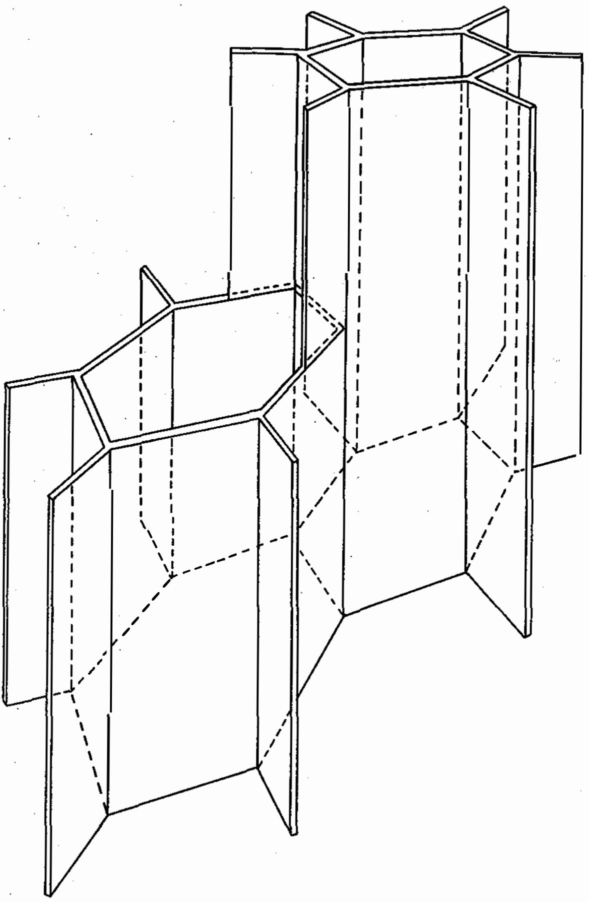
Clay Mineralogy of Pleistocene and Pennsylvanian sediments in east-central Illinois

W. Arthur White and Leon R. Follmer



18th Annual Field Conference of the Clay Mineral Society,
Champaign and Vermilion Counties, Illinois

Sponsors: Illinois State Geological Survey
University of Illinois

October 8, 1981

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Illinois Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
615 East Peabody Drive
Champaign, IL 61820

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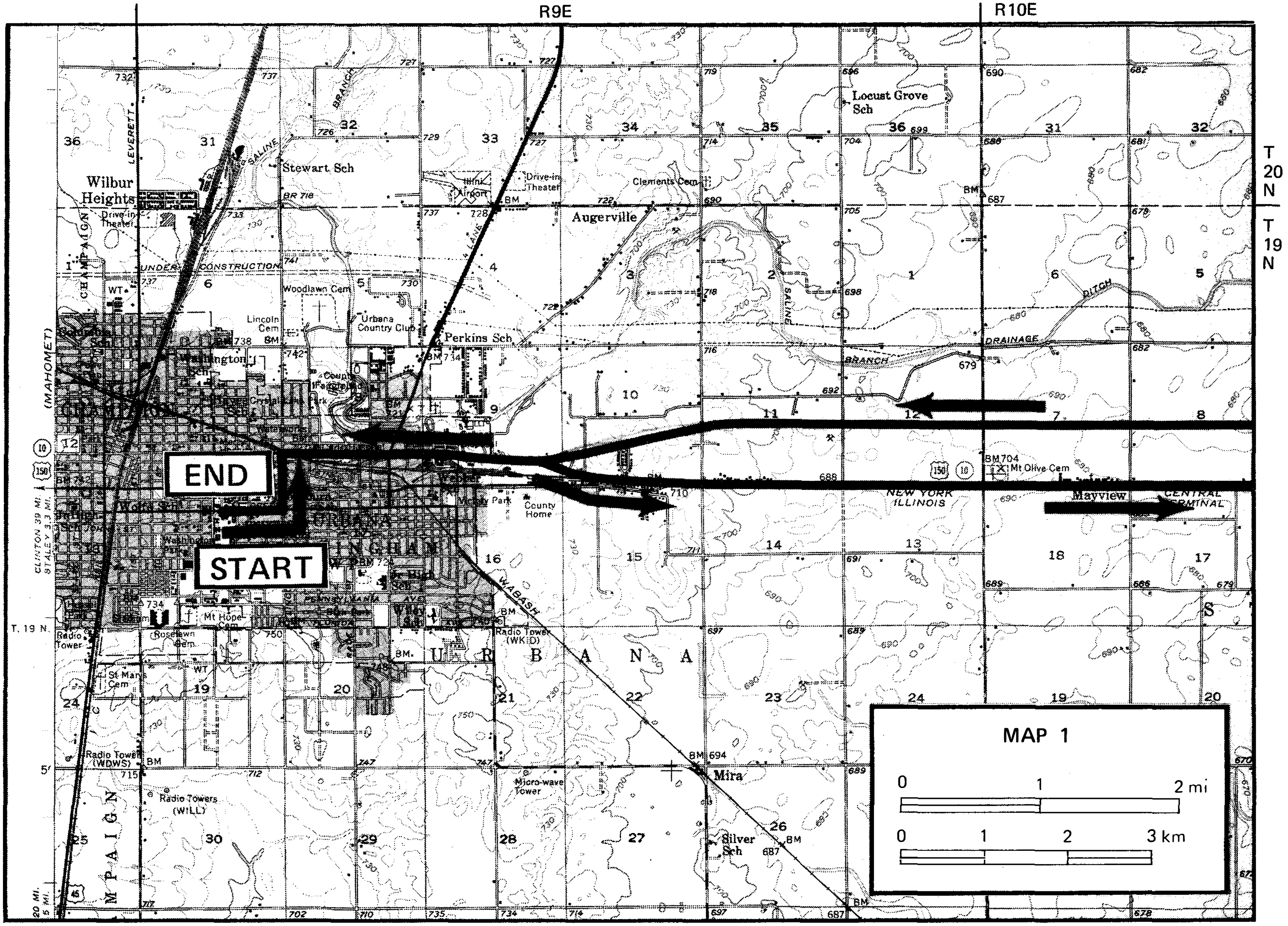

