are the minimum required for determining sedimentation rates over a long interval; they provide a basis for estimating the maximum age of the base of the peat (fig. 4b-1). The calculated sedimentation rates are 0.057 mm/yr in the peat and 0.28 mm/yr in the fibrous peat. Based on the radiocarbon chronology, the pollen sequence from the peats and silty peat below represents the interval between 49,000 and 38,000 BP. The fibrous peat began accumulating about 47,000 RCYBP.

The Pollen Record

The pollen record from Oak Crest Bog is dominated by Pinus and Picea and exhibits considerable variation with sediment type and depth (fig. 4b-2). The pollen data are divided into three local pollen assemblage zones (OC1, OC2, OC3) based on CONSLINK (Birks, 1979), a cluster analysis zonation program for stratigraphically oriented palynological data adapted for the microcomputer by

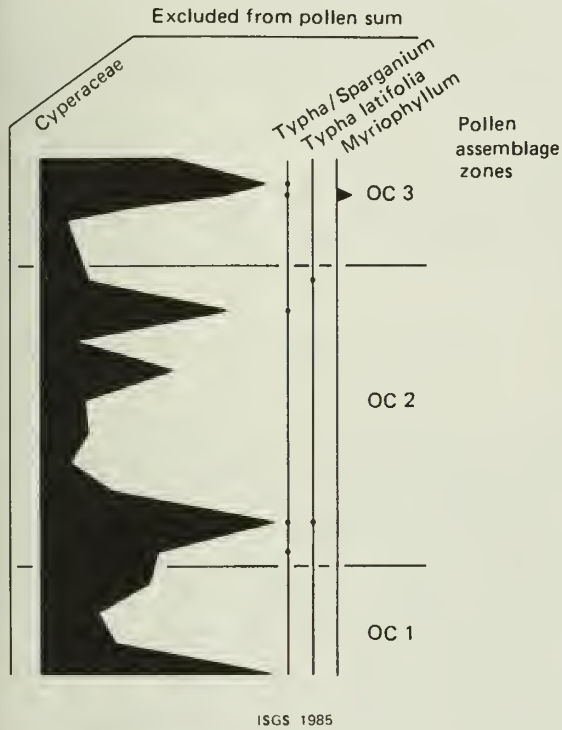


Figure 4b-2 Generalized pollen diagram for the Oak Crest Bog. Percentages were calculated as percent total terrestrial plant pollen in samples from cores 4a and 4b. Each sample contained more than 300 pollen grains of upland taxa. Aquatic taxa are shown as a percent of the included taxa. Sediment type, depth and radiocarbon dates are indicated to the left; pollen assemblage zones are shown in the right.

Dr. L. J. Maher, Jr. (personal communication, 1984). As a check on this method, the pollen diagram was also zoned by calculating the 0.05 confidence limits for percentages (Mosimann, 1965) and drawing zonal boundaries at the occurrence of coinciding significant changes in the percentages of the major taxa. Both methods produced the same results.

Plant macrofossils, although not numerous, were recovered from the core. Most indicated boreal conditions; charcoal was common in the peat.

Macrofossils from Oak Crest Bog

155 cm	charcoal, conifer needle
165 cm	charcoal, _Viola_ seed
175 cm	charcoal
185 cm	charcoal, _Viola_ seed
195 cm	_Scirpus_ seed
205 cm	_Chenopodium_ seed, conifer cone scale
215 cm	_Scirpus_ seed, conifer wood
225 cm	_Scirpus_ seed, conifer needle
235 cm	_Scirpus_, _Carex_, _Cyperus_ seeds
245 cm	_Scirpus_ _Betula_, _Najas_, _Carex_ seeds
255 cm	_Scirpus_, _Viola_ seeds
265 cm	_Scirpus_ seeds, conifer needle
275 cm	conifer needle
285 cm	_Scirpus_, _Carex_ seeds
295 cm	charcoal, _Cyperus_ seed

Pollen influx values (i.e. pollen concentration divided by the radiocarbon-determined sedimentation rate) yielded widely varying results.

The highest influx rates, 10,000 to 28,000 grains cm^{-2} yr^{-1}, were in the lowest pollen zone, OC1. They decline greatly to 1100 grains cm^{-2} yr^{-1} at the top of the zone. In zone OC3 they are again less than 3000 grains cm^{-2} yr^{-1}. Because of uncertainities with the radiocarbon chronology and the sedimentation rates, a pollen influx diagram was not prepared.

Pollen percentages vary widely within assemblage zones and frequently between individual samples. Many of these variations are not in concert with ecologically expected changes in associated taxa. However, an examination of the assemblage zones discloses trends in the data.

• Zone OC1 (250 to 285 cm)

From the base of the core at 285 cm to 250 cm, the pollen assemblage is characterized by 43 to 70 percent Pinus, 3 to 14 percent Picea, and a zonal average of 19 percent nontree pollen (NAP = nonarboreal pollen)--the highest percentages of NAP in the core. Throughout the zone, Pinus increases upward, while Picea remains less than 14 percent. The basal sample (285 cm) is from the silty peat, which is a different sediment type from that of the peat; its distinct pollen values may reflect accumulation processes and not actual vegetational changes. Salix declines upward, from 11 to 3 percent; Betula varies between 4 and 6 percent; Ostrya/Carpinus (hornbeam) and Quercus occur at less than 2 percent.

Among the NAP, Ambrosia (ragweed) and Gramineae (grass family) are the most abundant, and percentages of both taxa decline upward. Artemisia (sage), a common indicator of glacial environments, averages only 3 percent and is never abundant in the core. The largest total pollen influx for the core occurs in OC1.

Assemblage zone OC1 contains more taxa than the succeeding zones, an average of 18 per sample. This zone is within the top of the silty peat and the lower half of the fibrous peat. Except for an increase in Picea pollen, there are no major vegetational changes across the contact between the two types of peat. According to the radiocarbon-determined sedimentation rate (fig. 4b-1), zone OC1 with its characteristic interstadial pollen assemblage was deposited about 49,000 to 46,000 years BP within an early phase of a Wisconsinan (Altonian) interstadial.

• Zone OC2 (150 to 250 cm)

Between 255 and 245 cm within the fibrous peat, there are major changes in the percentages of Pinus, Betula, Salix, and Gramineae marking the boundary between pollen assemblage zones OC1 and OC2. Picea increases upward in OC2 from 4 to 28 percent. The large spruce peak at 215 cm occurs in only one sample; and as no other taxa have related changes, its significance is unknown.

Pinus, which declined across the zonal boundary from 70 to 37 percent, increases to a maximum of 67 percent in midzone before decreasing to

48 percent at the top. After early increases, both Betula and Salix declines. Quercus, less than 1 percent in zone OC1, increases in OC2 to 2 to 4 percent. Throughout OC2, both the percentage of herbs and grass and the number of taxa decline with decreasing depth.

Zone OC2 is within the upper half of the fibrous peat and all of the peat; its upper boundary coincides with the contact between the peat and the overlying organic silt. The sedimentation rate indicates that pollen assemblage zone OC2 accumulated between 46,000 and 38,000 RCYBP.

- **Zone OC3 (115 to 150 cm)**

Zone OC3 is confined to the organic silt and exhibits significant pollen changes from the underlying peat. Across this contact Picea declines abruptly from 28 to 4 percent, Pinus increases from 50 to 77 percent, and Betula declines. There is an increase in Ostray/Carpinus, as well as in Gramineae. The abrupt shifts in pollen frequencies and the sharpness of the contact between the organic silt and the peat indicate a sedimentary hiatus in the record. Major geological events were occurring at this time as the peat-accumulating bog was buried by alluvial/lacustrine silts. The radiocarbon dates and the calculated sedimentation rate indicate that this hiatus covered several thousand years before 38,000 BP.

Zone OC3 was not divided into subzones; however, both zonation methods identified the top three samples as distinct from the other samples taken in this zone: Picea percentages increase while Pinus and Betula percentages decrease. Also, the number of taxa increases slightly as does the NAP percentages.

Zone OC3 is confined to the organic silt, and pollen was not preserved in the overlying sandy sediments. The radiocarbon-dated sedimentation rate indicates that this pollen assemblage zone accumulated between approximately 33,000 and 25,000 BP.

DISCUSSION

The pollen from Oak Crest Bog provide data on the vegetation of the Altonian and Farmdalian Substages. Little data have previously been available for this area of the western Great Lakes. The vegetational trends indicated by the pollen assemblage zones suggest that glacial activity may have occurred elsewhere in the Great Lakes region. Glacial events may not have taken place in the immediate area.

Reconstructions of interstadial environments, based on sites mostly hundreds of kilometers south of the Great Lakes, have indicated that this period was one of continually stable conditions. Mid-Wisconsinan climatic shifts apparently had little effect on the vegetation. The vegetation across the middle of the continent from Missouri to the Carolinas (Delcourt and Delcourt, 1981; King, 1973; Whitehead, 1973) was dominated by the genus Pinus; and the macrofossils from many of these sites indicate that the species was jack pine, P. banksiana (Watts, 1983). The prominence of herbs and grasses at many sites indicates woodland or open parkland. Faunal records from the period (Saunders, 1977) indicate that numerous herbivores inhabited these pine-dominated open communities.

The Voegelli Farm site from northern Illinois (Whittecar and Davis, 1982) supplied the first reported interstadial pollen data from a northern location in the western Great Lakes area. The pollen record indicates relative vegetational stability between 40,000 and 26,000 RCYBP, although it shows considerably more *Picea* pollen than has been obtained from sites to the south.

The Oak Crest Bog pollen record indicates vegetational changes that may reflect glacial and climatic events elsewhere in the Great Lakes region (fig. 4b-3). Pollen assemblage zone OC1, deposited before 46,000 BP, is interpreted as the pine-dominated vegetation common during the interstadial. As at the Voegelli Farm locality, its more northern location is reflected in the greater abundance of spruce pollen. The zone contains taxa, such as *Ostrya/Carpinus*, *Salix*, and *Betula*, which suggest cool interstadial conditions. Assemblage zone OC1 may relate to the Port Talbot II Interstadial of the eastern Great Lakes, dated between about 50,000 and 37,000 RCYBP (Dreimanis and Goldthwait, 1973). While the calculated age for the top of zone OC1 at Oak Crest does not match these dates, there is no reason to expect events in the two regions to be synchronous due to the distance separating the Port Talbort II type area in Ontario from northern Illinois, and the fact that the two areas may have been under the influence of different glacial lobes.

Sometime after 46,000 RCYBP the pollen in Zone OC2 shifted toward higher spruce and lower pine percentages. These pollen changes may reflect climatic cooling associated with renewed glacial activity in North America. Dreimanis and Goldthwait (1973) place a glacial readvance in the eastern Great Lakes between 37,000 and 33,000 RCYBP. Unfortunately Woodfordian glacial activity in the western Great Lakes obliterated all but hints of the mid-Wisconsinan interstadial record. Organics beneath tills in Michigan were dated at 45,000 RCYBP (Stuiver et al., 1978) and a log in glacial outwash was dated at 33,300 RCYBP (Eschman, 1980); they have been cited as evidence for mid-Wisconsinan glacial readvances. The Capron Till in northern Illinois and adjacent Wisconsin may be mid-Wisconsinan in age (Krumm and Berg: Stop 3).

The spruce increase in the top of pollen assemblage zone OC2 began after 38,000 RCYBP according to the sedimentation rates.The depositional hiatus between the peat (zone OC2) and the organic silt (zone OC3) probably contained the culmination of the spruce increase, suggesting renewed glacial activity in the region. The radiocarbon dates suggest the missing section is several thousand years long, probably between about 38,000 and 33,000 years BP.

The OC2/OC3 boundary coincides with the contact between the peat and the overlying organic silt. Across this boundary the pollen once more changes to lower values of *Picea*, *Betula*, and higher percentages of *Pinus*. There are increases in the total number of taxa. These changes apparently reflect a return to interstadial conditions in lower OC3 that may be related to the Plum Point Interstadial of the eastern Great Lakes 33,000 to 25,000 RCYBP (Dreimanis and Goldthwait, 1973). Pollen zone OC3 is dated between approximately 33,000 and 25,000 BP, encompassing the late Altonian and Farmdalian substages.

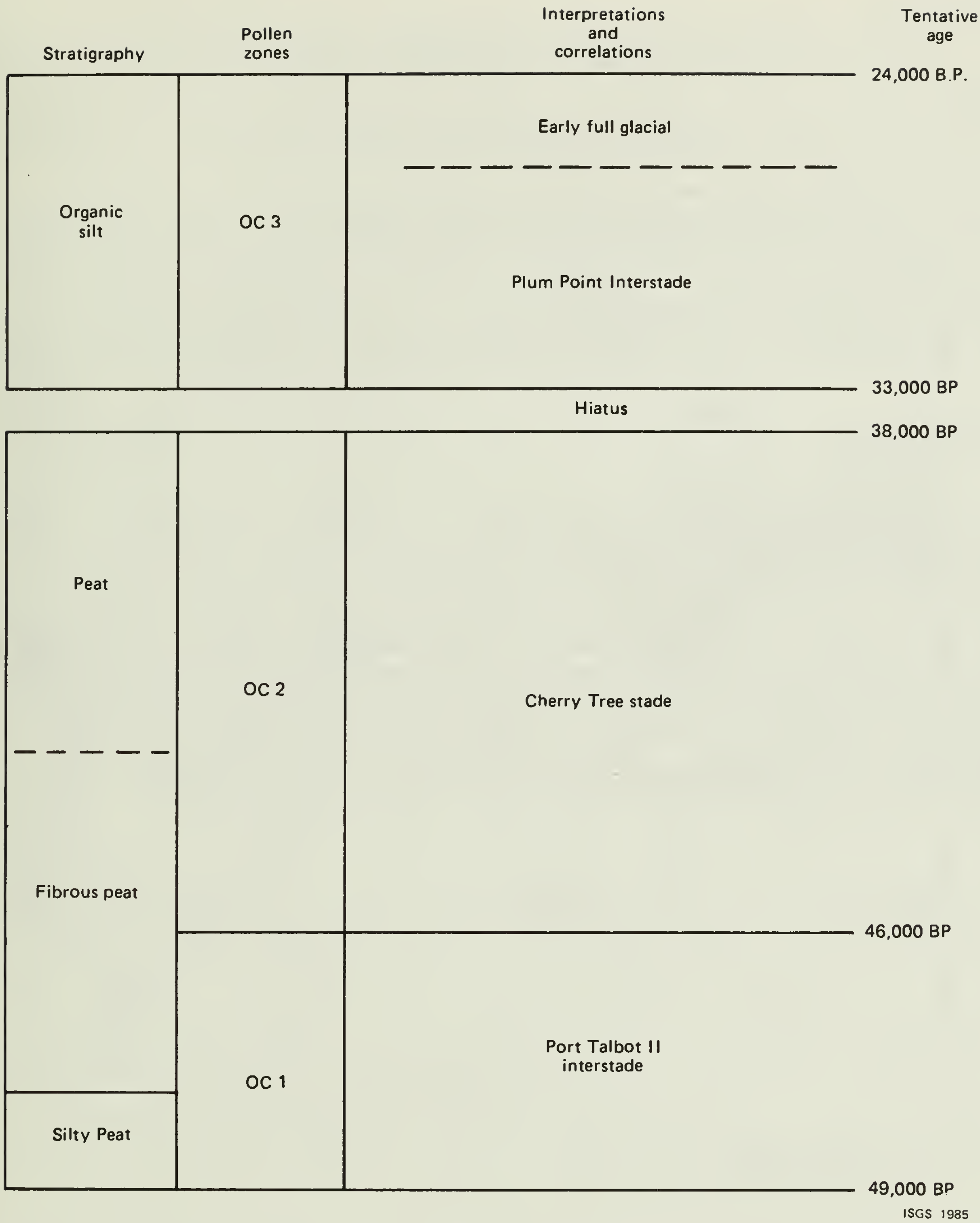


Figure 4b-3 Tentative interpretations and correlations of the geologic and palynologic sequence at Oak Crest Bog.

In the upper part of OC3, Picea increases and Pinus declines, signaling the onset of the classic late Wisconsinan Woodfordian Substage. This pattern of vegetation shift to dominance by glacial-indicating taxa is seen in pollen diagrams from throughout the midcontinent (Watts, 1983). The top of the organic sediments is dated at 24,830 ± 350 BP. At that time, the fossil vegetation record at Oak Crest ceased and Woodfordian age eolian silts and sands began to accumlate.

CONCLUSIONS

Because of the nature of the sedimentary regime at Oak Crest, the pollen record is more variable than is common in lake sediments. Sedimentation rates within peats can vary greatly, and there is no reason to expect that the rates indicated here were constant throughout the suggested times. In addition, the differing accumulation environments of the pollen-bearing silts both above and below the peats could have influenced the resulting pollen assemblages. However, the broad pollen assemblage zones suggest vegetation shifts that appear to reflect glacial events occurring elsewhere in the region. Although the evidence for ice-contact features in northern Illinois is not strong, the extensive deposits of Roxana Silt throughout the state point to mid-Wisconsinan glacial activity within the region of the western Great Lakes. The limited palynological data from Oak Crest may be reflecting such events.

ACKNOWLEDGMENTS

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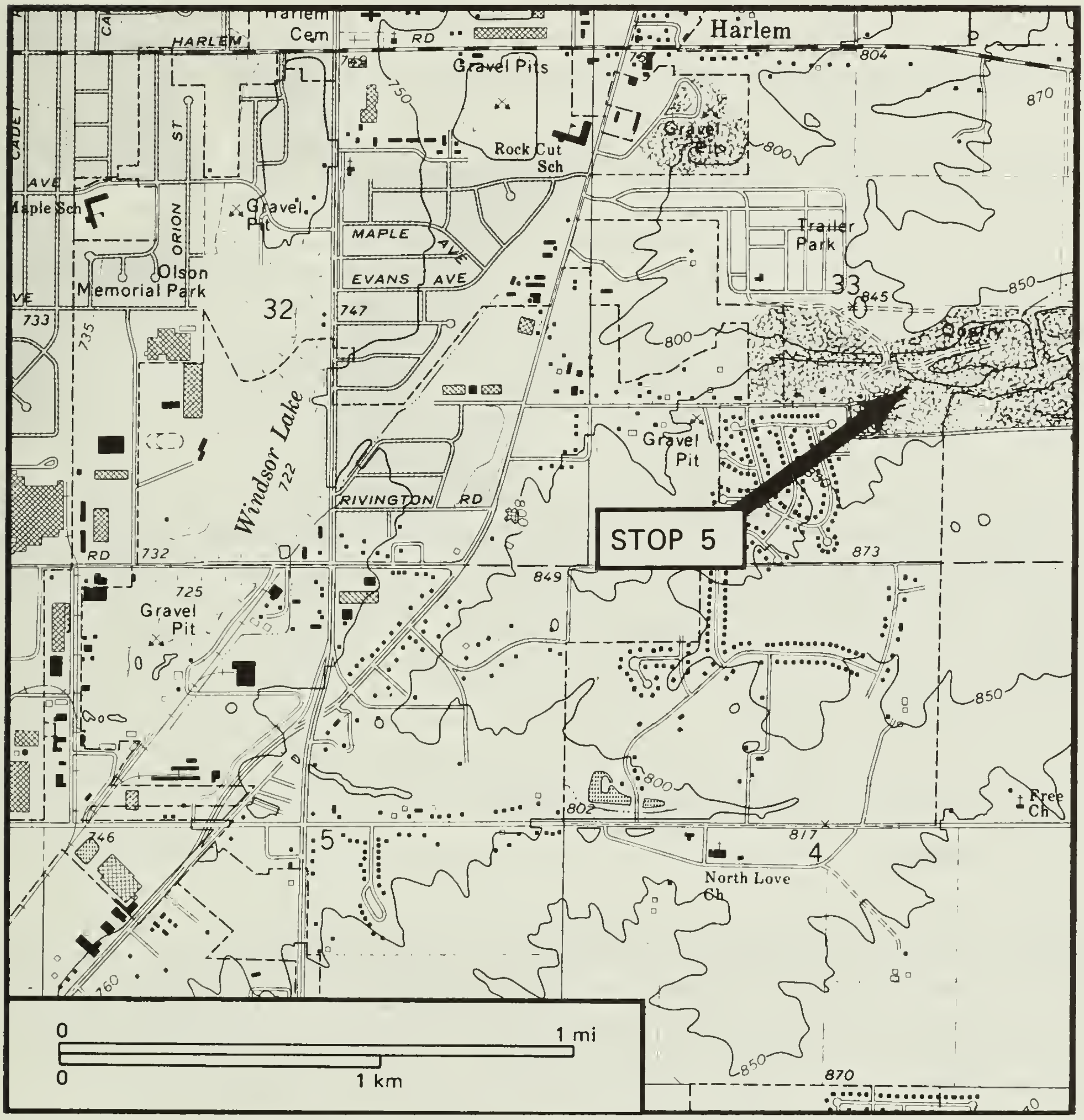
Winnebago and Glasford Formation Diamictons at the Nimtz Quarry Section

Richard C. Berg and John P. Kempton



STOP 5
Nimtz Quarry Section
SW NE SE Sec. 33, T 45 W, R 2 E, Winnebago County

The Nimtz Quarry Section is the most important multiple-diamicton exposure in central northern Illinois. At this exposure we will discuss the Argyle and Nimtz Tills and their relationship to older Glasford Formation till members.

INTRODUCTION

The Argyle Till Member of the Winnebago Formation was originally described by Frye et al. (1969) and formally defined by Willman and Frye (1970). Its type section is the Rock Valley College Section, 9 km southwest of Argyle, Illinois. The diamicton was described as very sandy, pinkish tan or "salmon" in color, and interpreted as Altonian in age. The upper boundary of the Argyle was the Plano Silt, while its lower boundary was unnamed deposits of the Winnebago Formation or older deposits. Its area of occurrence included Boone, Winnebago, Ogle, and Lee Counties.

Soil mapping showed that the Argyle Till contained a paleosol--presumably the Farmdale Soil that formed 22,000 to 28,000 years ago. However, Kempton, Berg and Follmer (this guidebook), McKenna (Stop 4a), McKenna and Follmer (Stop 6), and Follmer, Berg and Masters (Stop 7) interpret the paleosol to be the Sangamon Soil; therefore, the Argyle is Illinoian. This recognition catalyzed the revision of the geographic extent and rock-stratigraphic placement of the Argyle. The purpose of this paper is to present formal revisions which are based on data from the Nimtz Quarry Section and other locations. We also recognize an additional till member within the Winnebago Formation: the Nimtz Till Member.

The Argyle and Nimtz Till Members were identified during field investigations and through evaluation of deep borings (Berg, Kempton, and Stecyk, 1984). The Nimtz Till was informally named in that report. Field observatons were supplemented by laboratory data. Grain-size distributions were determined by the hydrometer procedure; clay-mineral compositions were calculated by the X-ray diffraction technique developed by Glass (Hallberg, Lucas, and Goodmen, 1978).

FORMAL DEFINITIONS OF THE ARGYLE AND NIMTZ

Argyle Till Member (revised)

Revising the stratigraphic boundaries of the Argyle Till Member establishes its upper boundary as the Berry Clay (Sangamon Soil) and its lower boundary as the Nimtz Till Member. The distribution of the Argyle Till Member is now limited to northern Boone and eastern Winnebago Counties. Mickelson et al. (1984) mapped a correlative unit to the Argyle in south-central Wisconsin: the Allens Grove Member of the Walworth Formation.

The earlier definition of Argyle Till was based on its stratigraphic placement beneath the Esmond Till Member, which was considered to be early Woodfordian (Willman and Frye, 1970). However, it is the Oregon, not the Argyle, that is exposed in western Winnebago, Lee, and Ogle Counties, and that underlies the Esmond. The reason for confusing the Argyle and the Oregon diamictons (Kempton and Berg: Stop 9; Kempton, Berg, and Follmer: this guidebook) is that their grain-size distributions are similar, and their clay-mineral compositions appeared to be similar. We now know that unaltered Argyle averages 65 percent illite; whereas unaltered Oregon averages 55 percent illite. Similar clay-mineral compositions for the Argyle and Oregon resulted from combining altered and unaltered samples. Sixty-one percent illite for Argyle and 59 percent illite for Oregon (Kempton, Berg, and Follmer: this guidebook) illustrate the similarity between these units when altered and unaltered samples are combined. The Argyle and Oregon Tills can now be distinguished, not only on their clay-mineral composition, but also on the basis of stratigraphic position and color; the Oregon is redder than the Argyle.