R9E
R10E
T 20 N
T 19 N
START
END
0 1 2 mi
0 1 2 3 km
Wilbur Heights
Stewart Sch
Locust Grove Sch
Augerville
Clements Cem
Illini Airport
Drive-in Theater
Woodlawn Cem
Lincoln Cem
Urbana Country Club
Perkins Sch
Washington Sch
County Fairgrounds
Crystal Lake Park
Champaign
Urbana
Meadow Park
County Home
Mt Olive Cem
Mayview
New York Central Illinois Terminal
Saline Branch
Drainage Ditch
Wabash
Mt Hope Cem
Roselawn Cem
St Marys Cem
Radio Tower (WKID)
Radio Tower (WDWS)
Radio Towers (WILL)
Micro-wave Tower
Mira
Silver Sch
Mahomet
Champaign
Leverett
Clinton 39 mi. Staley 3.3 mi.

MAP 1

ACKNOWLEDGMENTS

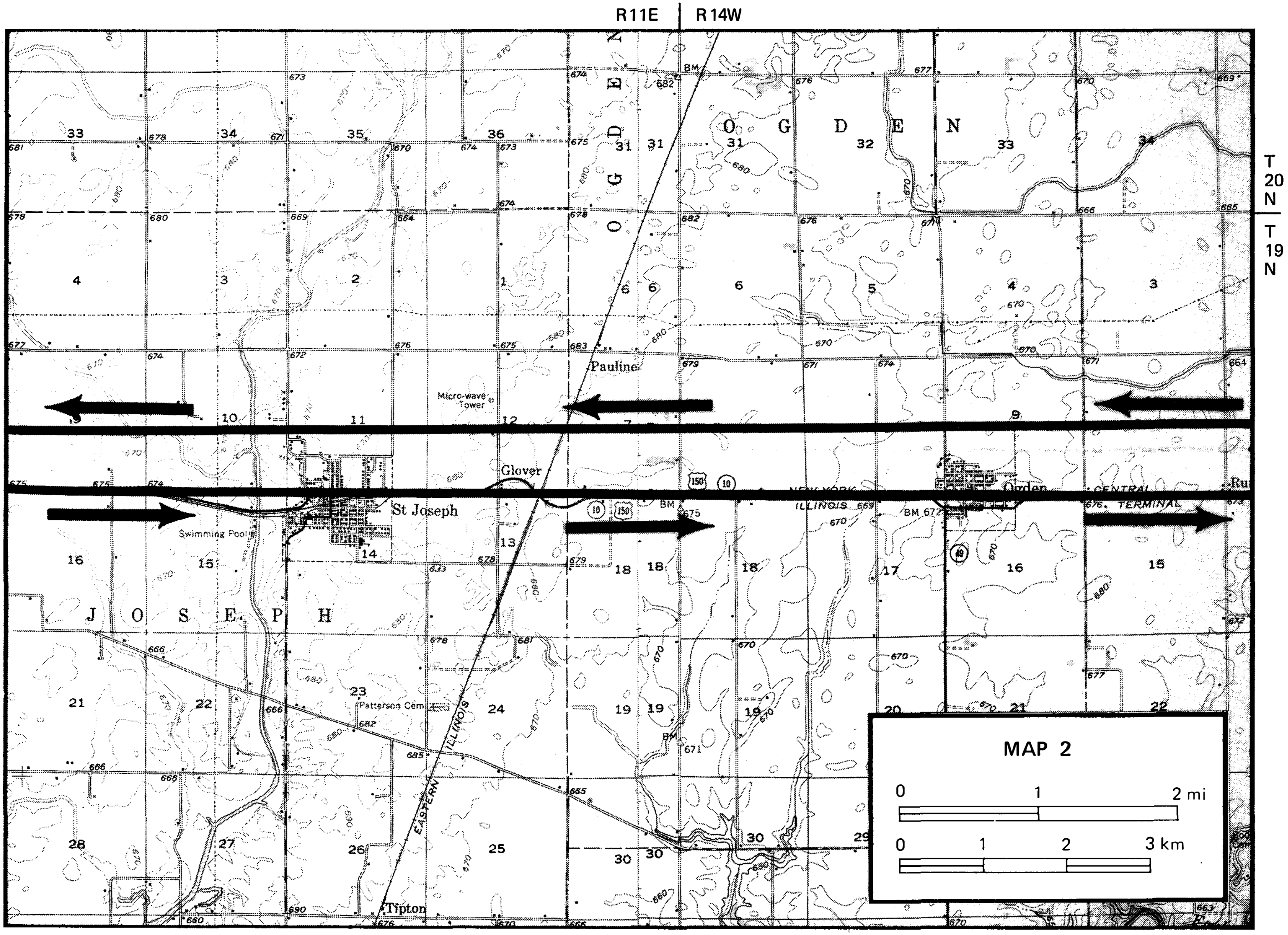
This field trip and guidebook were prepared by staff members of the Illinois State Geological Survey. Leon Follmer selected the soil profile exposures and wrote the discussions for Stops 2, 3, 5, 6, and 7. Randall Hughes and David Burke sampled the exposures and performed the clay mineral analyses. David Reinertsen provided much of the road log. Ronald Sears, project director of Conferences and Institutes at the University of Illinois, made arrangements for the field trip.

FOREWORD

This field trip, across a glaciated landscape involving bedrock of Pennsylvanian age, offers an opportunity to:

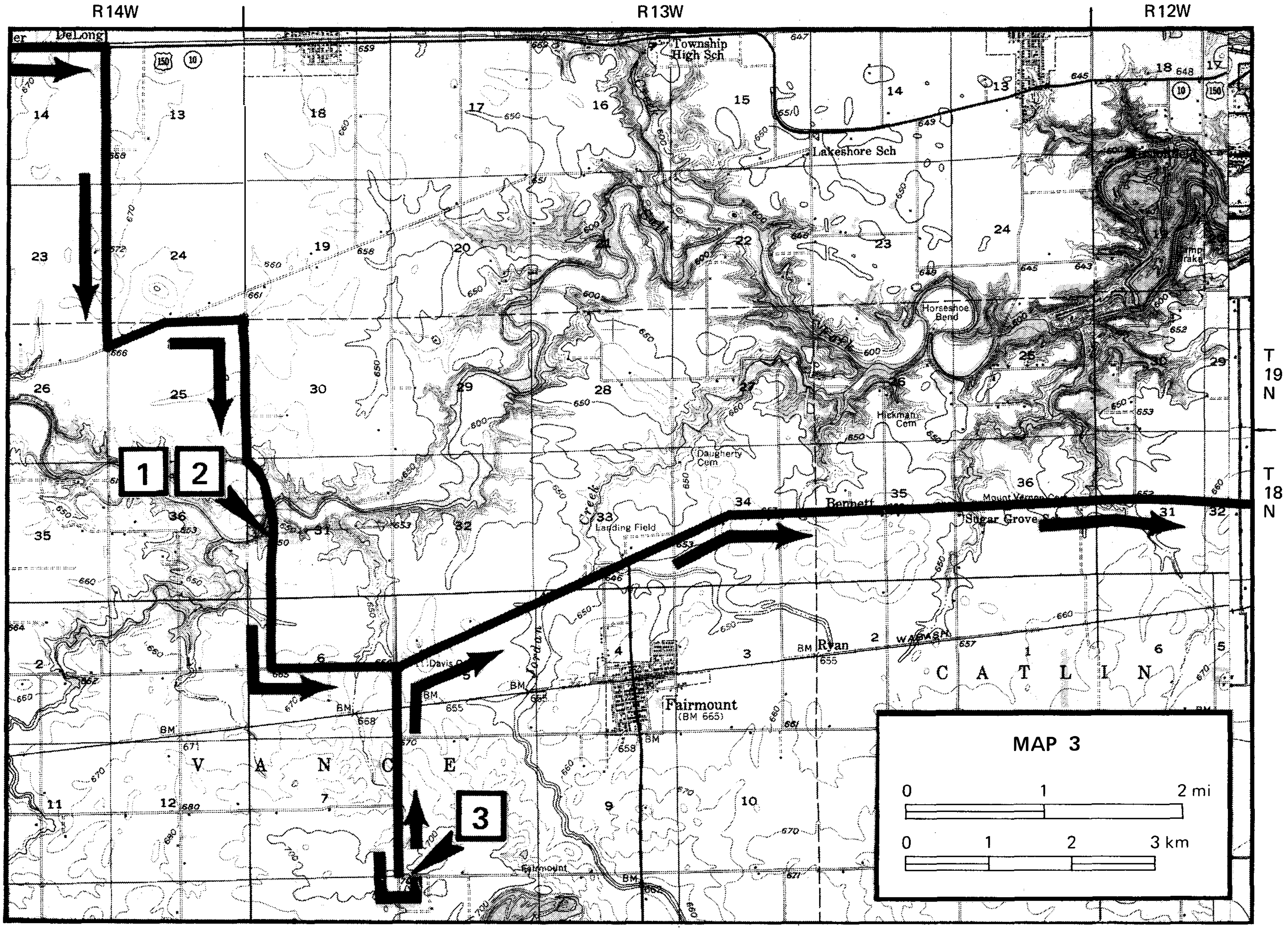
- observe modern soil profiles associated with loess, till, and glaciofluvial deposits
- study paleosols of Pleistocene age
- compare the latter with seatrocks (underclays-soils) as they occur below coal and coal hiatus in the Fithian, Brereton, Summum, and St. David Cyclothems of the Pennsylvanian sequence of rocks.