Because the original Rock Valley College type section for the Argyle Till Member is not accessible, a paratype section from a boring, designated the Argyle Boring, has been established. It is located .8 km southeast of the village of Argyle, in Boone County, NE NW NW Sec. 30, T 45 N, R 3 E. At this section both oxidized and unoxidized Argyle diamictons are present (Appendix).

Nimtz Till Member (new)

Another problem related to the recognition of the Argyle was that many diamicton samples were described as Argyle according to their lithologic characteristics and statigraphic position, yet they contained more illite than type Argyle Till. The diamicton containing more illite was determined to be stratigraphically distinct from the overlying Argyle; we have named it the Nimtz Till Member of the Glasford Formation (Centerville Road Section, and Winnebago County Boring W-45-20 shown in the Appendix; also Nimtz Quarry Section). The Nimtz Till Member is named for an exposure at Nimtz Quarry in Winnebago County, 5 km east of Loves Park, Illinois (N 1/2 SE Sec. 33, T 45 N, R 2 E).

Kempton, Berg, and Follmer (this guidebook) found that both the Argyle and Nimtz have similar grain-size distributions; however, the illite for Nimtz and Argyle Tills (combined altered and unaltered samples) averages 69 percent and 61 percent, repectively. Unaltered samples of Argyle Till average 65 percent illite; whereas unaltered samples of Nimtz Till contain the same illite percentage as altered samples: 69 percent.

The Nimtz is usually less than 15 m thick, gray-brown or buff, and loam to sandy loam. It stratigraphically overlies the Beaver Creek Sand Member; and where the Beaver Creek is absent, it overlies the Belvidere Till Member of the Glasford Formation. (The Belvidere-Nimtz relationship is shown in the Capron West and Northwest McHenry County Borings (Appendix); Berg and Kempton discuss the Beaver Creek-Nimtz relationship: Stop 8.) The Nimtz occurs above the Esmond Till Member of the Glasford Formation at the Spartan Store Secton (Appendix) and above the Oregon Till Member in the Garden Prairie North Boring, County Farm Landfill Section, and possibly in Winnebago County Boring W-45-20, (Appendix) and in Profiles 11 and 12, Nimtz Quarry Section. The Nimtz occurs below the Argyle Till Member is the Nimtz Quarry Section and at the Centerville Road Section (Appendix).

The Nimtz Till occurs primarily in the subsurface east of the Rock River in Winnebago, northern Boone, and northwestern McHenry Counties. It is exposed as a surficial unit on sloping land adjacent to the Kishwaukee River and Piscasaw Creek. The Nimtz has no stratigraphic equivalents, although it may be related to the same ice episode that deposited the Argyle Till. The clay-mineral compositions of both the Nimtz and Belvidere Tills are perhaps mixed, reflecting possible incorporation of the higher illite Esmond or Herbert Tills.

NIMTZ QUARRY SECTION

The Argyle and Nimtz Till Members are exposed at the Nimtz Quarry Section, the type section for the Nimtz Till. The Oregon, Belvidere, Herbert, and Kellerville Tills (fig. 5-1) may also be present.

The Nimtz Quarry Section is situated on the eastern flank of the Rock Bedrock Valley. The bedrock topography drops 75 m between the section and the axis of the bedrock valley, 4 km to the west. East of the section is a bedrock high separating the Rock Bedrock Valley from the Troy Bedrock Valley. This bedrock high apparently acted as a barrier to westward or southwestward flowing glacial ice, protecting older diamictons from glacial scouring on its leeward side.

Nimtz Quarry Section - Profile 1

Pleistocene Series
Illinoian Stage
Winnebago Formation
Argyle Till Member

Depth (m)	Sample no.		Thickness (m)
2.0 3.0	1a 1	Diamicton; sandy loam, yellowish brown (10YR 5/4), friable, calcareous	3.0
		Nimtz Till Member	
5.0 5.3	2 3	Diamicton; loam, yellowish brown (10YR 5/4), oxidized, massive to weak blocky structure, calcareous	2.3
5.6 6.1 6.5 7.0 7.2	4 5 6 7 8	Diamicton; loam, dark gray (10YR 4/1), unoxidized, massive to weak blocky structure, lowermost sample hard and oxidized with dark yellowish brown (10YR 4/6) mottles (oxidation presumably by groundwater), calcareous	1.9
		Sand; yellowish brown, leached	0.1
7.3 7.7	9 10	Diamicton; loam, light brownish gray (10YR 6/2), massive structure, calcareous	0.4
		Sand streaked with diamicton, yellowish brown	0.2

Depth (m)	Sample No.		Thickness (m)
		Glasford Formation	
		Belvidere Till Member	
7.9	11	Diamicton; loam, yellowish brown (10YR 5/4),	
8.2	12	massive structure, thin sand lense at base, calcareous	0.5
		Unnamed till member	
8.3 8.7 8.7	13 14 15	Diamicton; loam, brown (7.5YR 5/4) yellowish brown (10YR 5/6) stains, sand streaks associated with stains, color of stains fades with depth, calcareous	0.5
8.9 9.6	16 17	Diamicton; loam, grayish brown (10YR 5/2), calcareous	0.9
		Kellerville Till Member Pike Soil	
9.8 10.4	18 19	Diamicton; silty loam, dark grayish brown (10YR 4/2), blocky to coarse platy structure, leached, some strong brown (7.5YR 4/6) sand inclusions, iron staining, possible B3C1 horizon of Pike Soil	0.8
10.5 10.9	20 21	Diamicton; loamy silt, gray (5Y 5/1), some snails, calcareous	0.5
11.1		Ordovician System Galena Dolomite	
		Total	11.1

Nimtz Quarry Section - Profile 2

Depth (m)	Sample No.		Thickness (m)
		Pleistocene Series Illinoian Stage Winnebago Formation Argyle Till Member	
2.5 3.5 4.5	1 2 3	Diamicton; sandy loam, yellowish brown (10YR 5/4), weak blocky structure, numerous thin sand lenses, calcareous	4.5
		Glasford Formation Unnamed till member	
5.5 6.5 7.5	4 5 6	Diamicton; loam, yellowish brown (10YR 5/4), weak blocky structure, calcareous	3.0

Depth (m)	Sample No.		Thickness (m)
	Kellerville Till Member	Pike Soil	
8.5	7	Organic silt with wood fragments; leached, correlates with leached zone in Kellerville Till in samples 18 and 19 of Profile 1	1.0
13.0		Slumped material	4.5
	Ordovician System Galena Dolonite		
		Total	13.0

A small channel-like depression incised into the surface of the bedrock is exposured on the south side of Nimtz Quarry. This protected setting apparently has contributed to the preservation of older diamictons in the area. Although 12 profiles have been described on both sides of the quarry, the principal multiple-diamicton profiles are located just above this channel-like feature. These profiles are shown in figures 5-2 and 5-3.

Two diamictons of the Winnebago Formation, differentiated primarily on their illite percentages, are exposed in Profiles 1 and 2 at this section. The Argyle Till Member averages 63 percent illite; whereas the Nimtz Till Member averages 69 percent illite. The two uppermost Nimtz Till samples are altered and oxidized in Profile 1; however, the illite percentage is similar to the underlying unaltered and unoxidized samples.

The Nimtz Till also displays an unoxidized zone between two oxidized layers at Profile 1, although the lower oxidized zone does not appear to be a different diamicton. Grain-size distribution, clay-mineral composition, and carbonate data are similar to the overlying unoxidized layers. Oxidation of the lower zone may have resulted from groundwater flow through a 20-cm thick sand layer just below the unoxidized diamicton.

The difference in texture between the Argyle and Nimtz at Profile 1 is pronounced; however, the sand percentages of the diamictons are usually similar over the northern Illinois region (Kempton, Berg, and Follmer: this guidebook). Although both textures and clay-mineral compositions change at a contact (fig. 5-1), this contact is not readily observable at the Nimtz Quarry Section. The physical similarities between the Argyle and Nimtz Tills at the quarry suggest that they were deposited by the same ice advance; however, borings in Boone County and eastern Winnebago County show the Argyle and Nimtz Tills separated by sand or silt, which suggests two advances. Although a weathering horizon has not been recognized between these two diamictons, an organic horizon was discovered between the Argyle and the Nimtz Tills in a highway boring east of the Nimtz Quarry Section (Kempton, 1963).

Below the Nimtz Till in Profile 1 is a 20-cm thick layer of brown loamy diamicton. Grain-size distribution averages 42 percent sand, 34 percent silt, and 24 percent clay; clay-mineral composition averages 16 percent expandables,

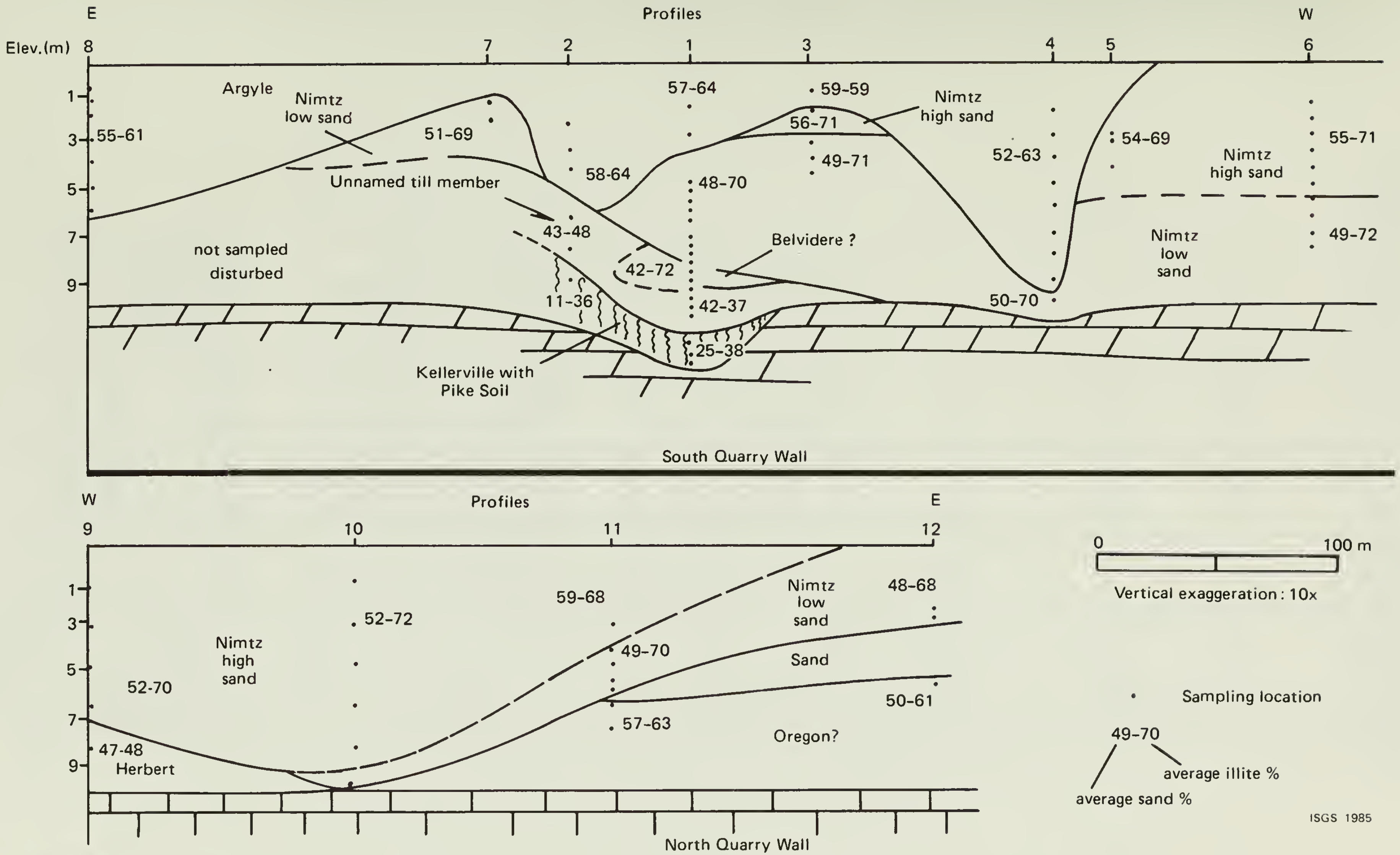


Figure 5-1 Quaternary deposits at the Nimtz Quarry Section.

Stratigraphic unit		Depth (m)		Sample no.	Grain size S-Si-C	Clay min. Ex-I-K+C	Cal. Dol. (counts/sec)	Vermiculite index
Winnebago Formation	Argyle Till Member	2.0		1	58-29-13	22-65-13	0-26	11>
Winnebago Formation	Argyle Till Member	3.0		1a	56-26-18	23-62-14	34-32	10>
Winnebago Formation	Nimtz Till Member	4.0						
Winnebago Formation	Nimtz Till Member	5.0		2	48-28-24	13-72-15	49-55	3>
Winnebago Formation	Nimtz Till Member			3	49-28-23	16-70-14	64-55	
Winnebago Formation	Nimtz Till Member		unoxidized	4	46-32-22	13-69-18	70-64	2<
Winnebago Formation	Nimtz Till Member	6.0	unoxidized	5	48-31-21	12-68-20	56-63	6<
Winnebago Formation	Nimtz Till Member		unoxidized	6	48-30-22	10-70-20	70-64	5<
Winnebago Formation	Nimtz Till Member	7.0	unoxidized	7	48-31-21	12-69-19	71-56	6<
Winnebago Formation	Nimtz Till Member		oxidized	8	47-35-18	17-69-13	37-44	6>
Winnebago Formation	Nimtz Till Member		oxidized	9	46-30-24	18-68-14	48-68	6>
Winnebago Formation	Nimtz Till Member		oxidized	10	49-32-19	18-69-13	48-58	4>
Glasford Formation	Belvidere T.M.?			11	43-35-22	14-74-12	34-55	4<
Glasford Formation	Belvidere T.M.?	8.0		12	42-34-24	18-70-12	45-54	4>
Glasford Formation	Unnamed Till Member			13	51-30-19	43-46-11	18-46	
Glasford Formation	Unnamed Till Member			14-15	49-32-19 45-35-20	54-34-12	23-33 4-40	
Glasford Formation	Unnamed Till Member			16	45-38-17	40-42-18	15-38	21>
Glasford Formation	Unnamed Till Member	9.0						
Glasford Formation	Unnamed Till Member			17	41-38-21	39-41-20	17-38	20>
Glasford Formation	Kellerville Till Member			18	38-34-28	44-38-18	0-0	34>
Glasford Formation	Kellerville Till Member	10.0					Pike Soil	
Glasford Formation	Kellerville Till Member			19	29-42-29	50-37-13	0-0	
Glasford Formation	Kellerville Till Member			20	15-63-22	42-36-22	15-14	35>
Glasford Formation	Kellerville Till Member			21	22-49-29	45-40-15	12-18	
		11.0						

ISGS 1985

Ordovician Bedrock
Galena Group

Figure 5-2 Grain-size distribution, clay-mineral composition, and carbonate data for Profile 1, Nimtz Quarry Section.

Stratigraphic unit		Depth (m)	Sample	Grain size S-Si-C	Clay min Ex-I-K+C	Cal. Dol. (counts/sec)
WINNEBAGO FORMATION	Argyle Till Member	2.0				
			1	59-23-18		31-39
		3.0				
			2	45-32-23	27-61-12	39-55
		4.0				
			3	56-25-19	22-66-12	47-46
GLASFORD FORMATION	Unnamed Till Member	5.0				
			4	45-35-20	37-45-18	21-39
		6.0				
			5	43-36-21	33-49-18	27-35
		7.0				
			6	43-36-21	33-49-18	22-36
	Kellerville Till Member	8.0				Pike Soil
			7	12-67-21	40-36-24	0-10

Ordovician bedrock at 13.0 Slump ISGS 1985

Figure 5–3 Grain size distribution, clay-mineral composition, and carbonate data for Profile 2, Nimtz Quarry Section.

72 percent illite, and 12 percent kaolinite plus chlorite. The diamicton is bounded above and below by sand layers. Although this unit is thin and discontinuous at the site, its characteristics suggest correlation with the Belvidere Till Member (Kempton, Berg, and Follmer: this guidebook).

Another brown loamy diamicton is below the diamicton that is possibly correlated with the Belvidere Till in Profile 2 and below the Nimtz Till in Profile 1. We have tentatively interpreted this brown loamy diamicton to be the Foxhollow till of Wisconsin (Mickelson et al., 1984); however, the Foxhollow is not formally recognized at the Nimtz Quarry Section. In both profiles the sand content decreases with depth. It averages 45 percent sand, 36 percent silt, and 19 percent clay. The clay-mineral composition of this diamicton (42 percent expandables, 43 percent illite, and 15 percent kaolinite plus cholorite) is in marked contrast to the overlying higher illite diamictons.

The lowest dark gray-brown to greenish gray silt loam diamicton at the Nimtz Quarry Section has been correlated with the Kellerville Till Member, which was described by Willman and Frye (1970). The type section of the Kellerville is near Kellerville, Adams County, Illinois. In Profile 1, at the Nimtz Quarry Section, the upper 0.8 m is leached of carbonates and iron stained; it averages about 33 percent sand, 39 percent silt, and 28 percent clay. The lower 0.5 m of diamicton is calcareous, contains snail shells, and is considerably more silty than above, averaging 19 percent sand, 57 percent silt, and 24 percent clay. The clay-mineral composition of the four samples averages 45 percent expandables, 38 percent illite, and 17 percent kaolinite plus chlorite. In Profile 2, an organic silt with abundant wood was observed. This unit has 68 percent silt and 36 percent illite. The Kellerville was not exposed beneath the silt.

The organic silt of Profile 2 and the leached Kellerville Till of Profile 1 may be the Pike Soil, described by Willman and Frye (1970). At its type locality, the Pike Soil is formed in the Kellerville Till. Diamicton correlated to the Kellerville has also been found underlying organic deposits in deep borings in northern Boone County and in the Rock Bedrock Valley (Berg, Kempton, and Stecyk, 1984). The grain-size distribution for the Kellerville in northern Illinois averages 30 percent sand, 43 percent silt, and 27 percent clay; its clay-mineral composition averages 41 percent expandables, 41 percent illite, and 18 percent kaolinite plus chlorite. The clay-mineral composition is almost identical to the Kellerville described by Follmer et al. (1979) in western Illinois.

Nine additional profiles on both sides of the quarry have been described (fig. 5-1). On the south side of the quarry, the Argyle Till pinches out to the west; the Nimtz Till then occurs at the surface. A diamicton possibly correlative with the Herbert is exposed beneath the Nimtz at the base of Profile 9 (fig. 5-1). The overall higher illite characteristics of the Nimtz than the Argyle may be the result of incorporation of high illite from this Herbert Till or Esmond Till. Two textural variants of the Nimtz Till, a high sand over a low sand, are present in Profiles 3, 6, 9, 10, and 11. The uppermost variant averages 55 percent sand; whereas the lowermost variant averages 48 percent sand. The Argyle Till is absent on the north side of the quarry.

A diamicton possibly correlative with the Oregon Till Member is exposed below the Nimtz Till and the Beaver Creek Sand Member in Profiles 11 and 12 on the north side of the quarry. Illite in this diamicton averages 62 percent. Its texture is a loam to sandy loam. Although both the Argyle and Oregon Tills have similar characteristics, they are separated at the Nimtz Quarry Section by the Nimtz Till. The identification of possible Oregon Till beneath the Nimtz Till was also verified by samples from borings north of the quarry (Kempton, Berg, and Follmer: this guidebook).

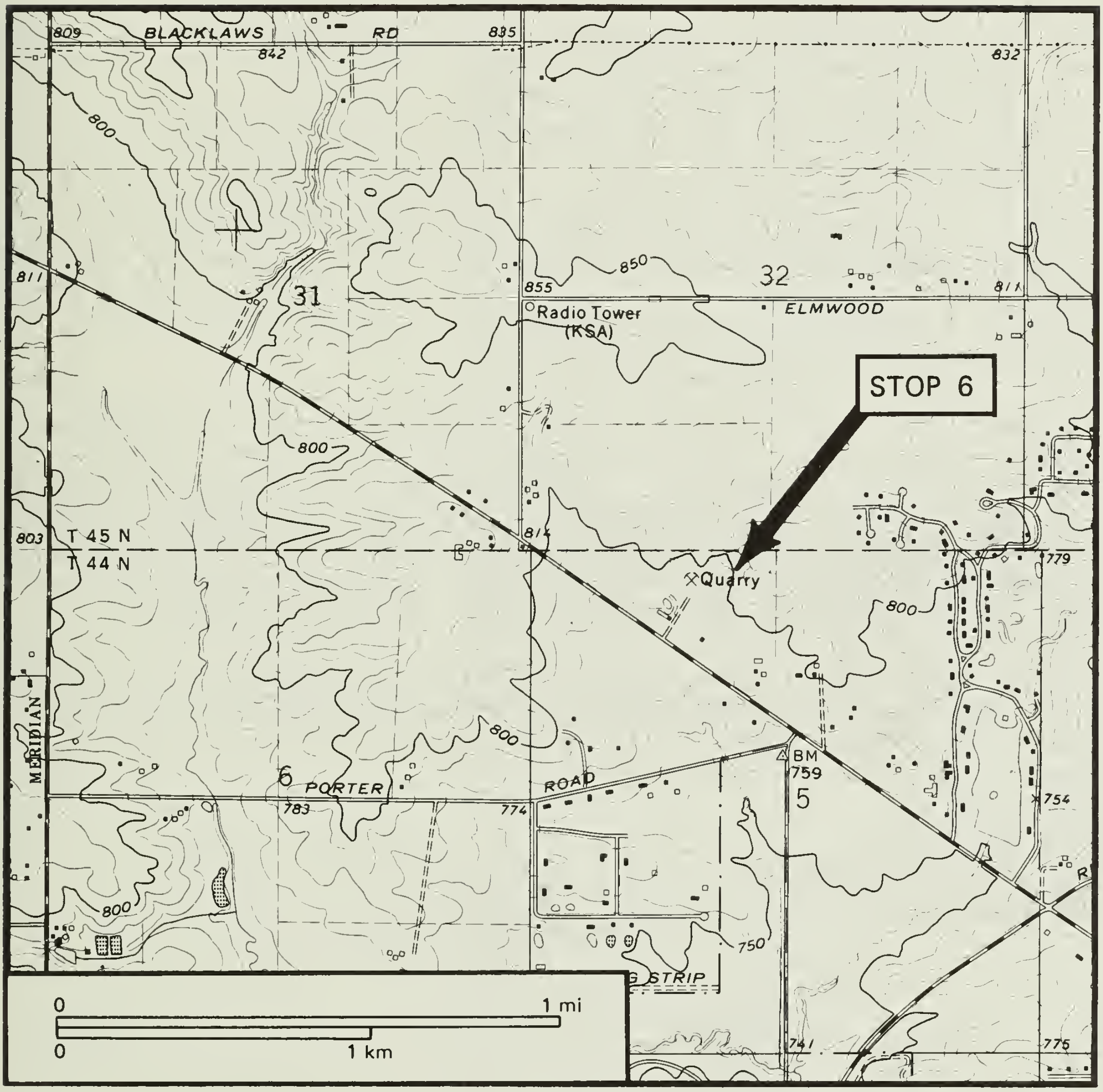
The Nimtz Quarry Section, the most complete multiple diamicton exposure in north-central Illinois, is also one of the most significant exposures of Ordovician bedrock in the area. The lower 6 m of the quarry is composed of the Platteville Group--The Quimby's Mill (above) and Nachusa Formations. Above the Platteville is the Galena Group. The entire Dunleith Formation is exposed, overlain by 4.5 to 6 m of the Wise Lake Formation. The Loves Park Member comprises most of the Dunleith Formation and consists of relatively pure dolomite that lacks argillaceous zones. Large chert nodules and bentonite layers are characteristic. The material is not very fossiliferous. A prominent bedding plane near the top of a cherty zone in the Dunleith is the contact with the Wise Lake Formation. Wise Lake dolomite is light brown, very pure, and non-cherty; it contains a wide variety of internal and external molds of fossils. The Wise Lake Formation commonly produces the best aggregate because of the absence of chert.

SUMMARY

The Nimtz Quarry Section provides evidence for the separation of key rock-stratigraphic units in northern Illinois. Although field evidence is lacking for separation of the Argyle and Nimtz Till Members at the quarry, the underlying Nimtz Till is identified by its illite percentage, which is higher than that of the Argyle Till. Evidence at the quarry suggests that the two diamictons may represent the same ice advance. Elsewhere in northern Illinois borings show silts or sands between the Argyle and Nimtz; this fact may suggest two advances. The Oregon, Belvidere, Herbert, and Kellerville Tills may also be present at the quarry. These diamictons are exotic to the immediate area and are preserved here perhaps because of the somewhat protected setting of the bedrock surface.

The Farmdale and Sangamon Soils at the Wempletown Southeast Section Winnebago County, Illinois

Dennis P. McKenna and Leon R. Follmer



STOP 6
Wempletown Southeast Section
NW 1/2 Sec. 5, T 44 N, R 1 E, Winnebago County

The Wempletown Southeast Section is the only exposure in northern Illinois showing a sequence of Roxana Silt, the Sangamon Soil, and the Argyle Till Member of the Winnebago Formation. This section places the age of the Argyle and Nimtz Tills as Illinoian rather than Altonian.

INTRODUCTION

The Wempletown Southeast Section is an exposure in a quarry on the uplands above the North Fork of Kent Creek in Winnebago County (NW Sec. 5, T 44 N, R 1 E).

This section is the first tollway boring to be 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). An unnamed organic soil dated at 20,150 ± 500 RCYBP (ISGS-1302) formed in the lower part of the Peoria Loess and a Farmdale Soil formed in the Roxana make this the most complete stratigraphic section within the area previously considered to be underlain by early Wisconsinan deposits. From the evidence found at this section and the Oak Crest Bog (McKenna: Stop 4a), we conclude that the lower Winnebago Formation deposits are late Illinoian in age.

The Wempletown Southeast Section was sampled in detail to identify its stratigraphic components. Each unit was sampled and analyzed for particle size and clay-mineral composition. A bulk sample of an organic-rich silt in the lower part of the Peoria Loess was collected for radiocarbon dating. This sample was dispersed, sieved to remove coarse material and a few roots, and treated with HCl to remove carbonate minerals. This process produced a fine silt and clay fraction that was submitted for radiocarbon dating.

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.

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

Soil horizon	Depth cm	Sample no.		Thickness (cm)
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
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 roots, 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) 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, gray silt is dolomitic	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

Soil horizon	Depth cm	Sample no.		Thickness (cm)
3A-E	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
3-4A-E	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 increase in black concretions, fragic characteristics (more brittle than above), few pebbles, stone line at bottom	83

The profile description continues 25 feet 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

4E-Bt	200-215	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

Soil horizon	Depth cm	Sample no.		Thickness (cm)
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
4C2	450-510 (590-650)	PB20 PB21	Diamicton; light yellowish brown (10YR 6/4) sandy loam, numerous pebbles, dolomitic	60
5R	510+ (590+)		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 these materials (fig. 6-1), we recognized (1) an additional soil in the Peoria Loess, and (2) that the Roxana 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, based on 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 characteristics of the Peoria Loess. Textural data further complicates 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 A horizon at 175 to 187 cm (PB-8) was dated at 20,150 ± 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-RCYBP 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 ± 500 RCYBP.

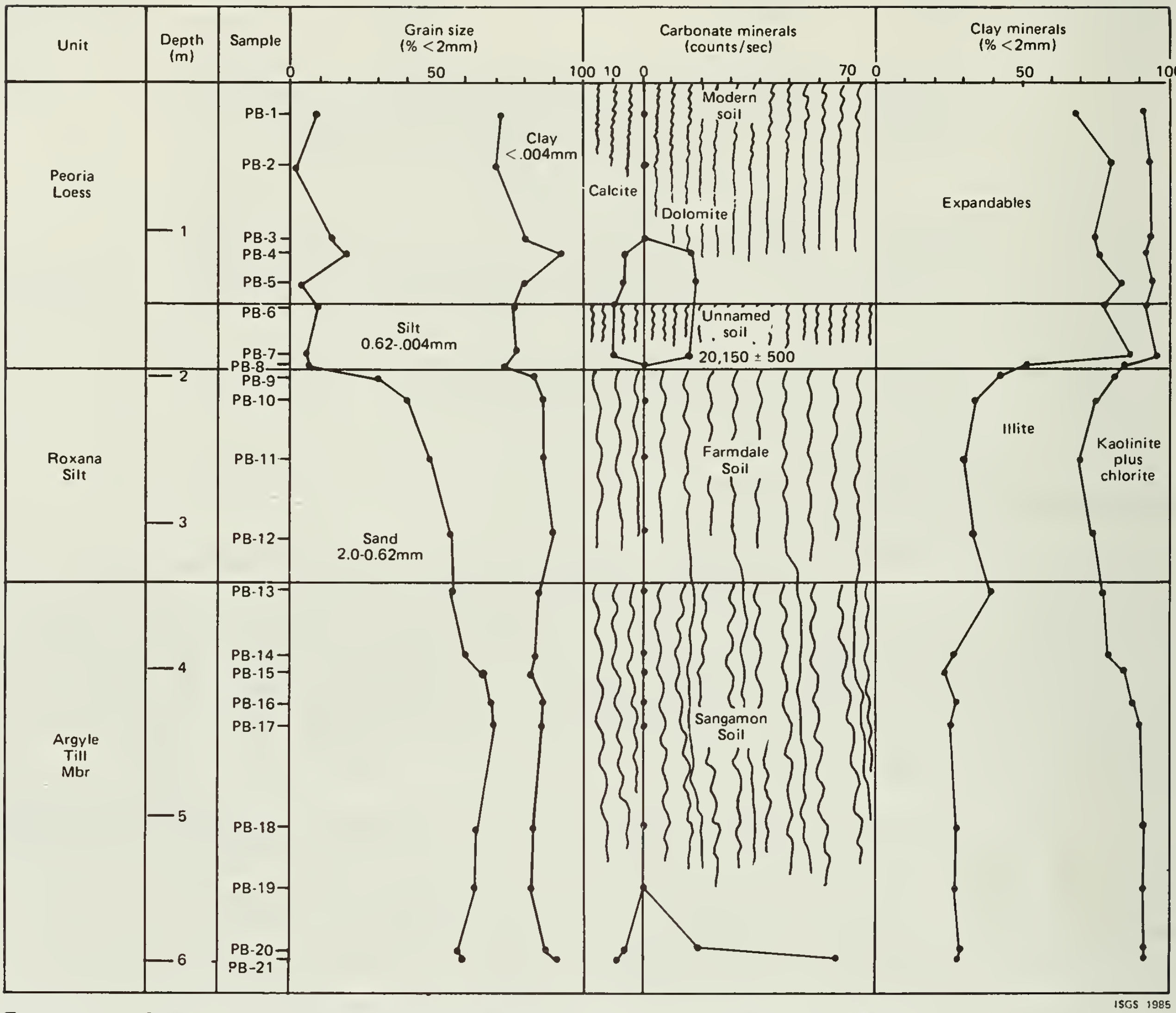


Figure 6-1 Grain-size distribution, clay-mineral composition, and carbonate data for the Wempletown Southeast Section.

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 have 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; it 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. This 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 SCS (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 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 as opposed 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 reformed into a Bt(B2) at a later time. Based on the evidence at the Oak Crest Bog (McKenna: Stop 4a), there may have been as much as 25,000 years of a cool moist climate in which the Farmdale Soil was subject to weathering. Assuming those conditions, the morphology of the presently exposed polygenetic paleosol is more understandable.

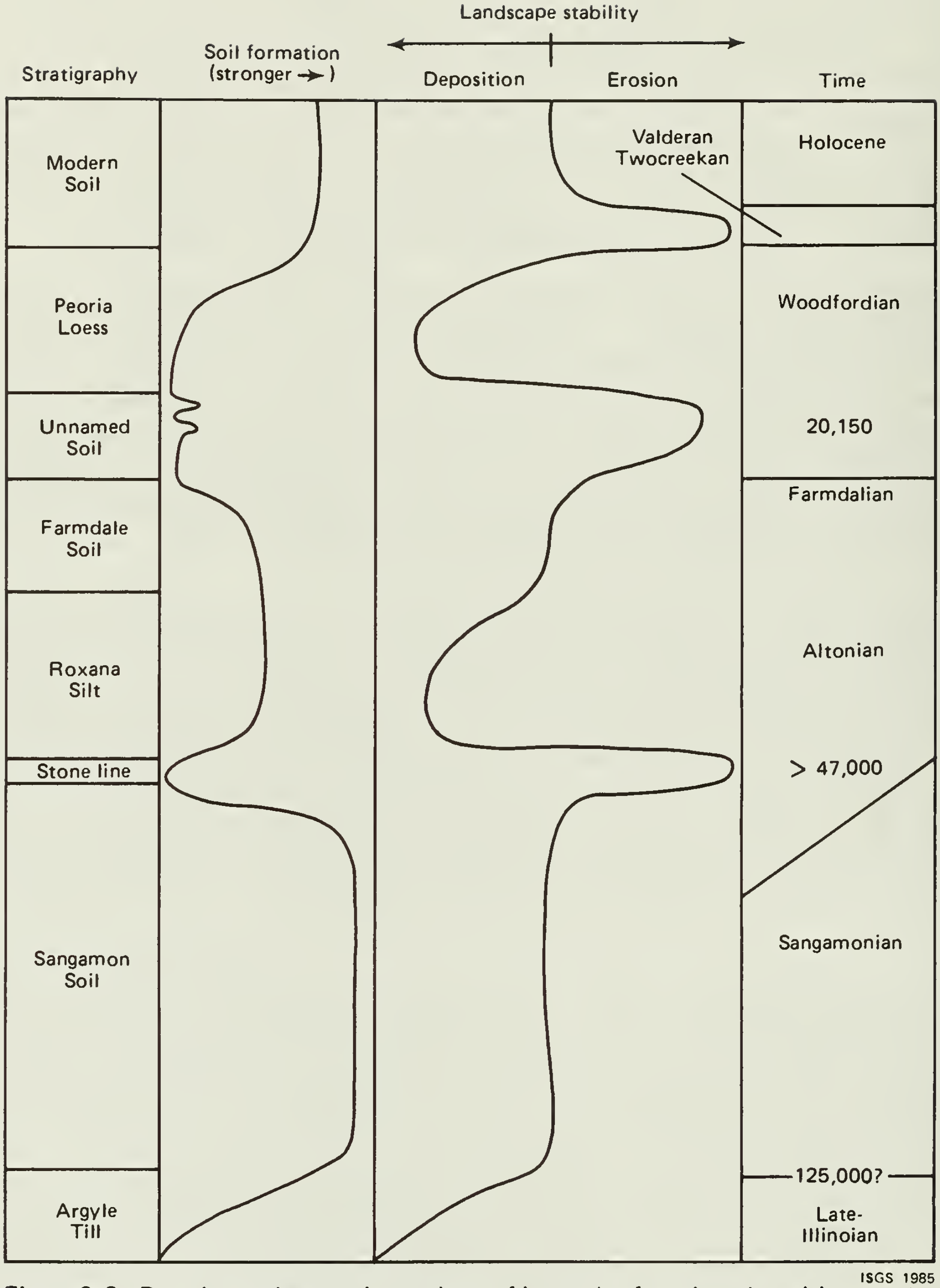


Figure 6-2 Duration and approximate dates of intervals of erosion, deposition, and soil formation since late-Illinoian time. The model is based on soil- and rock-stratigraphic evidence at the Wempletown Southeast Section and in adjacent sections.

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.

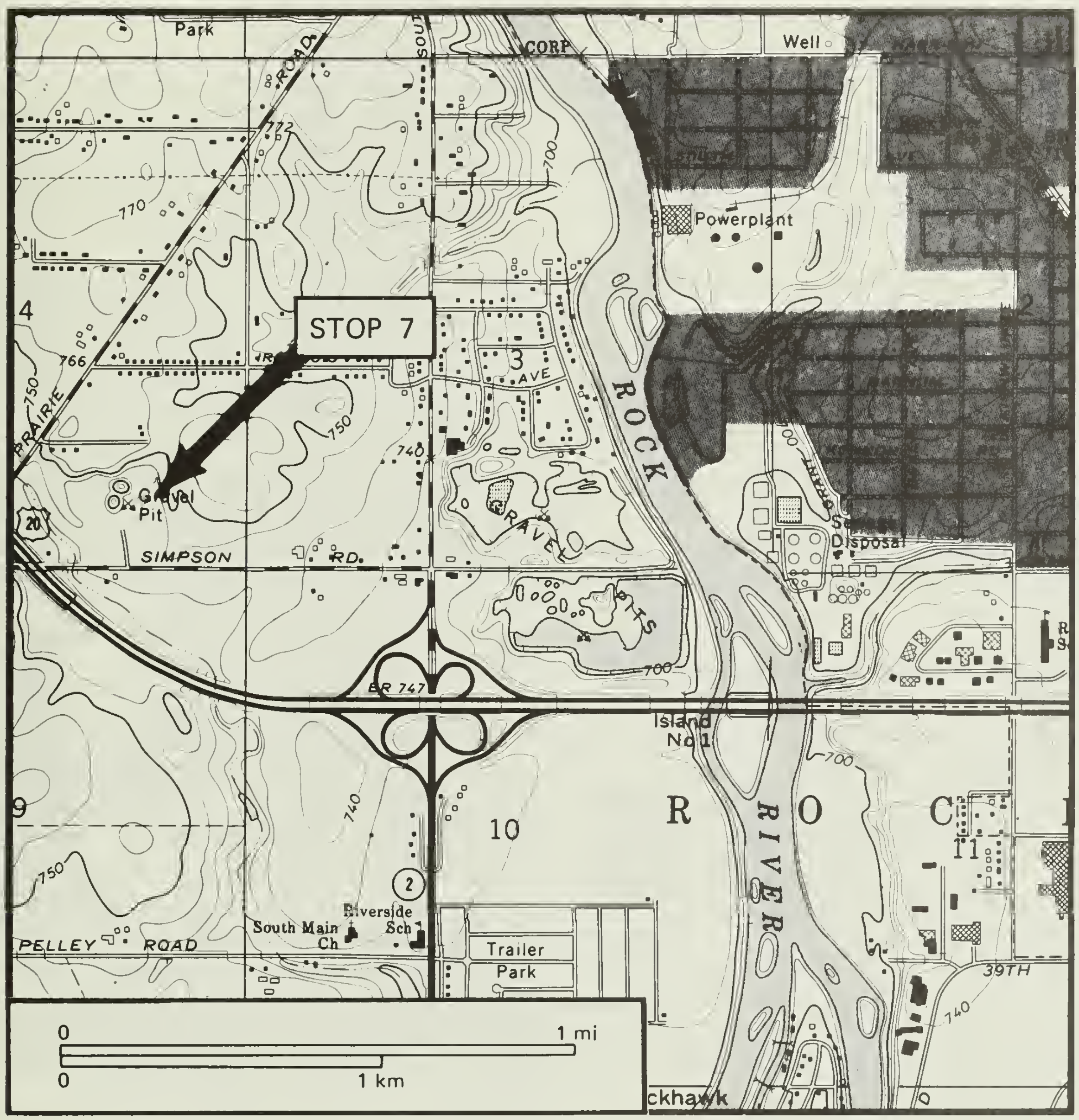
CONCLUSIONS

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 evidence at the Oak Crest Bog for erosion prior to 47,000 RCYBP (McKenna: Stop 4a), 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 1/4 Sec. 4, T 43 N, R 1 E, Winnebago County

At this site we will view an exposure of many ice wedges that have developed in the sand and gravel of the Rockford Terrace. Because the Argyle Till underlies the terrace deposits and the Sangamon Soil has formed into its surface, the Rockford Terrace probably was deposited by meltwater from the glacier that deposited the Argyle.

INTRODUCTION

The Rockford Terrace contains the highest outwash deposit along the Rock River in northern Illinois; it is located on the west side of the Rock River near Rockford. Anderson (1967) informally named it as a geomorphic unit and designated it as a terrace. He also described its distribution and some of its sedimentological and geomorphic aspects. Anderson and Masters further describe the Rockford Terrace in Stop 1.

This paper discusses the internal character of the terrace with particular emphasis on (1) the fossil ice wedges in the gravel and a paleosol formed in them; (2) the rock-stratigraphic and time-stratigraphic relationships of the terrace deposits to underlying diamiction members and the overlying paleosol; and (3) the origin of the terrace.

Specific work for this project involved describing and sampling materials within the ice-wedge casts as well as those materials overlying and underlying the terrace deposits at the Simpson Road gravel pit. In 1980 in conjunction with the geology-for-planning study in Boone and Winnebago Counties (Berg, Kempton and Stecyk, 1984), one boring was drilled through the Rockford Terrace. Materials were collected nearly continuously with a split-spoon sampler through hollow-stem augers. Munsell soil color notations were used in all descriptions. Diamicton samples were analysed for grain size using the standard hydrometer procedure. Clay-mineral composition was determined utilizing the technique of H. D. Glass (Hallberg, Lucas, and Goodmen, 1978).

Distribution of the Rockford Terrace

The Rockford Terrace is confined to areas west of the Rock River near the city of Rockford, Winnebago County, Illinois. The largest terrace remnant occurs just south of Rockford, east of Prairie Road in Sec. 3, 4, 9, 16, and 17, T 43 N, R 1 E (fig. 7-1). Less extensive remnants occur to the north (Anderson, 1967). Anderson and Masters (Stop 1) also suggest a possible Rockford Terrace remnant near Beloit. The terrace occurs at an elevation of about 230 m above sea level. Its surface is somewhat dissected--not flat, as are terraces at lower elevations along the Rock River. Soil maps of the area (Grantham, 1980) clearly show the boundary between the uplands and the Rockford Terrace. On the terrace, sand-and-gravel soils predominate; whereas the uplands are dominated by loess underlain by paleosols that have formed directly into the diamictons.

SIMPSON ROAD GRAVEL PIT

The materials of the Rockford Terrace are best displayed at an exposure in a gravel pit on the north side of Simpson Road (SE Sec. 4, T 43 N, R 1 E, Winnebago County; fig. 7-1). The Rockford Sand and Gravel Company operates the pit under the name of the Hoogie Pit.

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

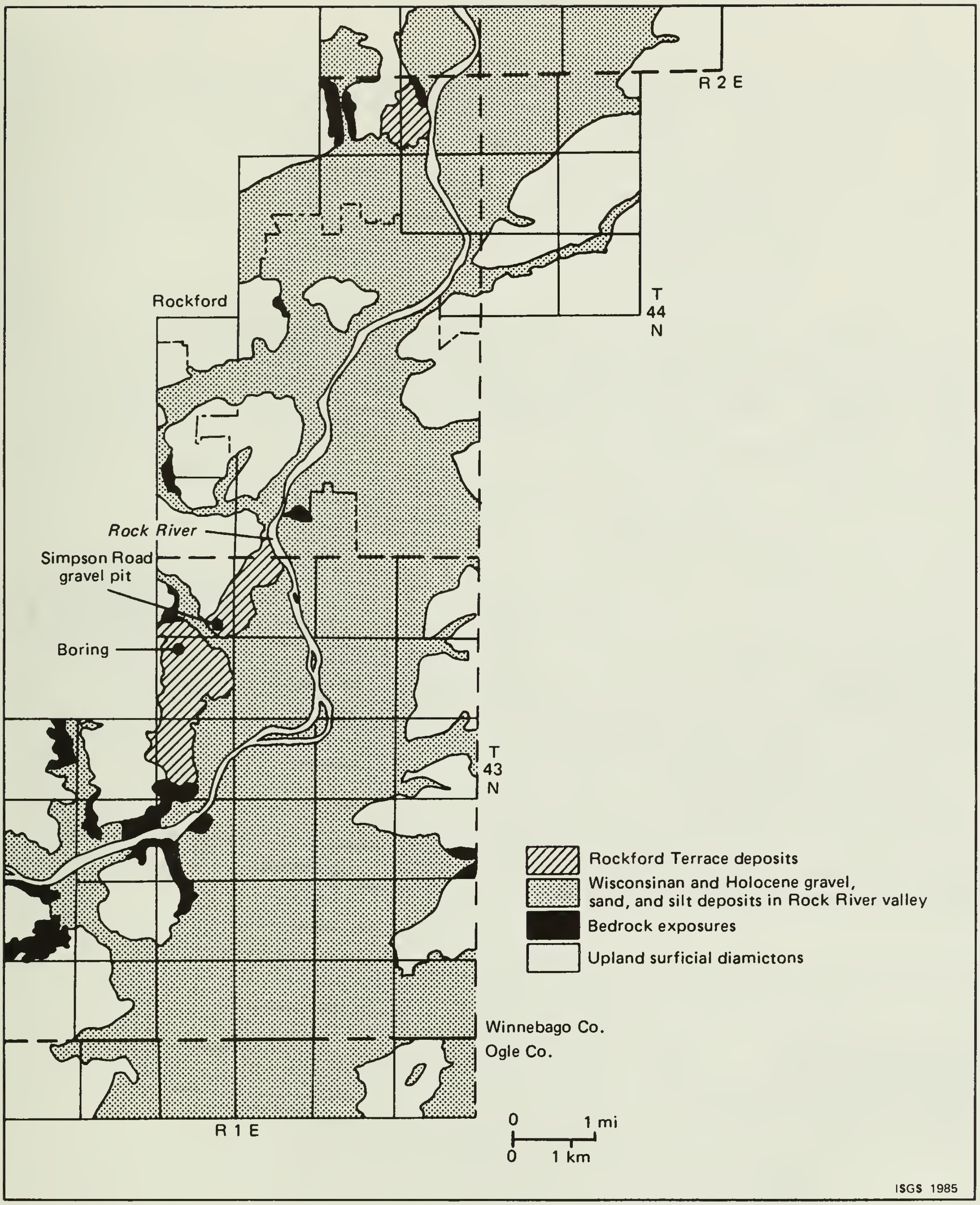


Figure 7-1 Distribution of the Rockford Terrace (modified from Anderson, 1967).

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.