Profile development will be discussed in terms of alteration of clay minerals, and clay mineral assemblages of seatrocks will be contrasted to those of marine and non-marine sediments unaffected by coal swamp conditions. In addition, sedimentary structures related to diagenetic processes affecting Pennsylvanian sediments and to rotational landslides in the Pleistocene will be discussed.


R11E
R14W
T 20 N
T 19 N
O G D E N
J O S E P H
Pauline
Micro-wave Tower
Glover
St Joseph
Swimming Pool
Ogden
Patterson Cem
Tipton
EASTERN ILLINOIS
NEW YORK
ILLINOIS
CENTRAL
TERMINAL
BM
MAP 2
0
1
2 mi
0
1
2
3 km

ROAD LOG

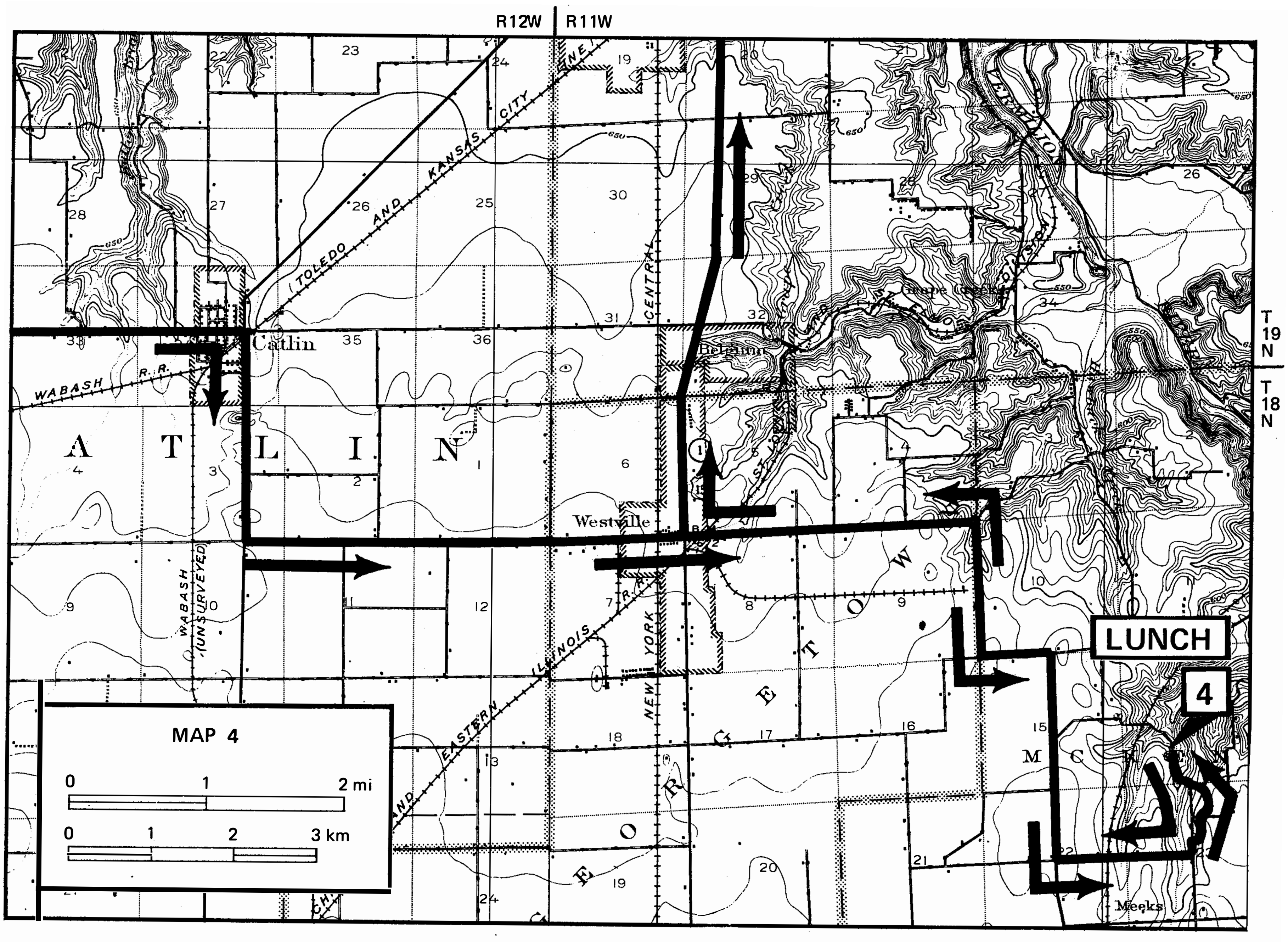
Distance between points	Cumulative mileage	
0.0	0.0	North entrance to the Illini Union. Leave the Union. Turn east (right) onto Green Street.
0.05	0.05	STOP. Green Street. Turn right (east) and proceed to second stoplight at Lincoln Avenue.
0.35	0.4	Second stoplight. Lincoln Avenue. Turn left (north) and proceed to second stoplight at University Avenue.
0.4	0.8	Stoplight at University Avenue. Turn right (east) and cross railroad. Proceed through 3 more stoplights on University Avenue (east) to junction with U.S. 150.
1.9	2.7	Turn right (easterly) on U.S. 150.
3.25	5.95	Isolated patches of original prairie can be seen across from the cemetery on the south side of the highway between the highway and the railroad tracts.
2.55	8.4	Excellent view of the Urbana ground moraine on both sides of highway.
2.3	9.7	Cross Salt Fork.
0.3	10.0	Enter St. Joseph. Proceed east on U.S. 150 after stopping at 4-way stop in St. Joseph.
0.8	10.8	In the distance (left) is the front of the Illiana Morainic System.
1.0	11.8	Railroad overpass.
2.7	14.5	CAUTION. Enter Ogden. Proceed east on U.S. 150 after stopping at 4-way stop in Ogden.
1.25	15.75	Enter Vermilion County.
1.95	17.7	Intersection with Route 49. Turn right (south) opposite U.S. Route 49. This road is 200E, a blacktop road.
1.2	18.9	STOP—one way. Turn left on gravel road.
1.3	20.2	To left is a fairly well-developed kame on a till plane.
0.75	20.95	Turn right (south) at T-road.
1.2	22.15	Descend valley wall.