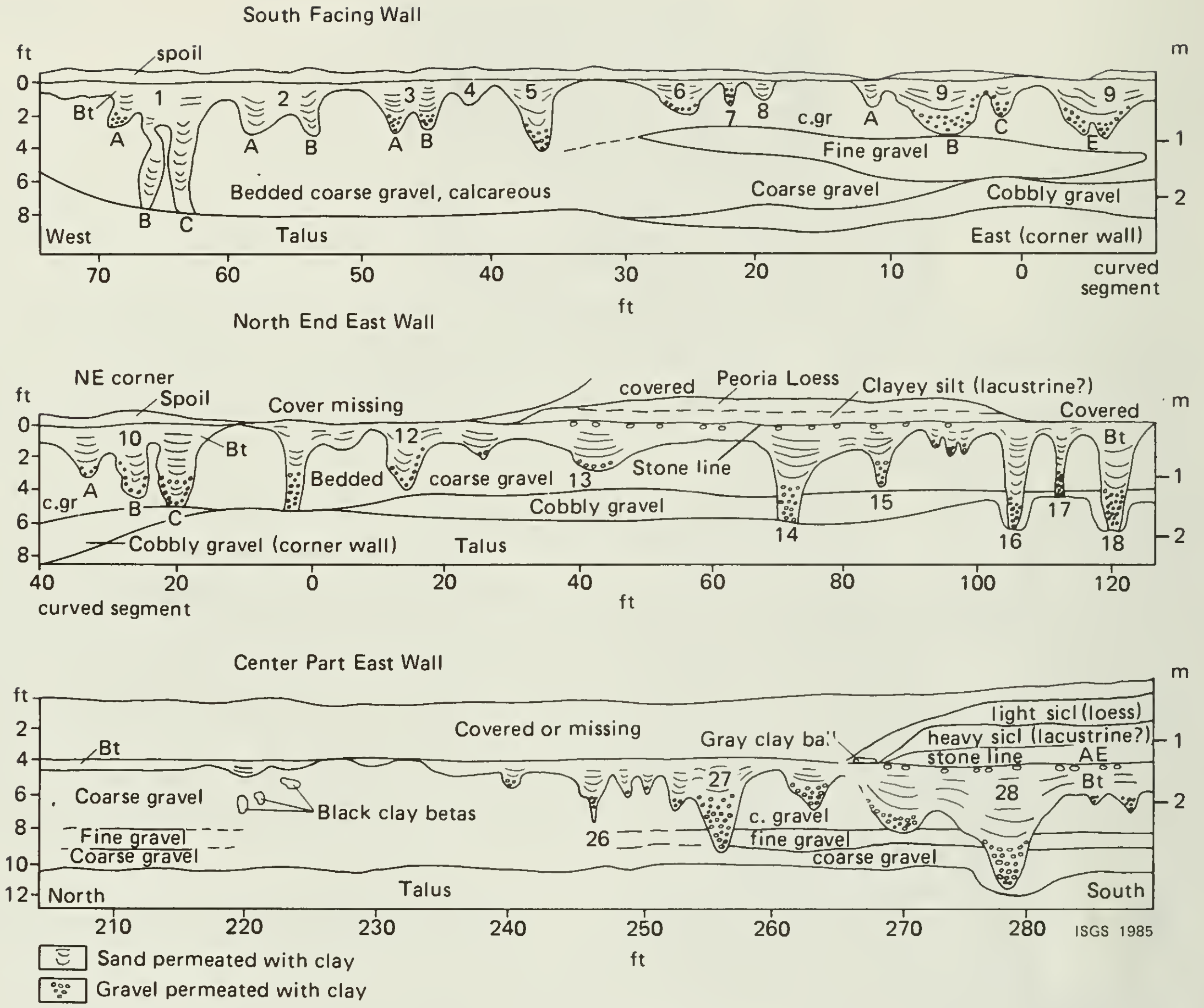


Figure 7-2 Sketch of soil pendants in highwall of Simpson Road gravel pit. Pendants are exaggerated up to 1.5x and numbered for convenience.

Profile Description

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

Horizon	Depth (m)		Thickness (m)
AP	0-.29	Loess; leached, very dark grayish brown (10YR 3/2), silt loam, many roots, friable, abrupt lower boundary	.29
A1	.29-.42	Loess; leached, very dark grayish brown (10YR 3/2), silt loam, few roots, fine thin platy structure, irregular lower boundary	.13

Horizon	Depth (m)		Thickness (m)
E	.42-.63	Loess; leached, dark brown (10YR 3/3), silt loam, slight bleached appearance, few fine roots, very gradual lower boundary	.21
Bt1	.63-1.07	Loess; leached, brown (10YR 4/3), silty clay loam, common roots, subangular blocky structure, gradual lower boundary	.44
Bt2	1.07-1.60	Loess; leached, brown (10YR 4/3), silty clay loam, strong subangular blocky structure, gradual lower boundary, many yellowish-red (5YR 4/6) mottles, few sand grains on ped faces, few lower chroma mottles	.53
BC	1.60-2.08	Loess; leached, brown (10YR 4/3), light silty clay loam, subangular blocky structure, many 2-chroma mottles, siltier with depth, clayey silt at base	.48
Illinoian Stage Pearl Formation		Sangamon Soil	
2BC	2.08-2.21	Sand; leached 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, perched water above, 18-cm diameter silt-clay ball (rip-up clast) at base of unit, very dark grayish brown (10YR 3/2), few fine roots in joints	.13
3Bt1	2.21-4.10	(Pendant #16 description) Diamicton (infilling); alternating dark reddish brown (5YR 3/3) to yellowish red (5YR 4/6) leached sandy clay within wedges protruding downwards into sandy gravel, curved horizontal bands (lamellae) of clay and iron-rich sand, textural boundaries stained red and are higher in clay content, some clay bands have a wavy appearance and dip downward in the middle of the pendant, some bow up near the edges, abrupt lower boundary	1.89

Horizon	Depth (m)		Thickness (m)
3Bt2	4.10-5.04	Diamicton; very dark reddish brown to black (5YR 3/3 to 2/1) leached clay-rich gravel, black clay accummulations at edges of pendant ("beta development"), some black clay passes into underlying and adjacent calcareous gravel, many rotten dolomite pebbles, abrupt lower boundary	.94
4C	5.04-8.0±	Stratified layers of gravelly sand and sandy cobbly gravel; calcareous, grayish brown to pale brown (10YR 5/2 to 6/3), lower part is covered by talus	2.96
Winnebago Formation Argyle Till Member			
5C	8.0	Diamicton; calcareous, brown to pale brown (10YR 5/3-6/3) sandy loam with 5 to 15 percent gravel, exposed in base of pit, probable basal till.	
		Total	8.0

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. Although the relatively impermeable reddish clay of the paleosol may be responsible for restricting the downward flow of soil water, the lacustrine clayey silt at the base of the Peoria is probably a more significant barrier where it is present.

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 is very irregular and 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, 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 the northeast corner of the pit, the exposure is benched at the top of the gravel. Although the bench is currently covered with debris, several years ago large areas were uncovered showing the 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 relation, 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 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 in the reddish, sandy clay, wedge infilling. These relationships suggest that the sand predates the paleosol, while the sandy silt postdates it. This means that the gravel surface probably experienced at least two episodes of erosion.

The character and stratigraphic relations of the materials at the Simpson Road gravel pit strongly suggest that the reddish paleosol is the Sangamon Soil developed in the top of the terrace deposits, which are overlain in most places by the Peoria Loess.

About 54 m south of Pendant 16, above Pendant 28 (the largest pendant in the vicinity, fig. 7-2), 10 to 20 cm of clayey silt (lacustrine) comformably underlies the Peoria Loess. This 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 in texture and can be correlated to the Roxana Silt. This 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.

Figure 7-3 Poorly sorted cobble gravel exposed in the east face of the Simpson Road gravel pit, November, 1984. Scale contains 10 cm divisions.

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 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 sandier than Argyle described elsewhere (Kempton et al., this report; Berg and Kempton: Stop 5).

Sedimentological Aspects of the Gravel

The terrace deposits consist of a poorly sorted, coarse cobble and pebble gravel (fig. 7-3) about 3 m thick, with crude horizontal bedding and cross strata. Clasts up to 20 cm in mediam diameter are common. About 70 percent of the cobble- to granule-size material is dolomite. Other rock types include about 10 percent chert, 10 perent 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. However, there has likely been some downward movement of fine-grained material from groundwater flow.

A crudely horizontal bed of poorly sorted cobble gravel is shown adjacent to the meter stick in figure 7-3. Cobble imbrication is often present in this type of bed; however, it is not apparent at this exposure. The underlying bed (about 1 m thick) contains low-angle crossbedding, consisting mostly of pebbles to fine cobbles; the crossbedding dips to the south. (Often individual crossbeds consist 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. The upper bed could have been part of a longitudinal bar that formed by clast accretion without sorting or developing stratification. The crossbedding in the lower bed probably represents avalanche-slope progradation under reduced sediment and water-discharge conditions, resulting in (1) a linguoid bar formed in shallow water, or (2) a deltaic bar formed in a deeper channel from an older bar remnant (Miall, 1977).

ROCKFORD TERRACE BORING

Information from a boring 0.8 km southwest of the Simpson Road gravel pit (NW SE NW sec. 9, T 43 N, R 1 E) reveals a sequence of materials similar to those displayed at the Simpson Road pit.

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Peoria Loess — Modern Soil

Depth (m)	Sample no.		Thickness (m)
1.12		Loess; leached, brown (10YR 5/3) silty clay loam Bt horizon, abrupt lower boundary	1.12
Illinoian Stage			
Pearl Formation		Sangamon Soil	
1.3	1	Sand and gravel; leached, brown (7.5 YR 5/4) loamy gravel, fairly abrupt lower boundary	.38
1.9	2	Sand; upper part leached, lower part calcareous, yellowish brown to	
3.4	3	brown (10YR 5/3-4), medium to	
4.7	4	coarse sand	3.10
Winnebago Formation			
Argyle Till Member			
5.0	5	Diamicton; calcareous, light yellowish brown (10YR 6/4), iron stained, sandy loam with common pebbles, hard and dense	0.61

Depth (m)	Sample no.		Thickness (m)
Glasford Formation Oregon Till Member			
5.6	6	Diamicton; calcareous, light brown (7.5YR 6/4) sandy loam	
6.3	7	with common pebbles, hard and dense	1.20
Fairdale Till Member			
6.7	8	Diamicton; calcareous, brown to yellowish brown (10YR 5/3-4) sandy	
6.9	9	loam with many pebbles, compact, numerous iron stains, lower portion appears to be good till, dense but more friable than above	1.40
		Total	7.90

Although the sand and gravel deposits at this drill site are about 2.5 m thinner than at the Simpson Road pit, the Sangamon Soil beneath the Peoria Loess is equally well expressed. It appears, however, that the drill hole did not penetrate a fossil ice-wedge. Beneath the sand and gravel is the Argyle Till with a grain size of 56 percent sand, 29 percent silt, and 15 percent clay. Its clay-mineral composition is 22 percent expandables, 65 percent illite, and 13 percent kaolinite plus chlorite. These data agree well with the diamicton beneath the Pearl Formation at the Simpson Road pit.

Beneath the Argyle diamicton are possibly two Glasford Formation diamictons, the Oregon and Fairdale Till Members. The Oregon has an average grain size of 53 percent sand, 27 percent silt, and 20 percent clay; and an average clay-mineral composition of 33 percent expandables, 53 percent illite, and 14 percent kaolinite plus chlorite. The Fairdale has an average grain size of 50 percent sand, 30 percent silt, and 20 percent clay; and a clay-mineral composition of 21 percent expandables, 64 percent illite, and 15 percent kaolinite plus chlorite. The sequence of diamictons fits the model of Kempton, Berg, and Follmer (this guidebook); however, limited stratigraphic evidence for diamictons beneath the Pearl Formation makes this correlation tenuous.

DISCUSSION

Both the exposure of the sand and gravel in the Rockford Terrace at the Simpson Road pit and the subsurface information show that these deposits thinly cover the landscape and are restricted to areas adjacent to the Rock River valley. We think that the high degree of weathering in the upper part of the terrace deposits represents the Sangamon Soil, which means that the sand and gravel correlates with the Illinoian age Pearl Formation, and that the Rockford Terrace is an Illinoian glaciofluvial landform. The sand and gravel of the Rockford Terrace ranges about 5 to 9 m higher than the Wisconsinan-aged terraces.

It does not appear that the deposits of the Rockford Terrace are equivalent to or continuous with subsurface outwash in the Rock Bedrock Valley. Outwash deposits reported by Berg, Kempton, and Stecyk (1984) in the Rock Bedrock Valley may either be related to Glasford Formation diamictons or be included in the Henry Formation. Outwash related to the Winnebago Formation is only observed in the Rock Bedrock Valley near the Wisconsin state line at Rockton. It appears that widespread erosion of outwash associated with the Winnebago Formation has occurred.

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 are 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 wedges. In general the pendants at both locations cut across horizontal bedding planes in a similar manner.

Sands and gravels of the Rockford Terrace were deposited between the deposition of the Argyle Till and the beginning of the Sangamonian Stage. Perhaps the terrace deposits were associated with the Argyle advance, or represent an event that occurred after the Argyle deposition but still during the Illinoian. Other alternatives are that the Rockford Terrace is the remains of a kame terrace, an eroded remnant of a kame or part of an outwash plain deposit. The poorly sorted large boulders in the terrace and lack of stratification, plus the absence of fine-grained constituents, suggest proximity to an ice margin and deposition in a high-velocity, braided glacial stream system.

The southward-dipping crossbeds suggest that the source of the meltwater was to the north, paralleling the trend of the Rock River valley. Thus perhaps an Argyle ice advance occupied the general location of the present valley, but at an elevation near that of the gravel deposit. If the Capron and Clinton are Illinoian in age and younger than that of the Argyle as Mickelson (1983) and Fricke (1976) suggest, then perhaps the Rockford Terrace gravel is related to a Capron or Clinton advance from the north. Krumm and Berg (Stop 3), however, suggest that the Clinton may be correlative to the Capron and that possibly both of these units are early Wisconsinan in age.

The formation of the ice-wedge casts observed at the Simpson Road pit would require that periglacial conditions existed 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; pedogenic horizonation features are not disrupted by wedge formation.

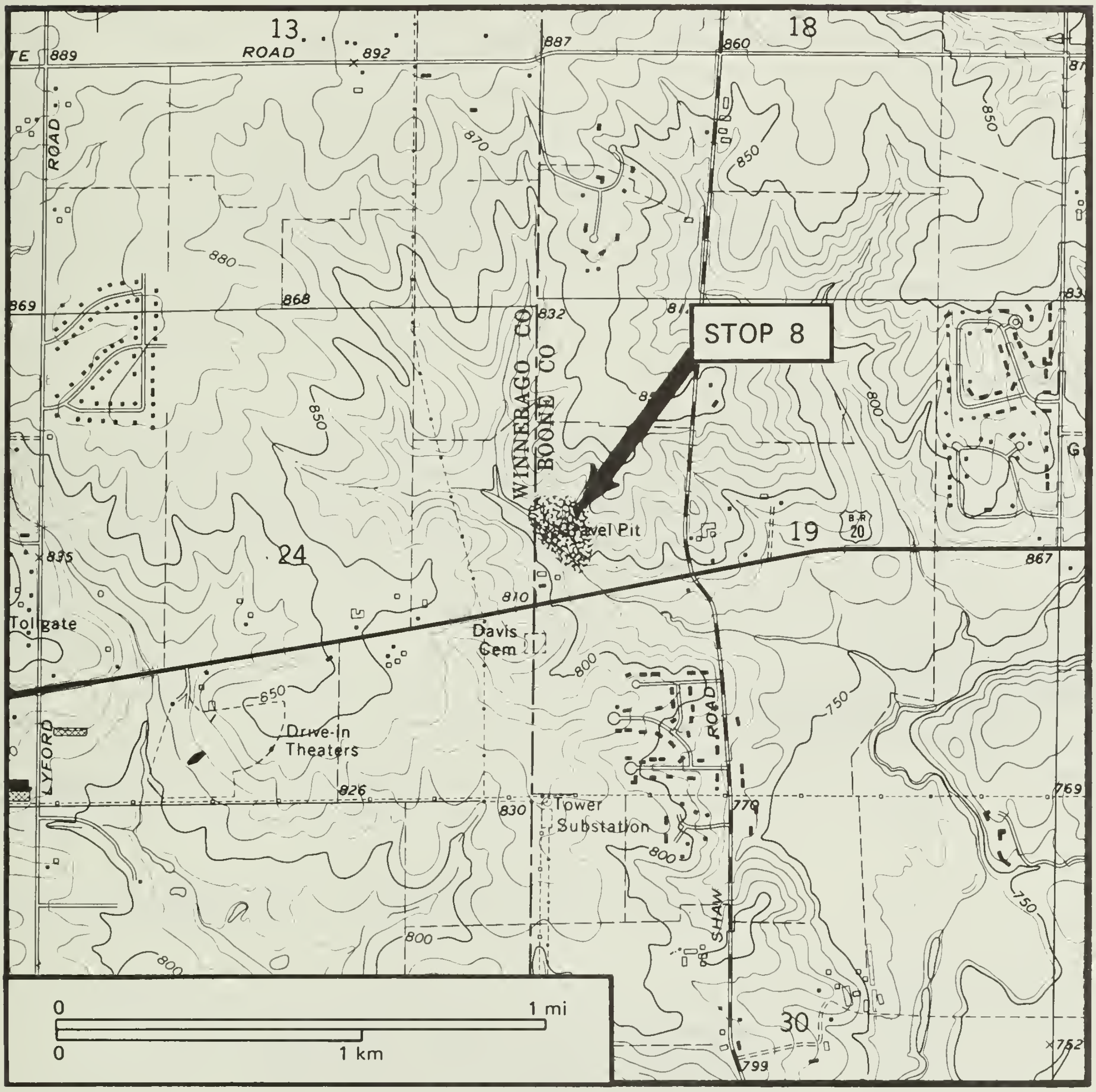
SUMMARY AND CONCLUSIONS

The Rockford Terrace is restricted to the west side of the Rock River valley at a higher elevation than Wisconsinan terraces. The gravel of the

Rockford Terrace overlies the Argyle Till Member of the Winnebago Formation. The gravel underlies the Peoria Loess and erosional remnants of older Wisconsinan sediment. The Sangamon Soil has formed into its surface and in general has exploited the fossil ice wedges in the terrace gravel. The terrace is Illinoian, probably constructed during the time of Argyle deposition. The ice-wedges in the gravel most likely formed immediately after gravel deposition during late Illinoian time, but before the Sangamonian soil-forming episode. Erosional remnants of pre-Peoria Loess indicate two or more erosional events before burial by the Peoria Loess which appears to be uneroded north of the pit.

Stratigraphic Relationships of the Beaver Creek Sand Member of the Winnebago Formation

Richard C. Berg and John P. Kempton



STOP 8
State Street Quarry Section
SW SW NW Sec. 19, T 44 N, R 3 E, Boone County

The State Street Quarry Section is the best exposure of the Beaver Creek Sand Member. We will discuss the regional extent and significance of the Beaver Creek Sand, which is the lowermost Winnebago Formation member.

INTRODUCTION

The Beaver Creek Sand Member is a sand and gravel deposit underlying the Argyle and Nimtz Till Members in central Boone County and east-central Winnebago County. It overlies the Glasford Formation and is the oldest member of the Winnebago Formation. The formal name derives from Beaver Creek in Boone County, Illinois. In this paper, we define the Beaver Creek and discuss its stratigraphic relationships with other deposits in central-northern Illinois.

The Beaver Creek was identified in field exposures, deep borings, and water well logs. To show its subsurface distribution, we developed cross sections. Diamictons overlying the Beaver Creek were identified on the basis of field relationships, texture, and clay-mineral compositions. Texture was determined by the standard hydrometer procedure, and clay-mineral composition calculated by the X-ray diffraction technique developed by Glass (Hallberg, Lucas and Goodmen, 1978)

STATE STREET QUARRY SECTION

The designated type section, the State Street Quarry Section, is an exposure in Boone County at a quarry 100 m east of the Boone-Winnebago county line, north of State Street (Business Route U.S. 20), SW SW NW, Sec. 19, T 44 N, R 3 E. The exposure contains 3.5 m of diamicton (Argyle and Nimtz Till Members) overlying contorted sands and gravels (Beaver Creek Sand Member).

Pleistocene Series
Illinoian Stage
Winnebago Formation
Argyle Till Member

Depth (m)	Sample no.		Thickness (m)
2.0	7-1-1 7-1-2	Diamicton; sandy loam, yellowish brown (10YR 5/4), highly weathered, calcareous	2.0
		Nimtz Till Member	
3.5	7-2-1 7-2-2	Diamicton; sandy loam, yellowish brown (10YR 5/4), platy structure, very hard, calcareous	1.5
		Beaver Creek Sand Member	
7.0		Contorted sand and gravel; yellow and tan, diamicton inclusions, calcareous	3.5

Ordovician System
Galena-Platteville Dolomite

Total 7.0

The principal diamicton overlying the Beaver Creek Sand at the type section averages 54 percent sand, 30 percent silt, and 16 percent clay; its clay-mineral composition averages 20 percent expandables, 70 percent illite, and 10 percent kaolinite plus chlorite. This diamicton correlates with the Nimtz Till Member of the Winnebago Formation (Berg and Kempton: Stop 5). The Nimtz is about 2 to 3.1 m thick at the exposure; its platy structure and hardness suggest that it is basal till. Apparently the glacier that deposited the Nimtz Till overrode the Beaver Creek sand and gravel, and caused the contortion of this deposit. A faint stone line and a thin sand seam occur within the Nimtz Till.

The Nimtz overlies the Beaver Creek, except along part of the eastern side of the exposure where the Nimtz is eroded, and the Argyle Till Member directly overlies the Beaver Creek. Data obtained for the Argyle at this exposure correspond to data obtained for it at other locations: grain-size distribution averages 50 percent sand, 31 percent silt, and 19 percent clay; clay-mineral composition averages 27 percent expandables, 63 percent illite, and 10 percent kaolinite plus chlorite.

The Argyle and Nimtz Tills are absent in the northern part of the quarry. About 0.5 m of Peoria Loess overlies a mixture of loess and colluvium (interpreted to be a pedisediment), which in turn overlies the contorted outwash of the Beaver Creek Sand Member. In some places, an erosional lag deposit lies between the pedisediment and the outwash.

The sand and gravel of the Beaver Creek shows vertical variability at the State Street Quarry Section. The deposit mostly consists of calcareous cross-bedded yellow to tan, medium sands; however, coarse cobbles and boulders are common. Iron stains and manganese concretions are visible throughout the exposure. Large inclusions of diamicton have been incorporated into the contorted beds of sand and gravel. The texture and clay-mineral composition of the diamicton suggest that it is derived from the overlying Winnebago Formation till members; presumably, it was thrust into the sand.

REGIONAL DISTRIBUTION

The distribution of the Beaver Creek Sand Member as a near-surface deposit was mapped in detail by Masters (Berg, Kempton, and Stecyk, 1984). He noted two principal areas: one along the lower reaches of Beaver Creek near its junction with the Kishwaukee River and the other about 11 km upstream inthe headwaters of Beaver Creek (fig. 8-1). Elevation of the upstream deposits is about 260 to 270 m. Downstream deposits are about 240 m in elevation; they are frequently exposed in valley walls where they underlie diamictons.

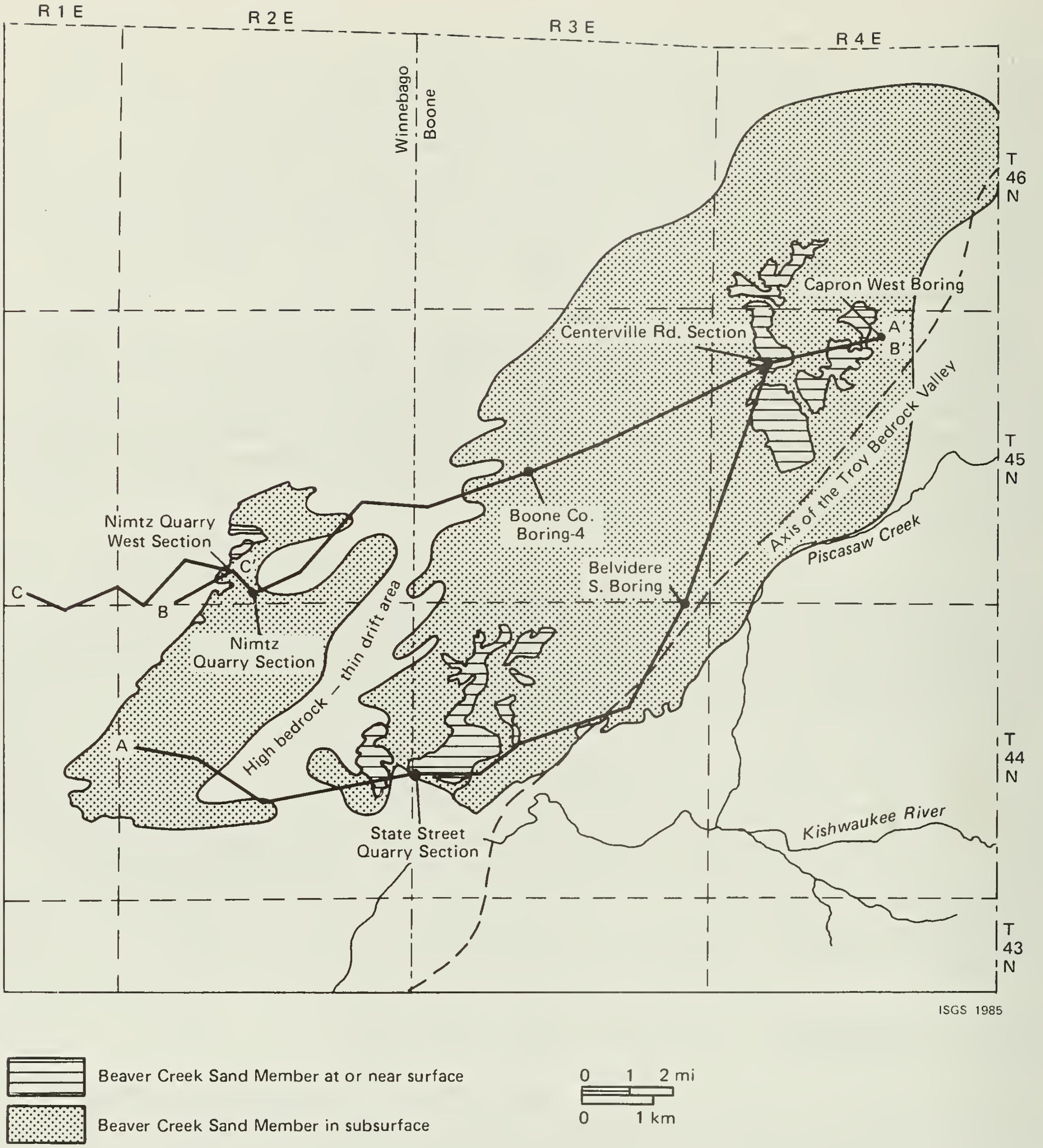


Figure 8-1 Distribution of the Beaver Creek Sand Member and lines of cross section.

Cross sections trending south-southwest (fig. 8-2, A-A') and southwest (fig. 8-3, B-B') from the headwaters of Beaver Creek show the continuity of the Beaver Creek Sand Member. It has been found as far east as the location of the Capron West Boring (figs. 8-2, 8-3, CW). The upper part of the Beaver Creek is fine grained in this boring; it becomes coarser with depth.

Cross section A-A' bisects an area near the headwaters of Beaver Creek where the member is close to the surface (figs. 8-1, 8-2). The Centerville Road Section (CR) is within this area. At this section, the member occurs

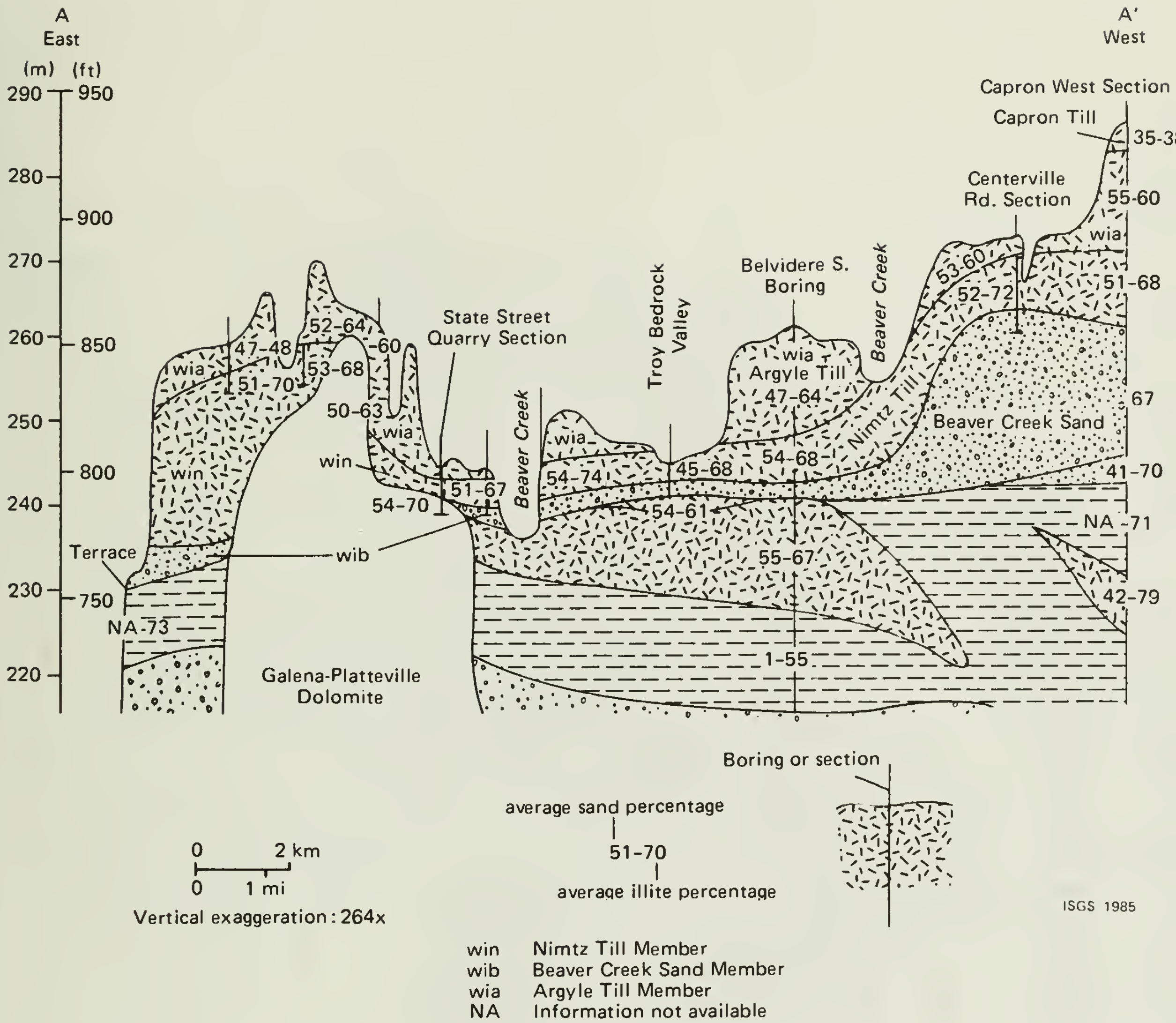


Figure 8-2 W-E cross section (A-A') through eastern Winnebago and Boone Counties showing extent of the Beaver Creek Sand Member. Beneath the Beaver Creek Sand lies diamicton, sand and gravel, and silt of the Glasford Formation.

about 1.5 m higher than it does in the Capron West Boring. The Argyle and Nimtz Till Members and the Beaver Creek Sand Member decrease in elevation as the land surface slopes downward in a southwesterly direction. It appears that the Argyle and Nimtz Tills are draped over the outwash of the Beaver Creek. Between the Belvidere South Boring and the State Street Quarry Section (fig. 8-2, BS and SS), the Beaver Creek thins to about 2 to 3 m and lies at an elevation of 240 m.

Between the Capron West Boring and the State Street Quarry Section in cross section A-A', the Beaver Creek Sand Member occurs in the Troy Bedrock Valley where it overlies Glasford Formation till members and underlies the Nimtz Till Member of the Winnebago Formation. The Beaver Creek Sand pinches out to the west over the bedrock high that separates the Troy Bedrock Valley from the Rock Bedrock Valley. The Beaver Creek Sand is also present beneath the Nimtz Till Member on the west side of the bedrock high.

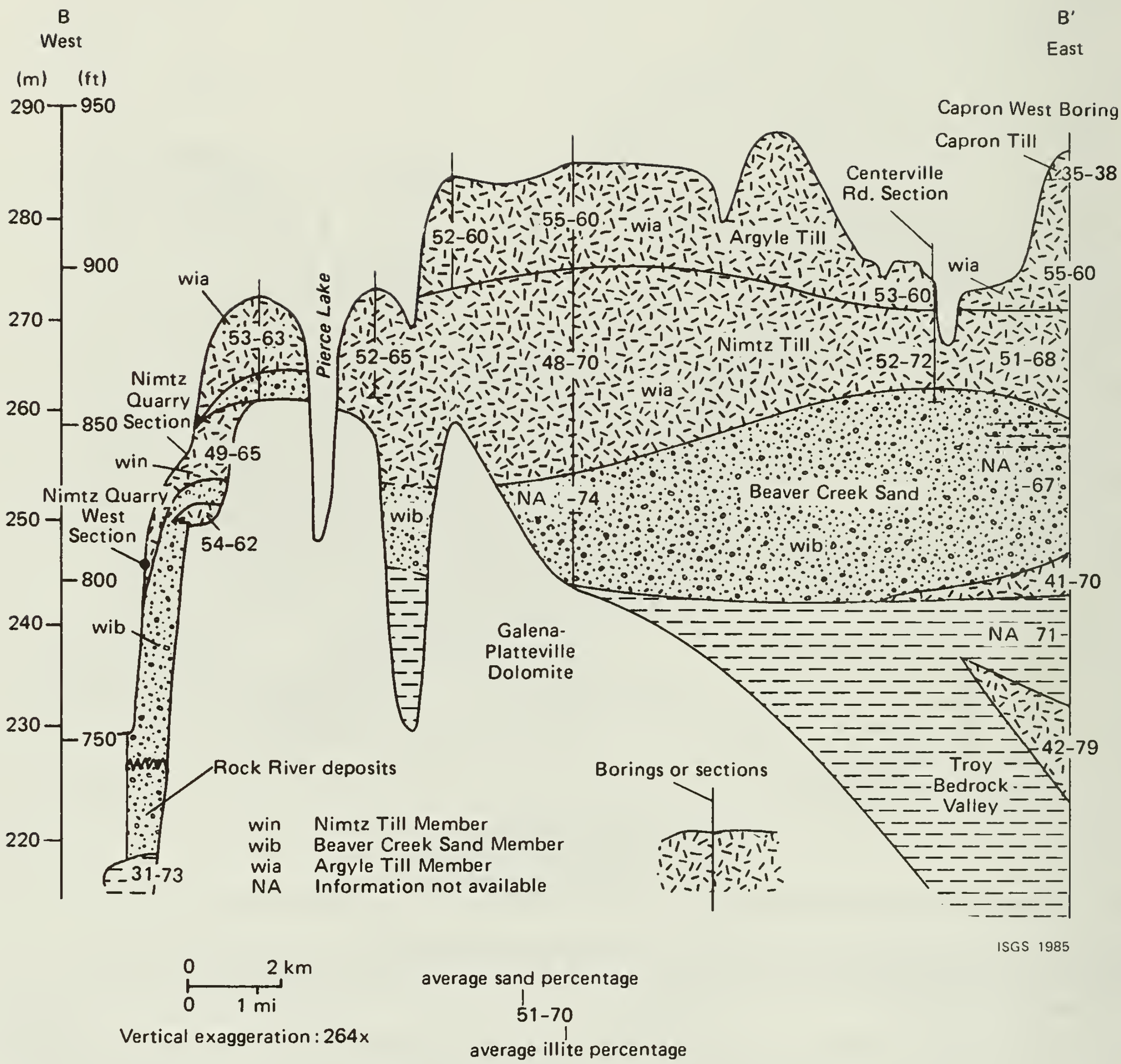


Figure 8-3 W-E cross section (B-B') through eastern Winnebago County and Boone County showing extent of the Beaver Creek Sand Member (north of A-A'). Beneath the Beaver Creek Sand lies diamicton, sand and gravel, and silt of the Glasford Formation.

Cross section B-B' (fig. 8-3), trends southwest from the Capron West Boring; this cross-section lies about 10 km north of cross section A-A'. The Beaver Creek Sand also pinches out to the west over the bedrock high between the Troy and Rock Bedrock Valleys, then reappears on the western side of the divide in the Nimtz Quarry Section (Berg and Kempton: Stop 5) and in the Nimtz Quarry West Section (figs. 8-3 and 8-4, NQW).

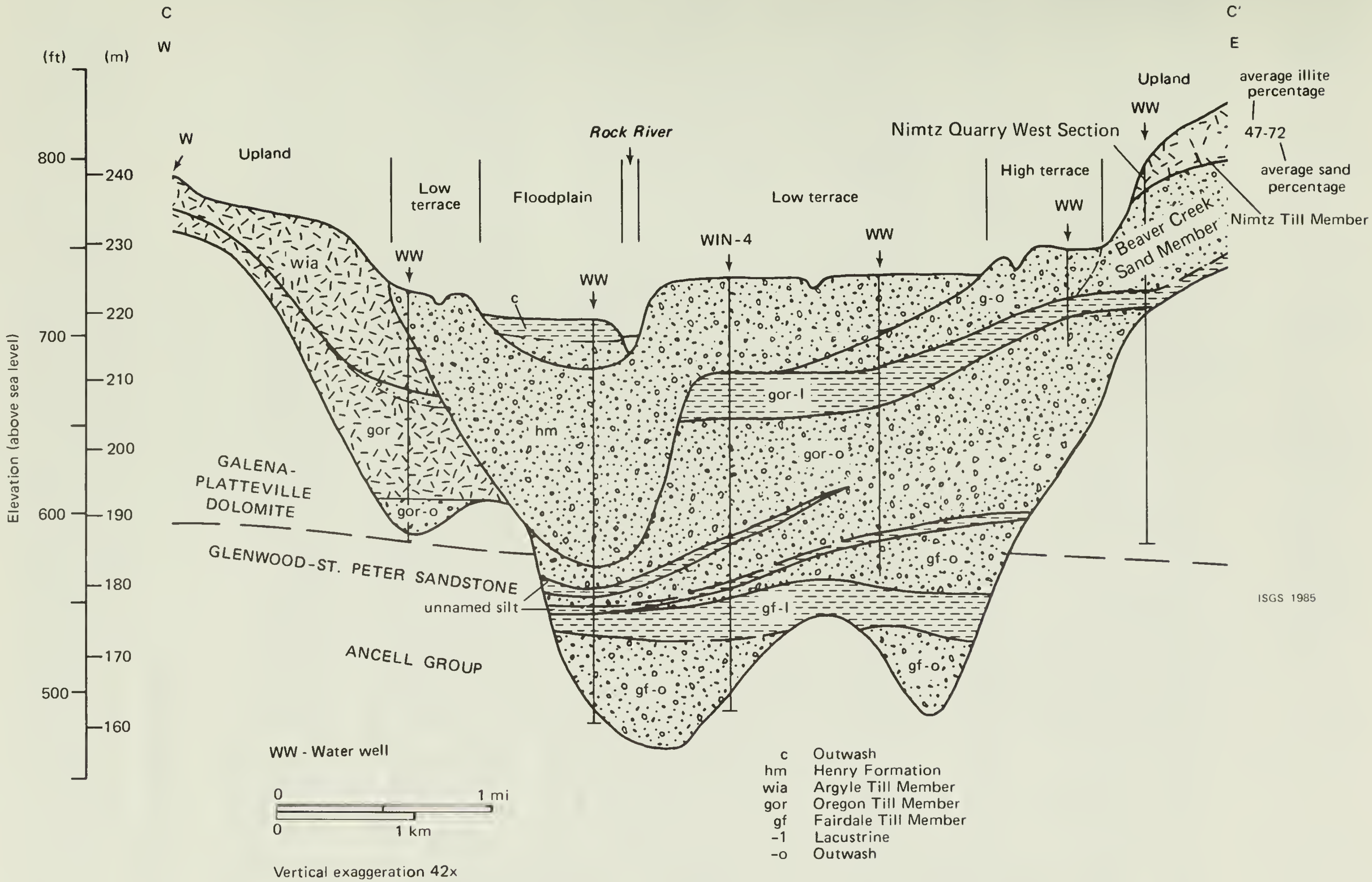


Figure 8-4 W-E cross section (C-C′) across Rock River valley at Loves Park showing Beaver Creek Sand Member below Nimtz Till Member (modified from Berg, Kempton, and Stecyk, 1984).

DISCUSSION

The Beaver Creek Sand at the State Street Quarry Section is the same as that exposed along the lower reaches of Beaver Creek. At both locations, the Beaver Creek Sand lies at about 240 m above sea level, beneath the Nimtz Till Member.

This same sand and gravel occurs in the upper reaches of Beaver Creek as shown at the Centerville Road Section. Although the Beaver Creek Sand Member occurs about 20 to 25 m higher along the upper reaches of Beaver Creek, the sand and gravel still underlies the Nimtz Till Member. Deformed beds, similar to those at the type section, are commonly present; this feature suggests that the Beaver Creek Sand Member was overridden by the ice advance that deposited the Nimtz Till. The Beaver Creek Sand Member is interpreted to be a proglacial outwash associated with this glacial advance. We have found no evidence to suggest that the Beaver Creek deposits are related to the Glasford Formation.

Meltwater deposited the sand and gravel of the Beaver Creek in both the Troy and the Rock Bedrock Valleys; it flowed from the north down the Rock Bedrock Valley, and from the east and northeast, down the Troy. The best evidence for this conclusion is that the Beaver Creek Sand is found below the Nimtz Till on both sides of the bedrock high separating the Rock and Troy Bedrock Valleys. Meltwater was not restricted to the deeper parts of the Troy, as indicated by the occurrence of Beaver Creek Sand about 10 km northwest of the Troy Bedrock Valley axis (Boone County Boring 4; fig. 8-3). The sand and gravel of the Beaver Creek seems to have been deposited uniformly over the landscape; perhaps the landscape was leveled off by the flowing water. The base of the Beaver Creek, where not resting on bedrock, does not vary more than 3 to 4 m in elevation, possibly suggesting an erosional surface. The Beaver Creek is absent where the bedrock between the Troy and Rock Bedrock Valleys is above an elevation of 240 m.

West of the bedrock divide between the Troy and Rock Bedrock Valleys, the Beaver Creek Sand is exposed at the base of the valley wall, adjacent to Wisconsinan Rock River terraces. Here, the Beaver Creek lies beneath the Nimtz Till at approximately the same elevation as it is east of the bedrock high. The Beaver Creek is particularly noticeable in a series of gravel pits cut into the uplands west of the Nimtz Quarry Section.

The Beaver Creek Sand Member appears to have been eroded and reworked into the Wisconsinan terrace deposits of the Rock River valley (fig. 8-4). Sand and gravel of the Beaver Creek is continuous with the sand and gravel of the high terrace.

SUMMARY AND CONCLUSIONS

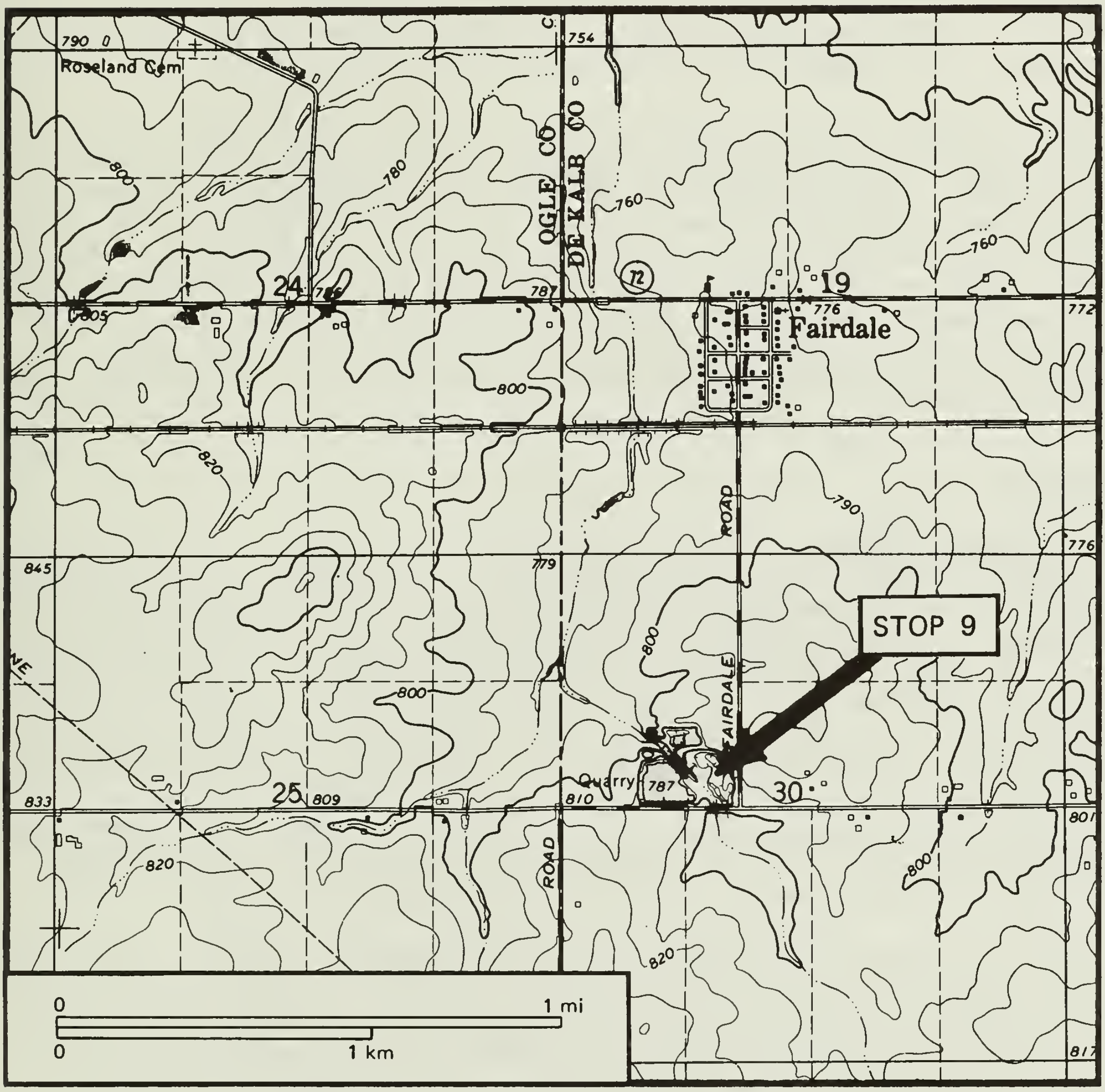
The Beaver Creek Sand Member of the Winnebago Formation is composed primarily of sand and gravel that was probably deposited by proglacial meltwaters from the ice advance that deposited the Nimtz Till. The Nimtz Till Member overlies the Beaver Creek Sand; till members of the Glasford Formation underlie the unit. The deposit is therefore the oldest member of the Winnebago Formation. The member is observed between elevations of 240 and 260 m above sea level in numerous borings and exposures. The elevation of the base of the Beaver Creek Sand is uniform just below 240 m.

The Beaver Creek Sand is distributed in east-central Winnebago County, and throughout central Boone County, north of the Kishwaukee River and Piscasaw Creek. Its distribution is interrupted by the bedrock high between the Rock and Troy Bedrock Valleys. East of the bedrock high, the Beaver Creek deposits spread out over the landscape. West of the high, the member is confined to areas adjacent to the east side the Rock River valley. Some Beaver Creek sand and gravel has been incorporated into Wisconsinan terrace deposits.

Additional sedimentological and mineralogical studies on the Beaver Creek Sand Member are needed. Although the stratigraphic position of the Beaver Creek Sand is fairly well established, additional test borings, particularly in its northern area of occurrence and east of the Rock River valley, would be helpful in documenting its distribution. Particularly important would be a comparison of Beaver Creek Sand deposits on either side of the bedrock high between the Rock and Troy Bedrock Valleys.

Stratigraphy of the Oregon Till Member Silty Facies and Fairdale Till Member

John P. Kempton and Richard C. Berg



STOP 9
Fairdale Quarry Section
SW NW Sec. 30, T 42 N, R 3 E, De Kalb County

The Fairdale Quarry Section is the only known exposure showing the reddish Oregon Till silty facies overlying the yellowish sandy Fairdale Till. We will discuss the similarity of these units to the Capron and Argyle Tills; this similarity is one of the reasons for previous miscorrelations.

INTRODUCTION

Recognizing the Esmond Till as a member of the Glasford Formation (Illinoian) rather than of the Wedron Formation (Wisconsinan) required reappraising the stratigraphic succession of diamictons below the Esmond. Several of these diamicton units were previously included in the Winnebago Formation (Altonian-early Wisconsinan). Their reclassification has been discussed by Kempton, Berg, and Follmer (this guidebook) and Berg and Kempton (Stop 5). In this paper, we discuss the stratigraphy of two Glasford Formation units: the Oregon Till Member silty facies and the Fairdale Till Member.