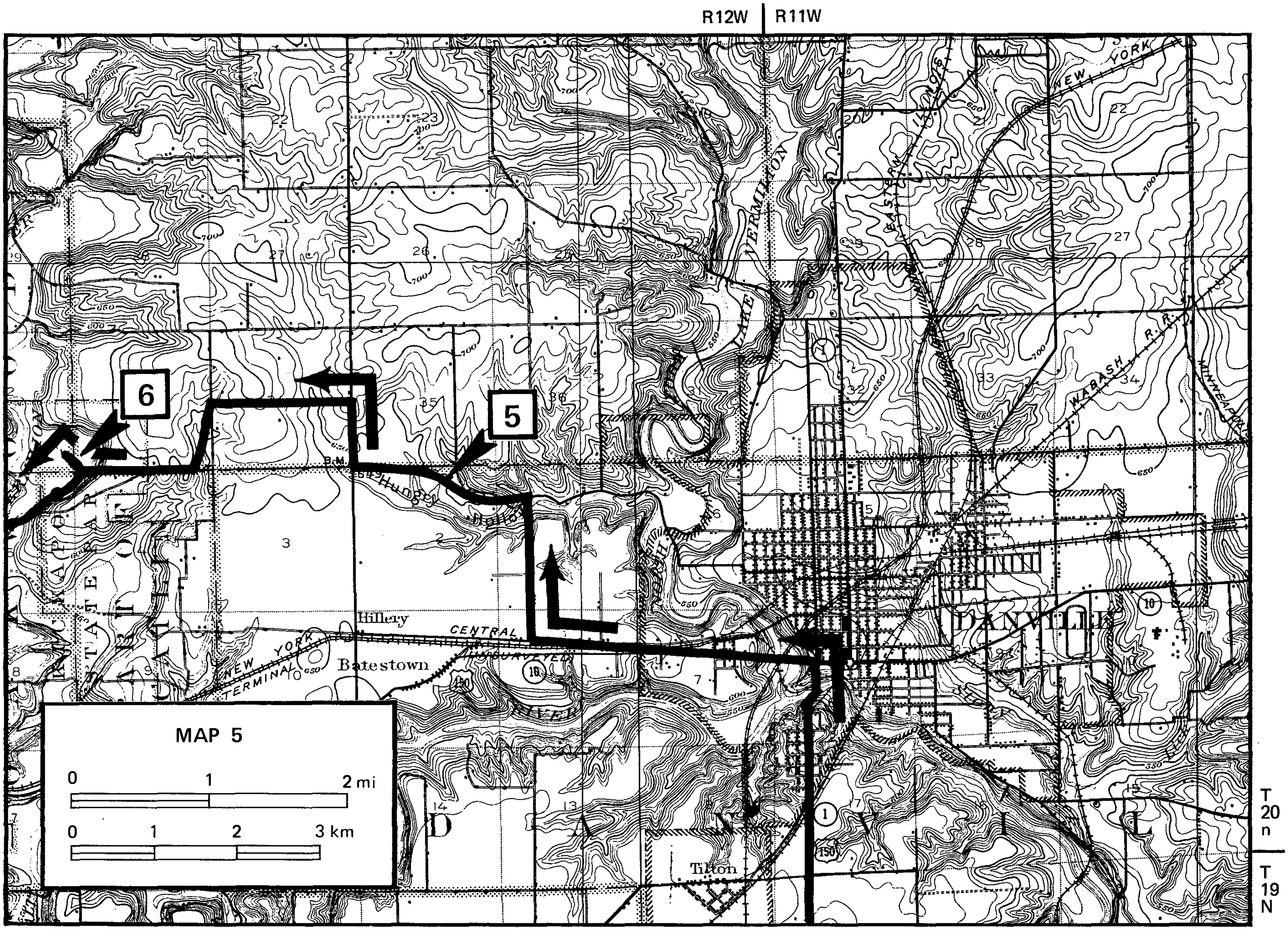
MAP 3

R14W
R13W
R12W
T 19 N
T 18 N
DeLong
Township High Sch
Lakeshore Sch
Horseshoe Bend
Hickman Cem
Daugherty Cem
Landing Field
Bennett
Mount Vernon
Sugar Grove
Davis
Ryan
WABASH
Fairmount
(BM 665)
Jordan Creek
V A N C E
C A T L I N
1
2
3
0
1
2 mi
0
1
2
3 km

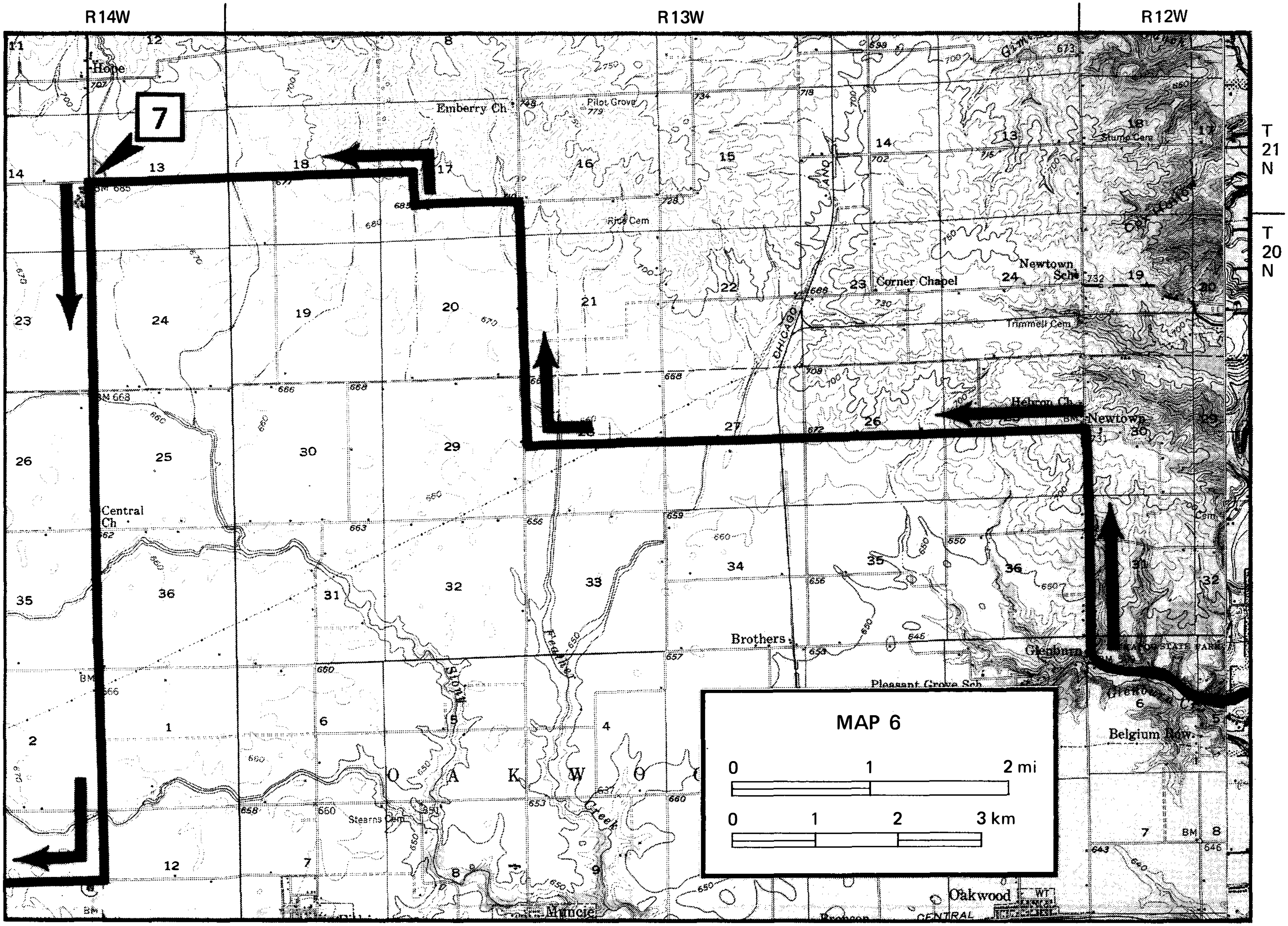
Distance between points	Cumulative mileage	
0.45	22.6	CAUTION. Narrow bridge over Salt Fork.
0.25	22.85	**STOP 1.**
0.0	22.85	Leave Stop 1. Immediately turn right (west) on narrow lane.
0.1	22.96	**STOP 2. No place to park so you will have to continue ahead a little bit to park and then walk back.**
0.0	22.95	Leave Stop 2. Continue ahead (west).
0.05	23.0	Turn vehicle around here at lane to left.
0.15	23.15	T-road intersection. Turn right (south).
0.95	24.1	STOP. Highway. Turn left (east).
0.7	24.8	Prepare to turn right.
0.2	25.0	Turn right (south) on 400E at power substation.
0.3	25.3	CAUTION. Unguarded railroad crossing. Continue ahead south.
0.25	25.55	We are now ascending the backslope of the Urbana moraine.
0.95	26.5	T-road from left. Turn left (east).
0.2	26.7	Dirt and rock barrier across gravel road.
		STOP 3. To the right (south) in the highwall.
0.0	26.7	Leave Stop 3. Turn around and retrace itinerary to paved road.
0.15	26.85	STOP. Turn right (north).
1.25	28.1	CAUTION. Unguarded railroad crossing. Continue ahead (north).
0.3	28.4	STOP. Turn right (easterly) on paved road (1250N).
1.8	30.2	Fairmount Road. Continue ahead straight.
0.55	30.75	The view to right and left shows typical morainal topography of the Urbana Moraine. Continue ahead to Catlin.