The Oregon Till silty facies and the Fairdale Till were recognized as distinct regional units from earlier subsurface studies (Kempton and Hackett, 1968a, 1968b). The assignment of these units to the Glasford Formation has recently been confirmed by deep borings, particularly those drilled for the geology-for-planning study of Boone and Winnebago Counties (Berg, Kempton, and Stecyk, 1984) and the present Fermilab mapping project (Illinois Department of Energy and Natural Resources, 1985). We analyzed diamictons for grain size by using the standard hydrometer procedure and determined the clay-mineral composition by the technique of Glass (Hallberg, Lucas, and Goodmen, 1978).

DISCUSSION

Stratigraphic Setting

Diamictons now recognized as the Oregon Till Member silty facies and the Fairdale Till Member were previously correlated with the Capron and Argyle Till Members of the Winnebago Formation respectively (Willman and Frye, 1970). The Oregon silty facies overlies the Fairdale in a stratigraphic relationship similar to that between the Capron and the Argyle. Both the Oregon silty facies and the Capron, which often occur as surficial units, are reddish brown. As unweathered diamictons, their clay-mineral compositions are very similar--about 55 percent illite. The previous correlation of the diamicton, which we now recognized as Fairdale, with the Argyle Till Member was based on similar sandy loam textures and clay-mineral compositions: they both contain about 65 percent illite in unweathered profiles.

We now separate the Oregon Till silty facies and Fairdale Till from the Capron, Argyle, and newly recognized Nimtz Tills. The Stone Quarry Road Boring (Kempton, Berg, and Follmer: this guidebook) clearly shows both the Oregon silty facies and Fairdale Till Members underlying the Esmond Till Member. The Capron Southeast Boring (fig. 9-1), located 2 km southeast of Capron, Illinois, is a significant profile illustrating the diagnostic features that distinguish the Capron from the Oregon. In this profile, the Capron overlies a fining downward succession of Oregon; silt 0.4 m thick separates the Capron from the underlying Oregon; about 1.0 m of oxidized and leached Oregon Till lies beneath the silt. If there were no weathered zone in the Oregon Till, it would be indistinguishable from the Capron.

Because the clay-mineral composition and texture of the Capron and the Oregon are often similar, diamicton was mapped as Capron Till in southern

Stratigraphic unit		Depth (m)	Sample	Grain size S-Si-Cl	Clay min. Ex-I-K+C	Cal. Dol. (counts/sec)
Winnebago Formation	Capron Till Member	1.0				
Winnebago Formation	Capron Till Member		1	35-36-29	38-53-9	0-49
Winnebago Formation	Capron Till Member	2.0	2	34-32-34	36-55-9	26-64
Winnebago Formation	Capron Till Member		3	18-67-15	32-58-10	65-64
Winnebago Formation	Capron Till Member	3.0	4	34-35-31	34-56-10	51-60
Winnebago Formation	Capron Till Member		5	37-36-31	35-56-9	72-64
Winnebago Formation	Capron Till Member		6	34-35-31	37-55-8	68-78
Winnebago Formation	Silt	4.0	7	7-75-18	60-32-8	16-38
Glasford Formation	Oregon Till Member		8	60-27-13	37-55-12	Sangamon Soil 0-0
Glasford Formation	Oregon Till Member		9	63-25-12	34-58-8	70-120
Glasford Formation	Oregon Till Member	5.0				
Glasford Formation	Oregon Till Member	6.0	10	42-45-13	39-53-8	79-81
Glasford Formation	Oregon Till Member silty facies		11	27-52-21	38-56-6	84-100
Glasford Formation	Oregon Till Member silty facies	7.0				
Glasford Formation	Silty sand	8.0	12	55-40-5	32-58-10	65-162

ISGS 1985

Figure 9-1 Grain-size distribution, clay-mineral composition, and carbonate data for the Capron Southeast Boring.

Boone County, northern De Kalb County and southwestern McHenry Counties (Lineback, 1979). The stratigraphic data now indicate that diamicton previously correlated with the Capron Till Member in areas south of Piscasaw Creek actually correlates with the Oregon Till silty facies and Belvidere Till (Krumm and Berg: Stop 3). (Piscasaw Creek is located in northeastern Boone County.) The occurrence at the surface of either the Oregon silty facies or Belvidere is due to local erosional conditions; 'windows' of Oregon are exposed throughout this region.

Recent soil mapping (Grantham, 1980) shows no paleosols in these Glasford Formation diamictons. This absence of paleosols was a principal reason for assuming that diamictons in this region were Wisconsinan; however, we now attribute the lack of paleosols to erosion of the land surface by ice and water.

Oregon Till Member silty facies

The Oregon Till Member of the Glasford Formation has been formally named and described by Kempton, Berg, and Follmer (this guidebook). A fining downward succession exists within the Oregon Till Member (Capron Southeast Boring in fig. 9-1). When the sand percentage drops below 40 percent, the unit is considered the "silty facies." The clay-mineral composition, color, and stratigraphic position of the Oregon Till Member silty facies are identical to the Oregon Till Member; the only difference is that the Oregon silty facies is silt loam, silty clay loam, or clay loam in texture, whereas the Oregon is sandy loam or loam.

Usually the Oregon and Oregon silty facies are not found in succession. They are distinct mappable units: the Oregon Till silty facies is generally mapped east of the Oregon Till. The Oregon Till Member silty facies was informally named the Creston till by Berg, Kempton, and Stecyk (1984).

The Oregon Till Member silty facies consists of a diamicton with an average grain-size distribution of 31 percent sand, 39 percent silt, and 30 percent clay. It has an average clay-mineral composition of 19 percent expandables, 60 percent illite, and 21 percent kaolinite plus chlorite. It stratigraphically lies above the Fairdale Till Member and below the Esmond Till Member (Stone Quarry Road Boring in Kempton, Berg, and Follmer, this guidebook; and the Huber Road Boring in the Appendix).

Fairdale Till Member

Berg, Kempton, and Stecyk (1984) informally named the Fairdale Till Member of the Glasford Formation for the town of Fairdale in De Kalb County, Illinois. It was formally named for an exposure described at the Fairdale Quarry Section (Center, Sec. 30, T 42 N, R 3 E, fig. 9-2). The Fairdale is also described in the Stone Quarry Road Boring (Kempton, Berg, and Follmer: this guidebook).

The Fairdale Till is a yellowish brown, sandy loam diamicton; however, most samples of the Fairdale taken from borings are grayish brown and unoxidized. It is usually less than 10 m thick. Average grain-size

Profile 1

Stratigraphic unit		Depth (m)	Sample	Grain size S-Si-C	Clay min. Ex-I-K+C	Cal. Dol. (counts/sec)	Vermiculite index
Glasford Formation	Fairdale Till Member	1.0					
		2.0	1	64-27-9	21-72-7	0-46	
		3.0	2	60-27-13	20-73-7	10-76	
			3	62-24-14	23-70-7	0-77	10½>
		4.0	4	63-26-11	22-72-6	19-84	
			5	59-27-14	20-73-7	35-81	
		5.0					
			6	60-25-15	20-73-7	45-82	

Profile 2

Stratigraphic unit		Depth (m)	Sample	Grain size S-Si-C	Clay min. Ex-I-K+C	Cal. Dol. (counts/sec)	Vermiculite index
Glasford Formation	Oregon Till Member silty facies	1.0					
			1	22-42-36	42-50-8	0-21	
			2	23-39-38	41-52-7	39-41	
			3	23-40-37	42-51-7	15-57	
		2.0	4	23-41-36	46-45-9	39-41	
			5	24-37-39	37-45-8	19-47	
	Sandy silt		6	48-42-10	42-52-6	16-61	
	Fairdale Till Member		7	59-31-10	22-70-8		
			8	69-23-8	18-73-9	11-71	
		3.0	9	60-28-12	23-72-5	13-67	7>
			10	64-26-10	20-72-8	-105	

ISGS 1985

Figure 9-2 Grain-size distribution, clay-mineral composition, and carbonate data for Profiles 1 and 2 at the Fairdale Quarry Section.

Figure 9-3 Photograph of Profile 2 showing the Oregon Till silty facies above the Fairdale Till.

distribution is 49 percent sand, 31 percent silt, and 20 percent clay; average clay-mineral composition is 10 percent expandables, 67 percent illite, and 23 percent kaolinite plus chlorite. Three textural variants have been identified for the Fairdale. The least common variant has 39 percent sand, while the more common variants have 48 and 59 percent sand. Correlation of the Fairdale Till to stratigraphic equivalents outside of the north-central Illinois region is suggested by Kempton, Berg, and Follmer (this guidebook).

The Fairdale Quarry Section

At its type section (fig. 9-2), the Fairdale Till Member averages about 10 percent more sand and 5 percent more illite than Fairdale described elsewhere; however, it is well within the range of Fairdale Till. The Fairdale Till is overlain by the Oregon Till silty facies in Profile 2 on the east side of the Fairdale Quarry Section. This profile is also shown in the photograph in figure 9-3. Between the two units is a mixed zone of light gray silt and sand. An abrupt contact exists between the mixed zone and the overlying Oregon Till silty facies and the underlying Fairdale Till. The mixed zone has the same clay-mineral composition as the Oregon Till. Color clearly distinguishes the two units at this profile: the Oregon silty facies is red brown, and the Fairdale is yellowish brown.

Fairdale Quarry Section, Profile 1

Pleistocene Series
  Illinoian Stage
    Glasford Formation
      Fairdale Till Member

Depth (m)	Sample no.		Thickness (m)
2.0	1	Diamicton; sandy loam, yellowish	
3.0	2	brown (10YR 5/6), oxidized,	
3.5	3	loose consistency, calcareous	
4.0	4		4.0
4.5	5	Diamicton; sandy loam, yellowish brown	
5.5	6	(10YR 5/4), oxidized, very dense	1.5
		and hard, massive, calcareous	
		Total	5.5

Fairdale Quarry Section, Profile 2

Pleistocene Series
  Illinoian Stage
    Glasford Formation
      Oregon Till Member silty facies

1.25	1	Diamicton; clay loam,	
1.5	2	brown (7.5YR 5/4), oxidized,	
1.75	3	calcareous, but weakly calcareous	
2.0	4	at top	
2.25	5		2.5
2.35	6	Silt and sand, mixed zone, loamy, yellowish brown (10YR 5/4) and light gray, oxidized, calcareous	.20

      Fairdale Till Member

2.5	7	Diamicton; sandy loam, yellowish	
2.75	8	brown (10YR 5/6), oxidized,	
3.25	10	calcareous	.80
		Total	3.25

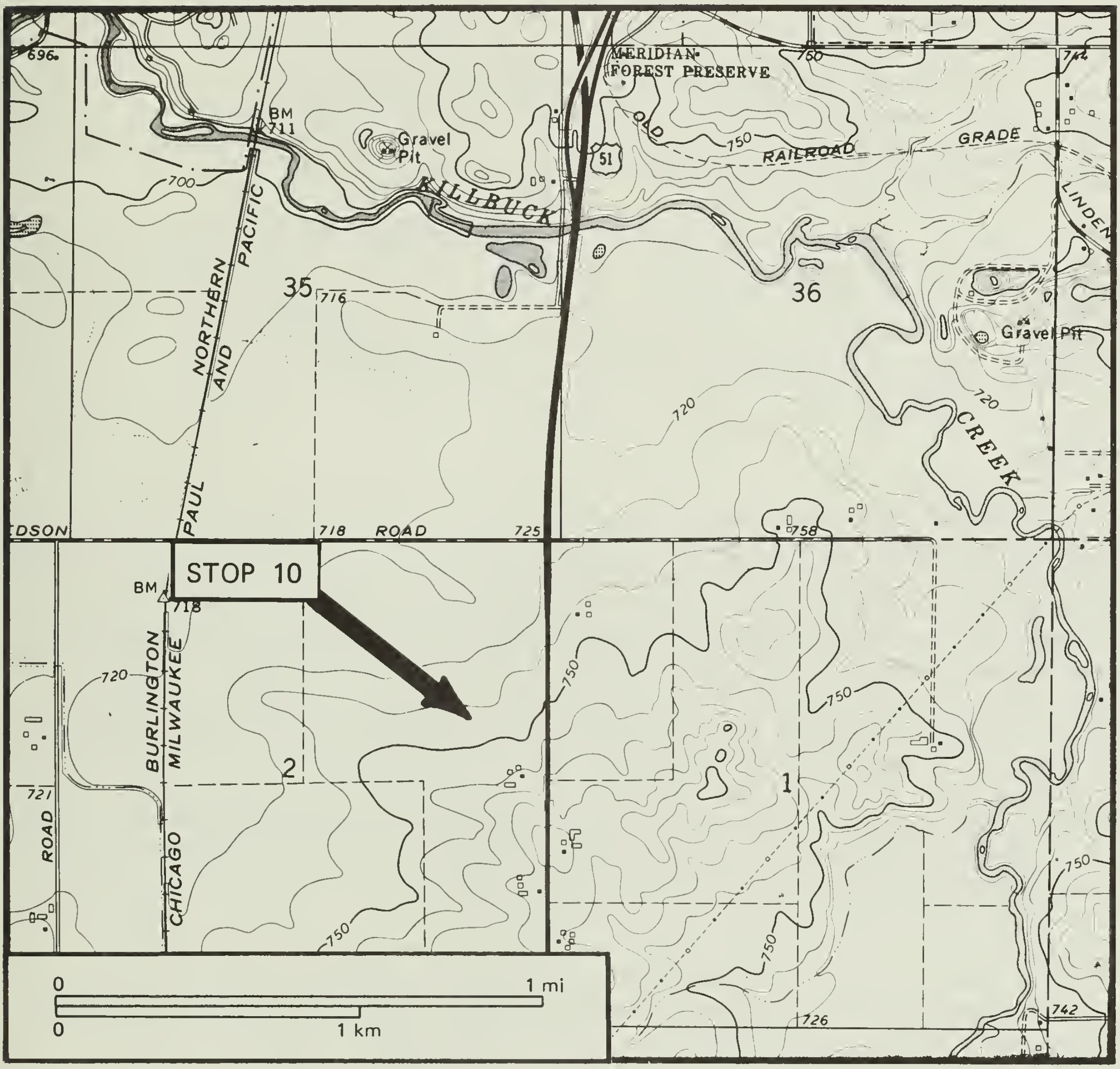
The Oregon Till silty facies in Profile 2 averages 23 percent sand, 40 percent silt, and 37 percent clay; whereas the clay-mineral composition averages 43 percent expandables, 48 percent illite, and 9 percent kaolinite plus chlorite. Profile 1 on the north side of the section is a continuous 5.5-m exposure of the Fairdale Till Member. The diamicton is very friable near the top and becomes progressively denser with depth. Its color is a uniform yellowish brown. A thin, highly weathered remnant of the Oregon Till silty facies is visible in places along the north exposure of the section, but for the most part, the Oregon silty facies pinches out toward the west, where it is replaced entirely by the Fairdale. Ordovician dolomite of the Galena Group underlies Pleistocene deposits at the Fairdale Quarry Secton.

SUMMARY

The previous correlation of diamictons now considered to be the Oregon Till Member silty facies and the Fairdale Till Member with Winnebago Formation members is no longer valid since the Esmond Till overlying the Oregon Till Member silty facies and Fairdale Till Member are Illinoian in age rather than Wisconsinan. The Fairdale and Oregon silty facies are now recognized instead of Capron, Argyle, and Nimtz when occurring south of Piscasaw Creek. The contact between the Oregon silt facies and the Fairdale can be observed at the Fairdale Quarry Section. This stratigraphic relationship is present in numerous borings in Boone, De Kalb, Ogle, and Kane Counties.

A Review of the Esmond Till Member

Leon R. Follmer and John P. Kempton



STOP 10
Browning-Ferris Landfill
NE 1/2 Sec. 2, T 42 N, R 1 E, Ogle County

The best exposure of the Esmond Till in northern Illinois is at the Browning-Ferris Landfill. The recognition of the Esmond Till as late Illinoian rather than early Wisconsinan was the principal catalyst for the stratigraphic reinterpretation of glacial deposits in central northern Illinois. An overview of the Esmond will be presented.

INTRODUCTION

The Esmond Till has had a long history of stratigraphic interpretation and reinterpretation. It once was thought to have been deposited during the Iowan, a glaciation between Illinoian and Wisconsinan. Other interpretations considered it Illinoian, early Wisconsinan, or late Wisconsinan in age. Although many studies have been made on the 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 Esmond, (2) discuss the Esmond at one of its best exposures, the Browning-Ferris Landfill site in Ogle County; and (3) present new information concerning its age and stratigraphic relationships with paleosols and other glacial deposits in the region.

The Esmond Till (Illinoian) 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. Subsequently, the Esmond was formalized by Willman and Frye (1970) as a member of the Wedron Formation (Wisconsinan).

BACKGROUND

The most recent study on the character and distribution of the Esmond was published by Frye et al. (1969), who 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. The site of the Browning-Ferris Landfill (fig. 10-1) is on the northern border of the area they mapped as Esmond. They showed the Esmond as the surface diamicton extending westward as the Dixon Lobe from the Bloomington Morainic System to the vicinity of Dixon. They considered a region to the south to be an interlobate area dividing the 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. 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 and no paleosol was allowed on deposits interpreted to be Belvidere Lobe, Shelbyville, or Esmond.

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

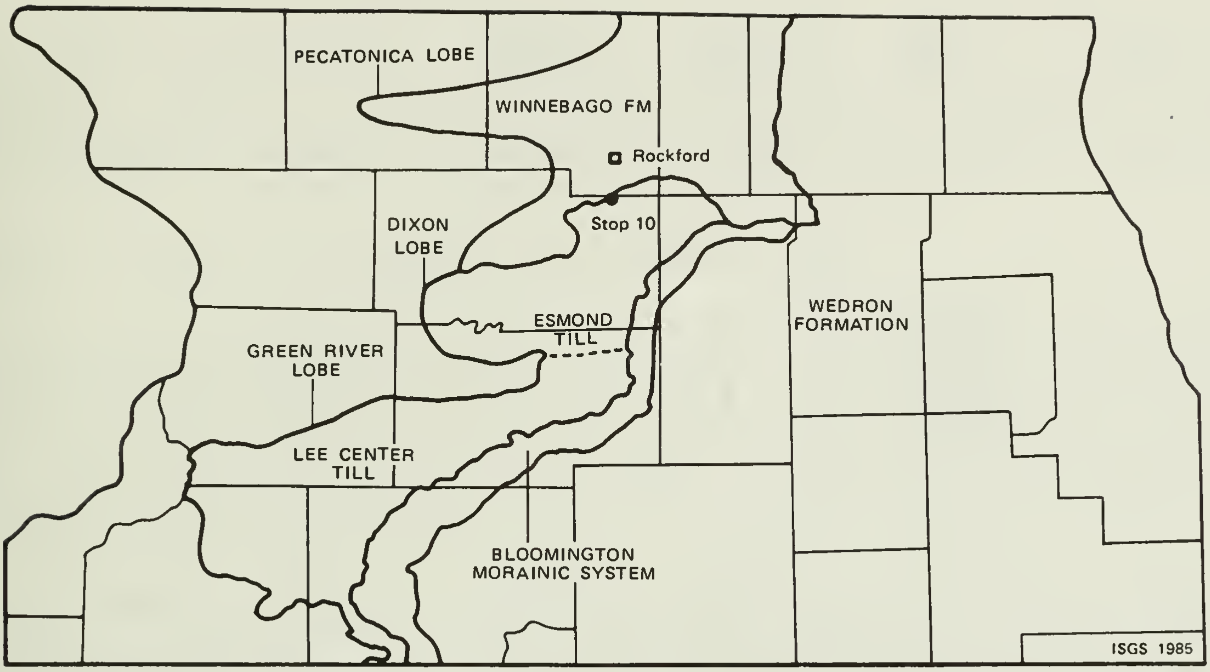


Figure 10-1 Location of pre-Woodfordian glacial lobes of northern Illinois (modified from Frye et al., 1969).

- the presence or absence of a silt (Roxana) 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. 10-2). 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. 10-2).

The drift of the landfill site has been variously classified as East Iowan Formation (Chamberlain, 1894), Iowan (Leverett, 1899), and Illinoian (Alden, 1918). Leighton (1923) did not agree with Alden's interpretation and delineated an area between Illinoian and Wisconsinan as the Belvidere Lobe. The present landfill site is located on the outer border of this area. Leighton correlated the drift of the lobe with Shelbyville drift, which at the time was thought to be "Early Wisconsin" or "post-Iowan" in age. Leighton's interpretation lasted with only minor changes until Shaffer (1956) remapped the area northwest of the Shelbyville drift as "Farmdale." Although Shaffer expanded the distribution of the Shelbyville drift, he accepted Leighton's Belvidere Lobe boundary as the Shelbyville boundary in the area of the landfill. The "Farmdale" was thought to be the earliest Wisconsinan glaciation and the Shelbyville was considered to be closely associated with the classic late Wisconsinan (Woodfordian).

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

ISGS 1985

Figure 10-2 Relative order and correlation of important names used in the discussion of the Browning-Ferris Landfill site.

Shaffer's concept of the Farmdale was soon challenged by Leighton and Brophy (1961) because Leighton had previously argued that all of the drift west of the Belvidere Lobe was Illinoian. However, Leighton and Brophy did accept that part of the area (Pecatonica Lobe) to the north in Winnebago County was Farmdale drift and also recognized an expanded distribution of the Iowan that included the landfill site. At this time, Leighton and Brophy considered the Belvidere Lobe to be Iowan and confined the Shelbyville to the outer edge of the Bloomington Morainic System.

A re-evaluation of the Iowan drift (Ruhe et al., 1968) established that erosion of Wisconsinan age had removed the paleosol from "Kansan" (pre-Illinoian) and older deposits, resulting in a youthful looking landscape. Based on this work we have dropped the term Iowan from rock-stratigraphic terminology.

Further confusion was introduced when new and revised terms were presented (Frye and Willman, 1960) and when all of the surficial drift from the Bloomington Moraine, westward to the Driftless Area, was classified as Wisconsinan (Willman et al., 1967, inset map on Geologic Map of Illinois). In 1960, the more precisely defined Woodfordian and Altonian replaced late or classic Wisconsin and Farmdale. In general the new terms are equivalent to late Wisconsinan and early Wisconsinan as used in the Midwest. Within this revised stratigraphic framework, the Esmond Till was classified as the oldest till member of the Woodfordian (Willman et al., 1967). In 1969, Frye et al. restricted the mapped area of Woodfordian and Altonian deposits and increased the area of Illinoian: these revisions did not affect the distribution of the Esmond. Berg, Kempton, and Stecyk (1984) recognized the Esmond as Illinoian in age and mapped it further north and east than had been observed previously.

GEOLOGIC SETTING OF THE BROWNING-FERRIS LANDFILL SITE

Many good exposures of the Esmond Till have been observed in the trenches at the Browning-Ferris Landfill site (NE Sec. 2, T 42 N, R 1 E, Ogle County, Illinois), but none have been studied in detail. The geological investigation for the site found the area to be covered with several feet of silt or sandy silt. The underlying deposits found in order of occurrence are (1) Esmond Till, loam to silty clay diamicton, (2) silt and sand (lacustrine), and (3) loam to sandy loam diamicton.

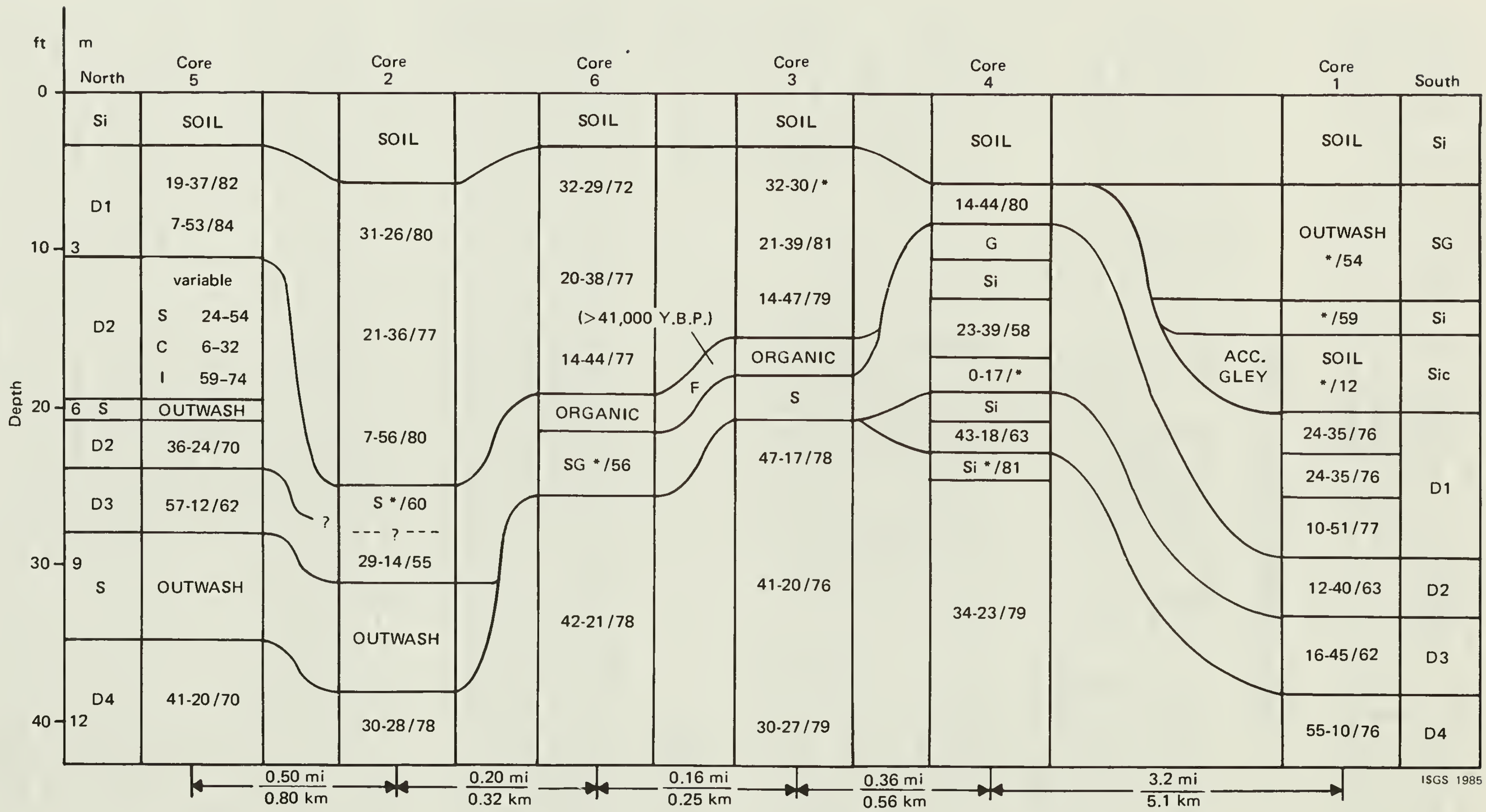
The landfill is located on the outer flank of the Harrisville Moraine described by Willman and Frye (1970). These dissected hills were previously considered to be the terminus of the Shelbyville or White Rock Moraine. The moraine is only recognized in a few places because morainal topography is rarely preserved in areas of high relief. Ice-contact deposits that are commonly associated with the Harrisville Moraine support an end moraine interpretation. However, at the landfill site the Esmond is draped over the underlying deposits, which suggests that the morainal form is a relict of an earlier landform.

Stratigraphy and Lithology

The composition of the Esmond Till is relatively easy to distinguish from other surficial diamictons in the area. The Esmond belongs to the gray-olive color 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 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. 10-3).

In most places a silt unit up to 3 m thick underlies the Esmond. It is usually silt loam in 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 Till was recognized by previous researchers and correlated with the Morton Silt by Willman and Frye (1970). The time-stratigraphic placement of the Morton Silt, however, is no longer valid because snails from this silt at the Byron Power Plant site 20 km



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 10-3 Correlation of the Greenway School Cores, Ogle County, Illinois.

to the southwest were dated >36,500 RCYBP (ISGS 378, Follmer, Berg, and Acker, 1978). At the landfill site, sand underlies the silt in many places. For now the sand is included with the silt as an unnamed member of the Glasford Formation (Illinoian).

A loam-textured diamicton beneath the sand and silt is fairly continuous across the site and may constitute the "main frame" of the morainal hill here. The loam diamicton was previously correlated with the Capron or Argyle Till Members of the Winnebago Formation (upper Winnebago), but is now correlated with the Oregon Till Member of the Glasford Formation (Kempton, Berg, and Follmer: this guidebook; and Kempton and Berg: Stop 9).

Soil Geomorphology

The soil geomorphology of this site was described by Follmer, Berg, and Acker (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 are mapped where the underlying sandy diamicton outcrops on hill slopes. In a few places on high parts of the moraine, 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, Berg, and Acker, 1978). Small eolian dunes are visible north of the landfill. No paleosol (Sangamon) has been found at the site but paleosols have been observed 8 km to the east (which is 3 km south of the Esmond type section) and in many other isolated locations. A sandy lag material (pedisediment), sometimes similar to the eolian loam, is present in places above Esmond. Rarely has a stone line been observed on the Esmond.

REGIONAL RELATIONSHIPS

Follmer, Berg, and Acker (1978) reported the Esmond in most of north-eastern 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, Berg, and Acker (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 Shelbyville 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 interdune 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, Berg, and Acker (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.

Eight kilometers south of the landfill site, near Holcomb, and well within the Esmond Till plain, a paleosol was studied by Follmer, Berg and Acker (1978). Based on 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 eolian materials.

AGE AND CORRELATION OF THE ESMOND TILL

There are several reasons why 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 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 (Kempton, Berg, and Follmer, this guidebook; and Berg and Kempton: Stop 5). 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 were very much alike, both having illite values of about 80 percent. 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 usng 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). Since 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, it appeared to confirm their model. Later a conceptual conflict arose between the growing soil-stratigraphic evidence that a Sangamon surface was above the Esmond and the evidence for a younger interpretation that depended on one radiocarbon date.

The Greenway School cores were obtained by J. E. Hackett and J. P. Kempton when they noted that Leverett had reported buried soils just west of Esmond. Kempton's earliest correlations (similar to fig. 10-3) were superseded by an interpretation that emphasized the lithology of the Esmond and better fit the radiocarbon date and the then accepted stratigraphic sequence. This interpretation excluded core 1 containing the accretion-gley, and it was not included in Frye et al. (1969).

Based on stratigraphic position and the lack of a paleosol, the units in cores 2 through 6 appeared to fit the young Esmond model. 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 only recently has been resurrected, and now provides additional evidence on the age of the Esmond.

The organic material below the Esmond was re-examined 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, we needed two more dates on the same material. 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. Silt 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.

CONCLUSION

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.

With this new information, the Esmond, Lee Center, Sterling, and Radnor (a central Illinois equivalent) are believed to be correlatives. The Belvidere Till discussed by Kempton, Berg, and Follmer (this guidebook) may also be equivalent. One name should be selected to represent all units we now think are rock-stratigraphic equivalents. On the basis of its widespread distribution in central Illinois, we propose the name Radnor.

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APPENDIX: Generalized Textural and Clay-Mineral Composition Data for Selected Borings and Exposures in Northern Illinois

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Illinois Tollway Boring 3-10-5						
Measured in a boring SE SE NE, Sec. 3, T 43 N, R 3 E, Stone Quarry Road overpass, Boone Co., IL						
Pleistocene Series						
Illinoian Stage						
Glasford Formation						
Esmond Till Member						
Diamicton; clay loam, brown, leached at top, calcareous below	0-1.8	2	29-37-34	10-74-16	40-45	5<
Sand; fine to coarse with silt, brown to yellowish brown, calcareous	1.8-3.7	3-4	-	12-72-16	24-70	-
Oregon Till Member						
Diamicton; sandy loam, dark yellowish brown, calcareous	3.7-4.6	5	53-39-8	24-57-19	30-75	2>
Sand and silt; yellowish brown, laminated, calcareous, rests on dolomite bedrock	4.6-6.7	6-7	-	16-68-16	25-108	2>
Argyle Boring						
ISGS file no. C12771; field no. ISGS-10(81) Measured in a boring in the NW NW NW, Sec. 30, T 45 N, R 3 E, Boone Co., IL						
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; yellowish brown, leached	0-0.9					
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; soil formed in top, leached	0.9-1.5	1-2				
Diamicton; sandy loam, light brown to brown with pinkish tint, pebbles, jointed in upper part-possible ablation till	1.5-2.7	3	55-28-17	55-28-11	6-36	20>
in sample 3, calcareous	2.7-9.2	4-10A	53-30-17	27-61-12	38-44	8>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Diamicton; loam, brown to gray-brown with a pinkish tint, sharp oxidation contact, calcareous	9.2-11.6	10B-12	51-30-19	16-64-20	43-46	1>

Belvidere North Boring

ISGS file no. C10514; field no. ISGS-9
Measured in boring in SW SE SW,
Sec. 36, T 45 N, R 3 E, 6.4 km N. of
Belvidere, Boone Co., IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; colluviated, yellowish brown, leached	0-2.9					
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; sandy clay loam to loam, brownish yellow, massive, oxidized, slowly calcareous,	2.9-4.6	1	49-24-27	32-56-12	-39	-
pinkish gray in lower part	4.6-7.6	2	50-42-8	19-61-20	42-48	8>
Diamicton; loam, grayish brown, massive, calcareous	7.6-10.7	3-4	41-34-25	12-65-23	29-28	1>
Nimtz Till Member						
Diamicton; sandy clay loam, grayish brown, massive, calcarous	10.7-18.9	5-6	54-23-23	12-67-21	29-30	1>
Beaver Creek Sand Member						
Sand and gravel	18.9-20.4	-	-	-	-	-
Glasford Formation						
Fairdale Till Member						
Diamicton; sandy clay loam, brown, massive, calcareous	20.4-26.8	7	50-26-24	14-62-24	29-38	-
Clayey silt; grayish brown, calcareous	26.8-27.8	9	3-63-34	13-67-20	46-41	2>
Diamicton; sandy loam, pale brown to brown, calcareous	27.8-33.2	10	59-25-16	10-68-22	26-50	2<
Undifferentiated Members						
Sand and gravel; light brown-gray	33.2-34.5	11	-	-	20-34	-
Clayey silt; brown to grayish brown, massive, calcareous	34.5-46.7	12-15	16-56-28	21-57-22	36-42	8>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Sand and gravel; pale brown, calcareous	46.7-58.3	16-19	-	-	18-27	10>
Silt; pinkish brown, trace of organics, laminated, calcareous	58.3-77.2	20-25	0-79-21	20-54-26	36-52	10>
Diamicton; loam, grayish brown, some plant fibers, calcareous	77.2-88.0	26	50-31-19	25-50-25	18-25	13>
Silt; brown, some plant fibers, bedded, calcareous, possible Pike Soil	88.0-90.3	27-29	7-71-22	24-49-27	18-27	12>
Sand and gravel; light brown to tan, fine sand with few pebbles, calcareous	90.3-101.0	30-33	-	-	19-41	4>
Kellerville Till Member						
Diamicton; loam, brown to dark brown, massive, calcareous, rests on dolomite bedrock	101.0-106.1	34	33-41-26	27-48-25	28-40	15>

Belvidere South Boring

ISGS file no. C12760; field no. BNE-5
Measured in a boring in the NW NW NW,
Sec. 6, T 43 N, R 4 E, Boone Co., IL

Pleistocene Series
Illinoian Stage
Glasford Formation
Belvidere Till Member (Type section)

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Diamicton; clay loam, pale brown or salmon, gravelly, massive and uniform, somewhat oxidized, calcareous	0-7.6	A1-A5+ 1-2	24-43-33	20-70-10	43-67	1>
Diamicton; clay loam, gray-brown to gray, violet hue, pinkish gray near base, few pebbles, massive and uniform, unoxidized, calcareous	7.6-15.3	3-5	25-46-29	18-69-13	58-69	4>
Diamicton; clay loam, sand, medium to coarse, and silt, gray-brown to yellowish brown, calcareous	15.3-22.6	6-7	-	14-68-18	40-92	1>
Herbert Till Member						
Diamiton; loam, light brown-gray to brown, uniform and massive with thin silt beds, few pebbles, calcareous	22.6-24.4	8	36-37-27	8-75-17	43-70	9<

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Sand; medium to coarse, brown, poorly sorted, gravel up to 1/2 inch, calcareous	24.4-27.5	9	-	8-74-18	26-92	-
Clayey silt; light brownish gray, calcareous	27.5-30.2	10a	-	9-75-16	40-75	10<
Sand, fine, pale brown to brown, well sorted, few pebbles, calcareous	30.2-32.0	10b	-	7-72-21	29-114	4<
Undifferentiated diamicton						
Diamicton; sandy loam, light brown-gray, few pebbles, calcareous, very compact and hard, rests on dolomite bedrock	32.0-37.2	11	-	12-67-21	41-71	1>

Boone North Boring

ISGS file no. C12756; field no. BNE-1
Measured in boring in the SE SE SW,
Sec. 24, T 46 N, R 3 E, 2.4 km west
of Blaine, Boone Co., IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; leached, tan-brown, modern soil in top	0-2.6					
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; yellowish brown, ablation till, leached		A6-A8	-	61-31-8	4-22	-
Diamicton; sandy loam, pinkish gray, calcareous	2.6-3.1	1	57-27-16	42-48-10	36-47	-
Diamicton; sandy loam, pinkish gray and oxidized in samples 2-6, unoxided in samples 7-11, few pebbles, calcareous,	3.1-32.0	2-11	53-29-18	12-65-23	52-58	-
Glasford Formation						
Oregon Till Member						
Diamicton; sandy clay loam, dark reddish brown, few pebbles, calcareous	32.0-39.3	12-13	52-26-22	23-54-23	58-63	11>
Undifferentiated diamicton						
Diamicton; clayey silt, some organics, calcareous	39.3-41.2	14	-	33-42-25	13-18	19>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Kellerville Till Member						
Diamicton; loam, greenish gray at top, contains some organics and wood fragments, gray near bottom, calcareous, possible Pike Soil inclusion	41.2-51.2	15-16	32-42-26	40-43-17	18-16	-
Unnamed silts						
Silt; gray-brown, lacustrine materials, laminated, some massive clay and silt, sand bed at base, calcareous	51.2-52.2	17	-	33-52-15	20-27	19>
Silt; dark brown to brown, lacustrine, massive to faintly bedded, calcareous, rests on dolomite bedrock	52.2-57.6	18	-	13-71-16	27-23	8<

Capron West Boring

ISGS file no. C12757; field no. BNE-2
Measured in a boring in the SE SE SW, Sec. 3, T 45 N, R 4 E, on North Boone School Road, Boone Co., IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; yellowish brown, leached	0-0.9					
Altonian Substage (or Illinoian Stage)						
Winnebago Formation						
Capron Till Member						
Diamicton; silt loam, ablation, yellowish brown to dark yellowish brown, gravelly, leached	0.9-2.7	A+1a	-	50-38-12	-11	23>
Diamicton; loam, pinkish brown, oxidized, very slowly calcareous	2.7-4.9	1b	35-39-26	24-64-12	17-68	14>
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; loam, yellowish brown to pinkish brown, few pebbles, calcareous	4.9-16.2	2-5	51-33-16	27-60-13	41-79	13>
Nimtz Till Member						
Diamicton; sandy loam, pale brown, slightly altered, few pebbles, calcareous	16.2-19.2	6	52-29-19	22-67-11	47-55	10>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Diamicton; loam, gray-brown, unaltered, few pebbles, calcareous	19.2-26.2	7-8	51-32-17	12-68-20	45-58	6<
Silty fine sand; gray-brown, lacustrine, few pebbles, highly calcareous	26.2-39.6	9-13	-	12-67-21	32-45	1<
Glasford Formation						
Belvidere Till Member						
Diamicton; silt loam, gray-brown, few pebbles, calcareous	39.6-42.7	14	41-50-9	10-71-19	22-41	4<
Sandy silt-silty sand; gravel, possible diamicton inclusions, lacustrine sequence, brown to gray-brown, calcareous	42.7-52.5	15-17	-	10-72-18	24-53	4<
Esmond Till Member						
Diamicton; loam, gray-brown, few pebbles, calcareous	52.5-61.6	18-19	42-39-19	6-76-18	25-54	11<
Silt; gray to gray-brown, till-like, calcareous	61.6-67.1	20	-	3-77-20	24-36	19<
Diamicton; clay loam, pale brown, few pebbles, calcareous	67.1-71.4	21	25-40-35	6-75-19	40-41	6<
Sand and gravel	71.4-75.6					
Fairdale Till Member						
Diamicton; sandy loam, pale brown to violet, few pebbles, lacustrine silt inclusion, calcareous	75.6-87.5	22-23	54-30-16	9-70-21	43-58	7<
Lacustrine silt; rests on dolomite bedrock	87.5-91.8					

Courthouse Boring

ISGS file no. C12769; field no. ISGS-8(81)
Measured in a boring in the NW SW NE, Sec. 16, T 44 N, R 3 N, on the east side of the county courthouse building, Belvidere, Boone Co., IL

Classification Description	Depth (m)
Pleistocene Series	
Wisconsinan Stage	
Woodfordian Valderan and Substages	
Peoria Loess	
Silt; tan-brown, leached	0-1.4

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; sandy loam, strong brown, very weathered, soil formed into surface	1.4-2.9	2	54-21-25	46-42-12	-	-
Glasford Formation						
Belvidere Till Member						
Diamicton; sandy clay loam, brown to strong brown, pinkish brown near base, yellow-brown mottles, few pebbles, ablation till or accretion gley, leached to 3 m	2.9-5.2	3-6	37-42-21	50-40-10	7-18	-
Diamicton; clay loam, brown to grayish brown, dense, uniform, some mottles, unoxidized, calcareous	5.2-7.0	7-8	30-38-32	20-71-9	6-11	-
Sand; fine to medium with silt, light brown; calcareous, possibly rests on dolomite bedrock	7.0-10.1	9-11	-	-	-	-

Garden Prairie North Boring

ISGS file no. C12758; field no. BNE-3
Measured in a boring in the SW SE SE,
Sec. 36, T 45 N, R 4 E, Boone Co., IL.

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; yellow-brown, leached	0-1.2					
Illinoian Stage						
Winnebago Formation						
Nimtz Till Member						
Diamicton; loam but has siltier parts, dark to light yellowish brown, massive, dense and uniform, few pebbles, weathered in top, calcareous	1.2-4.9	A1-5,1	48-32-20	25-68-7	6-55	9>
Glasford Formation						
Oregon Till Member						
Sand; fine, yellow-brown, well sorted, calcareous	4.9-7.0	2	-	31-57-12	28-83	-
Diamicton; loam, light brown to brown, few pebbles, calcareous	7.0-11.0	3	50-31-19	36-54-10	79-110	-

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Fairdale Till Member						
Sand; medium to coarse, with fine to medium gravel, yellow-brown to light olive-brown, poorly sorted, highly oxidized, calcareous	11.0-12.8	4	-	12-65-23	13-38	7>
Diamicton; sandy loam, pale brown to light brown-gray, few pebbles, calcareous	12.8-17.1	5	58-30-12	12-64-24	58-88	5>
Diamicton; loam, grayish brown to pinkish gray, few pebbles, calcareous	17.1-21.0	6-7	42-34-24	13-67-20	62-55	5>
Diamicton; sandy loam, grayish brown to brownish gray, thin sand inclusions, calcareous	21.0-30.5	8-10	54-32-14	10-69-21	48-65	2>
Sand and silt; light brownish gray, alternating beds, well sorted, calcareous	30.5-83.0	11-24	-	8-70-22	38-61	2<
Undifferentiated diamicton						
Diamicton; loam, light brown-gray, few pebbles, calcareous	83.0-89.1	25	39-47-14	13-65-22	56-69	-

Huber Road Boring

ISGS file nos. P20278-P20279 (upper);
field no. ISGS-7 (80)
Measured in a boring SE NE SW,
Sec. 15, T 43 N, R 4 E, on Huber Road,
Boone Co., IL

Pleistocene Series
Illinoian Stage
Glasford Formation
Belvidere Till Member

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Diamicton; silty clay loam, pinkish brown to brown, few pebbles, massive and uniform, calcareous	0-3.1	1-2	18-43-39	21-70-9	41-58	6>
Silts and sands; olive brown, iron staining, laminated, massive and uniform, some small clay balls, pebbles, calcareous	3.1-7.8	3-8	-	17-68-15	23-59	1>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Esmond Till Member						
Silty clay; light gray brown to brown gray, laminated, no gravel, uniform, calcareous	7.8-8.1	9	-	12-75-13	41-72	9<
Diamicton; silty clay, gray brown, massive and uniform, a little gravel, calcareous	8.1-8.8	10-11	16-42-42	8-76-16	33-61	11<
Oregon Till Member silty facies						
Diamicton; loam, pale to gray-brown with a pinkish cast, massive and dense, uniform, calcareous	8.8-10.1	12-12a	37-36-27	14-63-23	36-50	2>

Irene Boring

ISGS file no. C12761; field no. BNE-6
Measured in boring in the NE NE SE Sec. 33, T 43 N, R 3 E, on Flora Church Road, Boone Co., IL

Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; yellowish brown, leached	0-0.9					
Illinoian Stage						
Glasford Formation						
Belvidere Till Member						
Diamicton; clay loam, olive brown to brown, some gravel, calcareous	0.9-5.8	1-2	22-40-38	14-71-15	53-65	3>
Till-like material and clayey silt lacustrine deposits; olive brown to olive yellow, pinkish brown below, medium sand inclusion, calcareous, possibly related to Esmond ice event	5.8-9.4	3-4	-	7-72-21	31-69	3<
Oregon Till Member						
Clayey silt; dark olive gray with organic streaks and sand, stringers in upper portion, pale pinkish brown below, all calcareous, possibly related to Oregon ice event	9.4-11.6	5 top	-	34-52-14	21-55	11>
		5 bott.	-	12-61-27	45-86	4>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Herbert Till Member						
Diamicton; sandy loam, light olive to yellowish brown, gravelly, calcareous	11.6-14.6	6	52-36-12	11-77-12	21-93	5<

Manchester Road Boring

ISGS file no. 12776; field no. ISGS-15 (81)
Measured in a boring in the SW SE SE,
Sec. 10, T 46 N, R 3 E, on Manchester Road,
Boone Co., IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; yellow tan, leached	0-1.5	1-2				
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; sandy loam, yellow-brown, paleosol in top, oxidized, very weathered, few pebbles, leached	1.5-5.2	3-6	62-21-17	9-83-8	-	3<
Diamicton; sandy loam, light brown to brown, oxidized, few pebbles, slowly calcareous	5.2-7.2	7-8	60-28-12	20-69-11	- 26	6>
Diamicton; sandy loam, brown, oxidized, hard, much gravel, calcareous	7.2-11.0	9-11	54-30-16	23-65-12	18-32	7>
Diamicton; sandy loam, gray, unoxidized, dense, calcareous	11.0-15.9	12-14	54-30-16	12-65-23	34-42	2<

Northwest McHenry County Boring

ISGS file no. C4515; field no. NIPC-1
Measured in boring in the SE SW SW,
Sec. 7, T 46 N, R 5 E, 7 km north-northwest of Chemung, McHenry Co., IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Colluviated silt; olive brown, leached, very fine to fine sand, organic matter, Modern Soil in top	0-1.7					