R12W
R11W
T 19 N
T 18 N
MAP 4
0
1
2 mi
0
1
2
3 km
LUNCH
4
1
Catlin
Westville
Belgium
Grape Creek
Meeks
C A T L I N
G E O R G E T O W N
M C
WABASH R.R.
TOLEDO AND KANSAS CITY
NEW YORK CENTRAL
ILLINOIS AND EASTERN
WABASH (UNSURVEYED)
650
550
600

Distance between points	Cumulative mileage	
5.55	36.3	Enter Catlin. Proceed east through 4-way stop.
0.85	37.15	STOP. 2-way stop. Turn right (south) on Indianola Road.
0.05	37.2	CAUTION. Guarded railroad crossing—Norfolk and Western.
0.3	37.5	Ascend kame on south side of Catlin.
0.4	37.9	Abandoned shaft mine to the right (west of the road).
0.8	38.7	Crossroad, turn left (east) on Westville Road.
2.65	41.35	CAUTION. Enter Westville.
0.35	41.7	CAUTION. Railroad crossing (guarded). Continue ahead.
0.25	41.95	CAUTION. Stoplight, Illinois Route 1. Continue ahead (east).
0.75	42.7	CAUTION. Single concrete slab on the road. Follow single slab road.
1.75	44.45	Abandoned strip mine to the right behind the new home. Follow the concrete slab to crossroad 950N.
2.4	46.85	Crossroad 950N. Turn left toward Forest Glen County Preserve.
1.0	47.85	T-road. Turn left (north).
0.1	47.95	T-road. Bear right.
0.05	48.0	Bear left to ranger station.
0.35	48.35	Turn right (north) on one-way drive.
0.1	48.45	Bear left.
0.3	48.75	Turn right (north) towards Interpretative Center.
0.3	49.05	Entrance to Willow Creek Trail to the right. Continue ahead toward the left up the hill.
0.1	49.15	**STOP 4. Willow Creek Trail and lunch.**
0.0	49.15	Leave Stop 4. Retrace itinerary to Ranger Station area.
0.35	49.5	Turn left at T-road intersection (east).


R12W
R11W
MAP 5
0
1
2 mi
0
1
2
3 km
5
6
Hungry Hollow
Hillery
Batestown
Tilton
DANVILLE
LAKE VERMILION
NEW YORK CENTRAL
WABASH R.R.
EASTERN ILLINOIS
STATE OF
T 20 n
T 19 N
1
10
150
650
700
600
550

Distance between points	Cumulative mileage	
0.35	49.85	Loop in front of ranger station. Bear left, then turn right to go past the south side of the ranger station towards the back entrance to the park.
0.35	50.2	T-road. Bear right.
0.05	50.25	T-road from left. Bear left. This is south of the Nature Center.
0.1	50.35	STOP. T-road intersection. Turn right (west) on gravel.
1.0	51.35	Crossroad. Two-way stop. Turn right (north) on 1850E. Follow the single slab concrete road into Westville.
4.55	55.90	Enter Westville.
0.35	56.25	CAUTION. Stoplight. Illinois Route 1 and U.S. 150. Turn right (north) on South State Street.
0.3	56.55	Westville Miners Memorial to the right in the northwest corner of the city park. Continue ahead (north) on Illinois 1 and U.S. 150.
4.0	60.55	Cross Interstate 74. Continue ahead (north).
1.1	61.65	Cross Vermilion River and prepare to turn left on U.S. 150.
0.25	61.90	CAUTION. Stoplight. Turn left (west) on Main Street (U.S. 150).
0.15	62.05	Cross North Fork Vermilion River.
0.95	63.00	Turn right at Frontage Road entrance and then stop. Continue straight ahead across Warrington Street on Avenue D and cross railroad tracks.
0.05	63.05	CAUTION. Railroad crossing.
0.05	63.1	Turn left.
0.85	63.95	Turn right (north) on Western Avenue.
0.5	64.45	The area has been strip mined on both sides of the road.
0.4	64.85	Cross Hungry Hollow Culvert.
0.1	64.95	STOP. Use extreme caution. Turn left (west) on Hungry Hollow Road.