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Altonian Substage or Illinoian Stage						
Winnebago Formation						
Capron Till Member						
Diamicton; loam, pinkish brown in upper 2.5 m., appears reworked, mottled yellowish in lower 1.4 m., upper 1 m leached, calcareous	1.7-2.1	1	48-30-22	43-42-15	-	-
	2.1-4.0	2	43-37-20	34-54-12	52-82	25>
	4.0-5.2	3	40-39-21	57-32-11	30-90	60>
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; sandy loam yellow-brown, mottled in upper portion, some gravel, calcareous	5.2-10.1	4-6	53-41-7	24-63-13	53-82	13>
Silty sand; yellowish brown, some gravel, calcareous	10.1-11.6	7	63-36-1	23-63-14	49-88	11>
Nimtz Till Member						
Diamicton; loam, pinkish gray to brownish gray, gravelly, calcareous	11.6-21.7	8-15	49-29-22	9-70-21	56-90	4<
Glasford Formation						
Belvidere Till Member						
Diamicton; clay loam, grayish brown, massive, calcareous	21.7-26.8	16-18	35-35-30	7-71-22	52-79	8<
Sand and gravel; silty, pale brown, subangular gravels, massive, calcareous	26.8-34.5	19-23	64-29-7	16-61-23	27-52	4>
Diamicton; clay loam, grayish brown, massive, calcareous	34.5-38.4	24-26	36-38-26	6-72-22	54-61	12<
Clayey silt; brownish gray, calcareous	38.4-52.2	27-34	0-58-42	8-71-21	59-72	10<
Diamicton; clay loam, brownish gray, massive, some gravel and fine sand, calcareous	52.2-66.1	35-44	32-33-35	7-72-21	55-72	10<
Oregon Till Member						
Silty clay; brown, some organics, calcareous	66.1-72.6	45-48	0-60-40	20-55-25	62-86	11>
Sand; fine to medium, light brownish gray, some fine gravel, well-sorted, calcareous	72.6-84.2	49-55	-	18-64-18	58-80	1>
Diamicton; sandy loam, reddish brown, massive, trace of gravel, calcareous	84.2-86.3	55A-56	56-25-19	25-55-20	69-82	17>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Sand; fine to medium, pale brown, massive, calcareous	86.3-88.4	57	-	-	45-77	12>
Diamicton; loam, reddish brown, massive, some gravel, calcareous	88.4-102.2	58-66	46-30-24	21-57-22	69-86	16>
Sand; fine to coarse, light brown, some plant fibers, some gravel, calcareous	102.2-103.7	67	-	20-56-24	54-96	5>
Sandy silt; yellowish brown, organic material, wood, some gravel, calcareous, Pike Soil	103.7-106.7	68-69	56-35-9	26-54-20	36-72	16>
Kellerville Till Member						
Diamicton; loam, dark brown, massive, some plant fibers, calcareous	106.7-108.0	70	26-52-22	37-43-20	27-30	32>
Undifferentiated units						
Sand and gravel; brownish gray, some wood chips, calcareous	108.0-119.0	71-77	-	-	23-112	-
Silty sand; dark brown, organics, calcareous	119.0-122.6	78-80	45-41-14	33-50-17	30-45	24>
Sand and gravel; light yellowish brown, some organics, calcareous	122.6-139.7	81-92	-	-	32-98	2>
Silt with sand; brown, gravel at bottom, plant fibers, calcareous	139.7-143.3	93-94	5-83-12	15-64-21	21-55	8>
Diamicton; silty clay loam, light pinkish brown, massive, calcareous, rests on dolomite bedrock	143.3-143.9	95	16-56-28	26-54-20	48-74	15>

Sycamore East Boring

ISGS file no. C4513; field no. NIPC-18
Measured in a boring in the SE NE SE,
Sec. 35, T 41 N, R 5 E, De Kalb Co., IL

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Wedron Formation
Tiskilwa Till Member

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Diamicton; loam, brown to reddish gray, massive, calcareous	0-28.7	1-36	37-40-23	9-71-20	48-69	4>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Diamicton; loam, reddish gray, much gravel, ice contact, calcareous	28.7-30.0	37	-	11-67-22	39-84	2>
Sand and gravel; light olive brown, calcareous	30.0-31.1	-	-	-	-	-
Illinoian Stage						
Glasford Formation						
Belvidere Till Member						
Diamicton; clay loam, yellowish brown to brown, slight pinkish cast, calcareous	31.1-40.5	39-44	29-40-31	12-67-21	76-87	1<
Oregon Till Member silty facies						
Diamicton; clay loam, brown, calcareous, mixed zone from 43.1 to 45.1 m.	40.5-45.1	45-47	33-35-32	17-61-22	75-88	9>
Herbert Till Member						
Diamicton; loam, light brown to brown, some medium to coarse sand with gravel inclusions, calcareous, rests on dolomite bedrock	45.1-50.0	48-50	45-43-12	7-77-16	35-71	7<

Boone County Exposure HK-95

Field no. HK-95
Measured in a shallow boring in the NW NW NW, Sec. 23, T 43 N, R 3 E on Stone Quarry Road, Boone Co., IL. Boring to be used in conjunction with the Stone Quarry Road Boring, 0.8 km S on Stone Quarry Road.

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Illinoian Stage						
Glasford Formation						
Belvidere Till Member						
Diamicton; silty clay loam, pinkish gray, calcareous	0-1.0	-	20-47-33	20-69-11	22-45	-

Winnebago County Boring W-45-20

ISGS file no. C8816
Measured in a boring in the NW NE NE, Sec. 33, T 45 N, R 2 E on Harlem Road, Winnebago Co., IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; yellow-brown, leached	0-2.9	1-3	-	-	-	-
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; sandy loam, yellowish brown, calcareous	2.9-3.7	4-5	55-27-18	22-65-13	35-47	7>
Silt; water-laid, calcareous	3.7-7.0	6-9	-	-	-	-
Nimtz Till Member						
Diamicton; loam, gray-brown, massive to slightly blocky, calcareous	7.0-9.5	10-12	50-35-15	18-67-15	34-36	6>
Glasford Formation						
Oregon Till Member						
Diamicton; loam, gray-brown to buff, calcareous	9.5-10.7	13-14	46-31-23	24-61-15	35-42	11>

Winnebago County Boring W79-7

ISGS File no. C11509
Measured in boring in the SE SE NE,
Sec. 15, T 46 N, R 2 E, Winnebago Co., IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; sandy loam, pinkish gray, calcareous	0-1.5	1-2	54-29-17	28-54-18	56-54	15>
Nimtz Till Member						
Diamicton; loam, gray-brown, massive, calcareous	1.5-7.0	3-5	50-32-18	20-68-12	45-61	6>
Glasford Formation						
Kellerville Till Member						
Diamicton; loam, gray-brown, calcareous	7.0-9.8	6-7	45-33-22	42-45-13	37-54	23>
Undifferentiated diamicton						
Diamicton; clay loam, weathered, leached, possible soil on top, rests on dolomite bedrock	9.8-11.6	8	35-25-40	34-53-13	-	-

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Centerville Road Section						
ISGS file nos. P21431-P21440; field no. RCB-70-2 Measured in an exposure in the N 1/2 SW SE, Sec. 8, T 45 N, R 4 E, Boone Co., IL						
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; yellowish tan, leached	0-0.9					
Ilinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; sandy loam, buff, partially leached	0.9-2.1	1-2	53-29-18	30-60-10	4-19	12>
Nimtz Till Member						
Diamicton; loam, buff, calcareous	2.1-7.0	3-10	49-32-19	21-72-7	19-24	5>
Beaver Creek Sand Member						
Sand and gravel; yellowish brown, contorted beds, calcareous	7.0	-	-	-	-	-
Chrysler Railroad Section						
ISGS file nos. P8008-P8020; field no. HK-8 Measured in an exposure, NE NE SE, Sec. 34, T 44 N, R 3 E, on west side of Stone Quarry Road, Boone Co., IL						
Pleistocene Series						
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Sand; gravelly silt, oxidized to light brown in upper part, leached above	0-2.1					
Diamicton; sandy loam, pinkish brown to gray, oxidized to light brown in upper 0.7 m. with oxidation through out, calcareous	2.1-2.7	1-3	59-28-13	16-64-20	24-51	-

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Glasford Formation						
Esmond Till Member						
Diamicton; clay loam, dark violet gray, some black shale fragments, dense, calcareous, measured laterally down section 6 m. south of above Argyle units	2.7-4.2	4	32-38-30	5-81-14	12-27	-

County Farm Landfill Section

ISGS file nos. P20245-P20246;
field no. RCB-14
Measured in an exposure NE NE NW, Sec. 14, T 44 N, R 3 E, east side of Route 76, Boone Co., IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Wisconsinan Stage						
Woodfordian and Valderan Substages						
Peoria Loess						
Silt; yellow-brown, leached	0-0.9					
Illinoian Stage						
Winnebago Formation						
Nimtz Till Member						
Diamicton; loam, buff, massive, maximum of 2.3 m. thick, thins to west where it is about 1-1.7 m. thick, calcareous	0.9-1.5	1	45-32-23	25-68-7	57-56	-
Glasford Formation						
Beaver Creek Sand Member						
Sand; bright orange, highly oxidized and leached	1.5-1.7					
Oregon Till Member						
Diamicton; sandy loam, gray, calcareous	1.7-2.1	2	54-28-18	31-61-8	48-60	-

Grand Detour Section

ISGS file nos. P8189-P8198
field no. HK-108
Measured in a roadcut exposure in the SW SW NE Sec. 25, T 22 N, R 9 E, Lee County, IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Illinoian Stage						
Glasford Formation						
Sand and gravel; brown soil at top	0-1.7	1	-	14-78-8	-30	7>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Esmond Till Member						
Diamicton; clay, gray, massive, calcareous	1.7-2.7	2-3	8-37-55	10-81-9	14-32	-
Undifferentiated silt (formally Morton Loess)						
Silt; gray to gray-tan, massive, calcareous, diamicton inclusion from overlying Esmond	2.7-3.5 3.5-4.3	4-5 6-7	- 4-75-21	14-78-8 56-34-10	10-26 22-23	4> -
Oregon Till Member						
Diamicton; loam, salmon-pink, massive, silt at top, calcareous	4.3-5.3	8-9	45-32-23	39-54-7	53-59	19>

Nimtz Quarry Section

Exposure in an active quarry in the N1/2 of the SE, Sec. 33, T 45 N, R 2 E, Loves Park, Winnebago Co., IL

See Berg and Kempton; Stop 5, for Profile 1 and Profile 2.

Profile 3, South Wall Exposure, 46 m west of Profile, ISGS file nos. P21446-P21451; field no. RCB-74-2

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; sandy loam, buff, calcareous	0-1.5	1	59-29-12	28-59-13	-30	-
Nimtz Till Member						
Diamicton; sandy loam, buff, massive to slightly blocky, calcareous	1.5-2.7	2-3	56-30-14	19-71-10	18-37	3>
Diamicton; loam, buff, massive to slightly blocky, calcareous	2.7-4.3	4-6	49-32-19	18-70-12	28-33	-

Profile 4, South Wall Exposure, 92 m. west of Profile 3 ISGS file nos. P21452-P21461; field no. RCB-74-3

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Argyle Till Member						
Diamicton; sandy loam, buff, oxidized stone line at 4 m., oxidized sand above, calcareous	0-6.7	1-6	55-30-15	23-64-13	23-35	8>
Diamicton; loam, gray, unoxidized, calcareous	6.7-8.5	7-8	45-33-22	22-63-15	26-36	7>
Nimtz Till Member						
Diamicton; loam, buff gray, massive to slightly blocky, calcareous, slump at base overlying dolomite bedrock	8.5-9.8	9-10	49-33-18	16-70-14	19-25	-
Profile 5, South Wall Exposure, 23 m. west of Profile 4 ISGS file nos. P21462-P21464 field no. RCB-74-4						
Nimtz Till Member						
Diamicton; sandy loam, gray-brown, unoxidized, sand lenses, massive to slightly blocky, calcareous	0-4.0	1-3	55-28-17	19-69-12	22-37	3>
Profile 6, South Wall Exposure, 76 m. west of Profile 5 ISGS file nos. P21465-P21476 field no. RCB-74-5						
Nimtz Till Member						
Diamicton; sandy loam, gray-brown, massive to slightly blocky, contains thin sand lenses, calcareous	0-4.9	1-6	53-31-16	18-72-10	26-28	5>
Diamicton; loam, gray-brown, oxidized, massive to slightly blocky, calcareous	4.9-7.9	7-11	49-34-17	15-71-14	24-26	1>
Diamicton; loam, gray, unoxidized, massive to slightly blocky, calcareous, rests on dolomite bedrock	7.9-9.2	12	50-33-17	13-74-13	30-30	2<
Profile 7, South Wall Exposure, 153 m. east of Profile 1. ISGS file nos. P21478-P21479 field no. RCB-74-6						
Nimtz Till Member						
Diamicton; loam, brown, calcareous, rests on dolomite	0-2.1	1-2	51-32-17	18-67-15	14-25	2>

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Profile 8, South Wall Exposure, easternmost, ISGS file nos. P21479-P21485; field no. RCB-74-7						
Pleistocene Series						
Illinoian Stage						
Winnebago Formation						
Argyle Till Member						
Diamicton; sandy loam, pinkish brown, calcareous, stone line at base	0-1.5	1-1'	54-30-16	30-59-11	27-40	13>
Diamicton; sandy loam, brown-tan, oxidized, calcareous	1.5-2.1	2-5	55-32-13	25-62-13	23-28	6>
Diamicton; loam, gray, unoxidized, calcareous	2.1-5.5	6	46-38-16	17-63-20	15-25	3>
Profile 9, North Wall Exposure, westernmost ISGS file nos. P21486-P21490; field no. RCB-74-8						
Nimtz Till Member						
Diamicton; sandy loam, gray-brown, massive to slightly blocky, numerous sand streaks, calcareous	0-6.9	1-4	52-29-19	17-70-13	25-28	3>
Herbert Till Member						
Diamicton; loam, gray-brown, massive to slightly blocky, calcareous, rests on dolomite bedrock	6.9-7.6	5	47-32-21	13-78-9	18-26	2<
Profile 10, North Wall Exposure, 99 m. east of Profile 9 ISGS file nos. P21491-21496 field no. RCB-74-9						
Nimtz Till Member						
Diamicton; sandy loam, gray-brown, massive to slightly blocky, numerous sand streaks, calcareous	0-8.2	1-5	53-31-16	20-72-8	18-26	6>
Diamicton; loam, gray-brown, massive to slightly blocky, calcareous	8.2-9.2	6	47-32-21	23-71-6	19-23	4>
Profile 11, North Wall Exposure, 99 m. east of Profile 10 ISGS file nos. P21497-P21503; field no. RCB-74-10						

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Nimtz Till Member						
Diamicton; sandy loam, buff, oxidized, massive, slightly blocky, calcareous	0-3.7	1	58-28-14	19-68-13	16-31	3>
Diamicton; loam, buff, oxidized, massive to slightly blocky, calcareous	3.7-4.9	2-3	48-33-19	17-71-12	27-34	3>
Beaver Creek Sand Member						
Sandy loam; cemented 0.3 m. sand lense between samples 5 and 6	4.9-6.7	4-6	52-32-16	17-69-14	26-27	-
Oregon Till Member ?						
Diamicton; sandy loam, gray-brown, very hard, calcareous, rests on dolomite bedrock	6.7-7.0	7	62-25-13	25-60-15	15-26	-
Profile 12, North Wall Exposure, 122 m. east of Profile 11 ISGS file nos. P21504-P21506; field no. RCB-74-11						
Nimtz Till Member						
Diamicton; loam, brown, oxidized, massive to slightly blocky, calcareous	0-2.4	1	48-37-15	21-69-10	24-28	4>
Diamicton; loam, gray, unoxidized, massive to slightly blocky, calcareous	2.4-2.7	2	49-34-17	21-67-12	28-40	7>
Beaver Creek Sand Member						
Sand; very fine, 0.8 m. of white sand underlain by 1.7 m. of yellowish brown sand, a layer of cemented sand at top of unit	2.7-5.2					
Oregon Till Member ?						
Diamicton; loam, yellowish brown, calcareous, rests on dolomite bedrock	5.2-6.1	3	50-41-9	18-61-21	15-32	-

Spartan Store Section

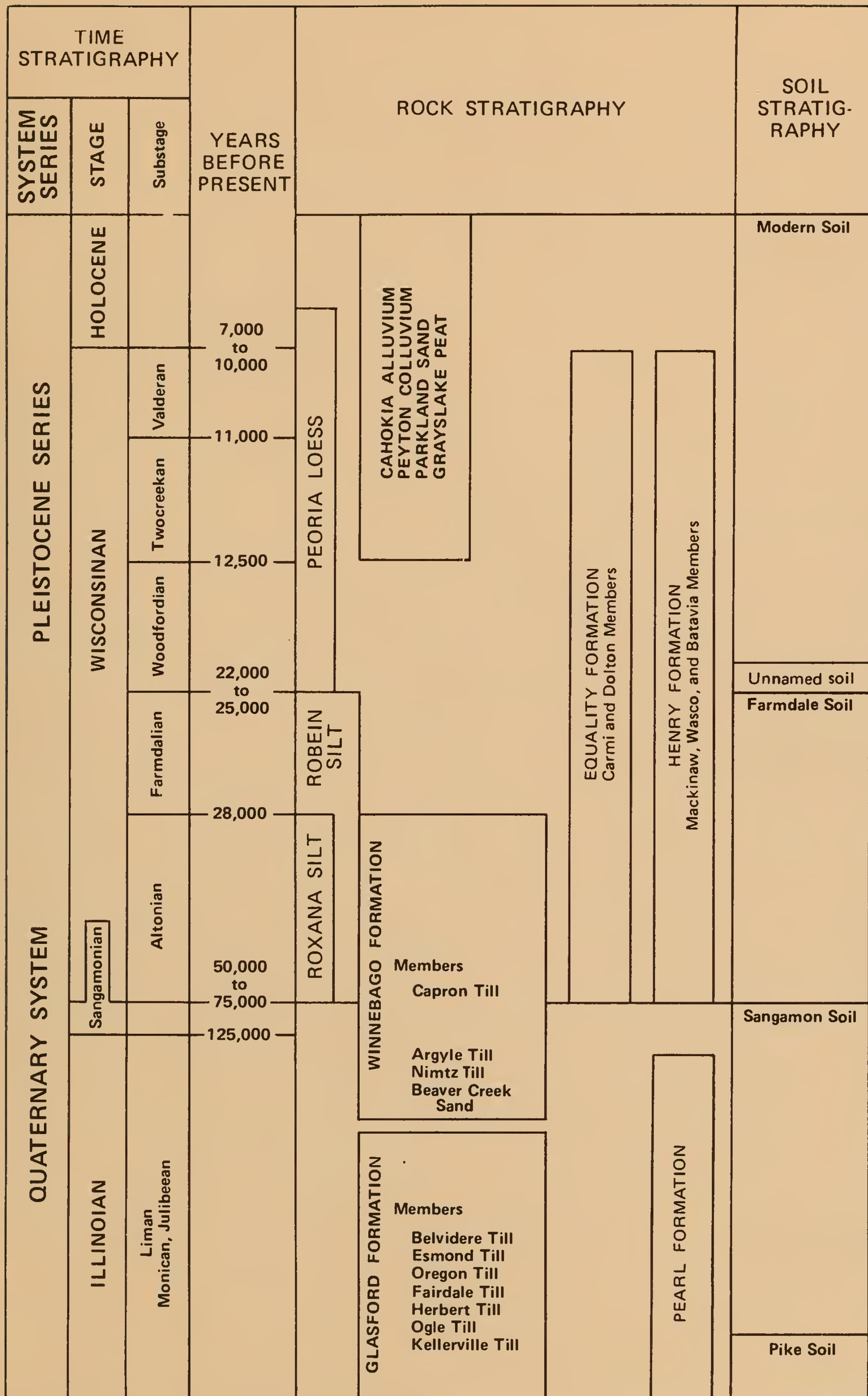
ISGS file nos. P8041-P8042;
field no. HK-27
Measured in an exposure in the SW SW NW, Sec. 29, T 44 N, R 2 E on State Street, Rockford, Winnebago Co., IL

Classification Description	Depth (m)	Sample no.	Sd-Si-C	Ex-I-K+C	C-D	VI
Pleistocene Series						
Illinoian Stage						
Winnebago Formation						
Nimtz Till Member						
Diamicton; sandy loam, brown to dark brown, calcareous	0-0.3	1	52-31-17	19-68-13	57-60	-
Glasford Formation						
Esmond Till Member						
Diamicton; loam, grayish to greenish brown, trace of shale, calcareous	0.3-0.6	2	35-41-24	12-77-11	25-5	-

Abbreviations used

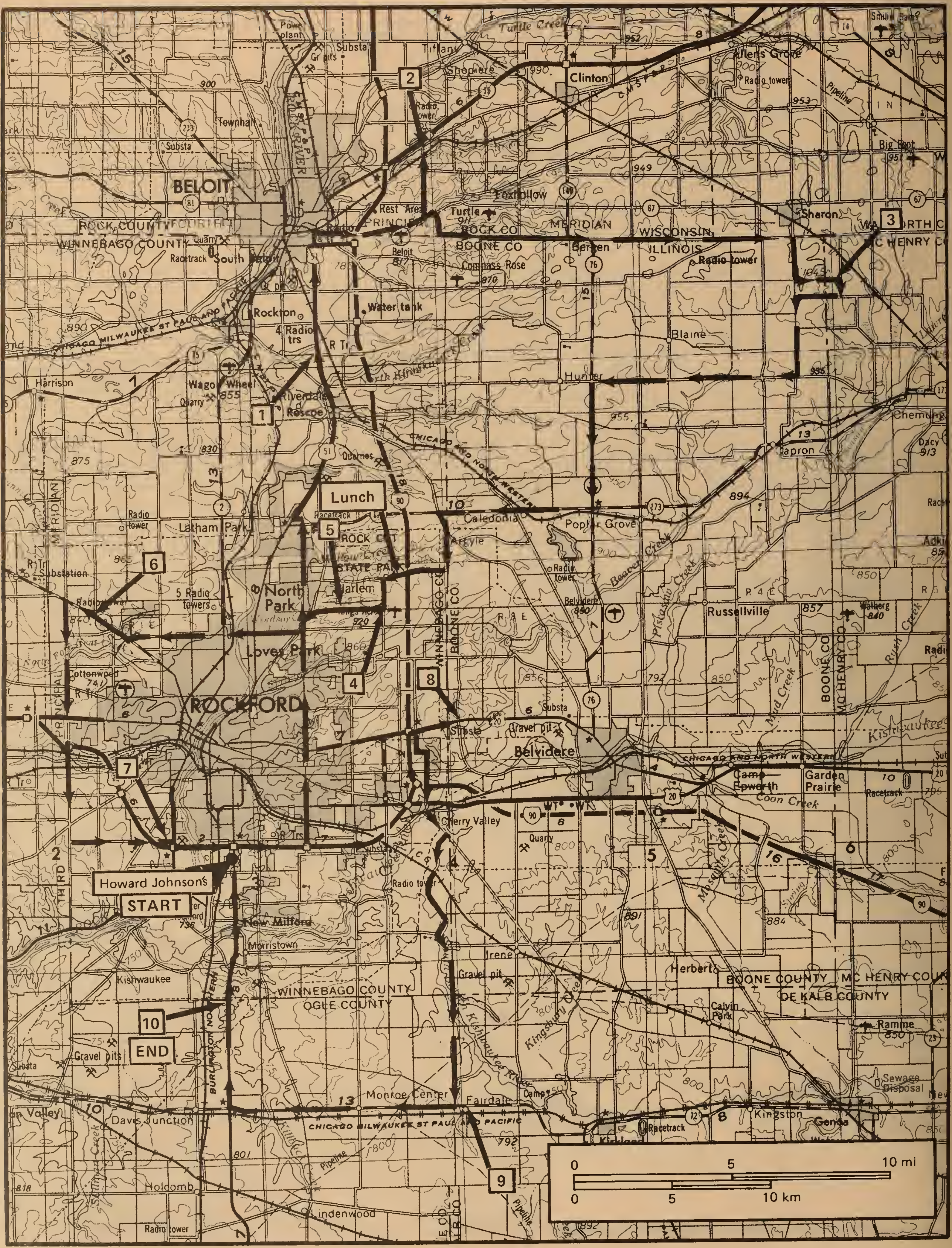
Sd-Si-C - sand-silt-clay
Ex-I-K+C - expandable clay minerals - illite - kaolinite plus chlorite
C-D - calcite - dolomite counts per second
VI - vermiculite index

all use averages per sample groupings
colors are from field descriptions



ISGS 1985

Stratigraphic classification of Quaternary deposits of central-northern Illinois.



Area covered and field-trip route of the 1985 Friends of the Pleistocene Field Conference.