R14W
R13W
R12W
T
21
N
T
20
N
7
Hope
Emberry Ch
Pilot Grove
Rice Cem
Stump Cem
Newtown
Sch
Corner Chapel
Trimmell Cem
Hebron Ch
Newtown
Central
Ch
Brothers
Pleasant Grove Sch
Glenburn
Belgium Bow
Stearns Cem
Oakwood
Muncie
O A K W O O
Stony Creek
Feather Creek
CHICAGO
MAP 6
0
1
2 mi
0
1
2
3 km

Distance between points	Cumulative mileage	
0.4	65.35	Turn right at entrance to new home. Bear hard right along the old gravel road and park just east of the turn off from the road so you are out in front of the house on the grass area across the gravel road from the house.
		STOP 5.
0.0	65.35	Leave Stop 5. Re-enter Hungry Hollow Road and turn right (westward).
0.9	66.25	STOP. Turn right (north) on Vermilion County 1. The road to the north beyond the turn is rising up on the Newtown Moraine and is composed of clayey till.
0.5	66.75	Turn left (west) on Vermilion County 32.
2.05	68.80	Turn right (north) on the Emerald Pond Road.
0.15	68.95	**STOP 6A. We will stop to see the soil profile and upper till, then walk north to see the lower tills (6B) and shale (6c).**
0.2	69.15	**STOP 6B. Exposure of three tills, to the right across the small bridge.**
0.15	69.3	**STOP 6C. Farmington Shale, overlain by Pleistocene. The bus will reload between 6B and 6C.**
0.0	69.3	Leave stop 6C.
0.05	69.35	First boat ramp to the right and turn around loop and retrace itinerary.
0.65	70.1	STOP. Turn right toward Kickapoo State Park main entrance.
0.25	70.35	STOP. Entrance to Kickapoo State Park. Continue ahead and follow road through park. Keep to right.
0.8	71.15	Cross Middle Fork Vermilion River.
0.45	71.6	Pennsylvanian sandstone exposed on the east and west side of the crossroad.
0.85	72.45	STOP. Turn right (north) and ascend hill.
0.5	72.95	STOP. T-road intersection. Turn right (north) on 900E.
0.5	73.45	We are now driving up the first ridge of the Illiana Morainic System, the Newtown Moraine.

Distance between points	Cumulative mileage	
0.75	74.2	Turn left (west) on blacktop, 2050N.
0.35	74.55	The front of the Newtown Moraine is trending slightly to the northwest.
0.9	75.45	View to the right up the front of the Newtown Moraine.
0.3	75.75	Notice the glacial erratics in the front yard of the house on the left.
1.1	76.85	Outwash plain in front of the Newtown Moraine.
0.1	76.95	CAUTION. Railroad crossing. Continue ahead (west). There are occasional high points of till rising throughout the outwash plain. The outwash plain is better developed on the west side of the railroad crossing.
1.1	78.05	Still crossing the outwash plain, which is sloping gently to the left (southwest) and which parallels the moraine front, about a mile to the right. Although this is a large area of outwash, it has few sand and gravel deposits of economic importance.
0.85	78.90	STOP. T-road intersection. Turn right (north) on single slab pavement (500E).
1.75	80.65	Crossroad. Turn left (west).
3.3	83.95	Turn right (north), just before the bridge along the west side of the gravel pit.
0.05	84.00	**STOP 7. Park in narrow lane near the northwest corner.**
0.0	84.0	Leave Stop 7. Continue around the gravel pit on the north and east sides to the south side of the pit.
0.15	84.15	STOP at blacktop. Turn right and cross bridge.
0.05	84.20	Turn left (south) on Illinois 49.
4.6	88.80	Turn right at entrance to Interstate 74.
0.35	89.15	Merge left onto I-74.
2.7	91.85	Enter Champaign County.
2.55	94.40	Railroad overpass.
7.85	102.25	Prepare to turn right.
0.3	102.55	Bear right. University Avenue turn-off.

Distance between points	Cumulative mileage	
0.3	102.85	CAUTION. Stoplight—Cunningham Avenue. Continue ahead (straight west) through 2 more stoplights to Lincoln Avenue.
0.75	103.60	CAUTION, railroad crossing and stoplight—Lincoln Avenue. Turn left (south) through 1 stoplight to Green Street.
0.35	103.95	CAUTION. Stoplight—Green Street. Turn right (west).
0.2	104.15	CAUTION. Stoplight—Goodwin Avenue. Continue ahead (west).
0.25	104.40	Turn left at entrance (west to Illini Union Circle Drive. End of field trip.

FIELD TRIP LEADERS

W. Arthur White, consulting geologist and geologist emeritus, Illinois State Geological Survey
Leon R. Follmer, geologist, Illinois State Geological Survey
David L. Reinertsen, geologist and head, Educational Extension, Illinois State Geological Survey
Randall E. Hughes, geologist, Illinois State Geological Survey
David A. Burke, research assistant, Illinois State Geological Survey

FIELD TRIP COMMITTEE

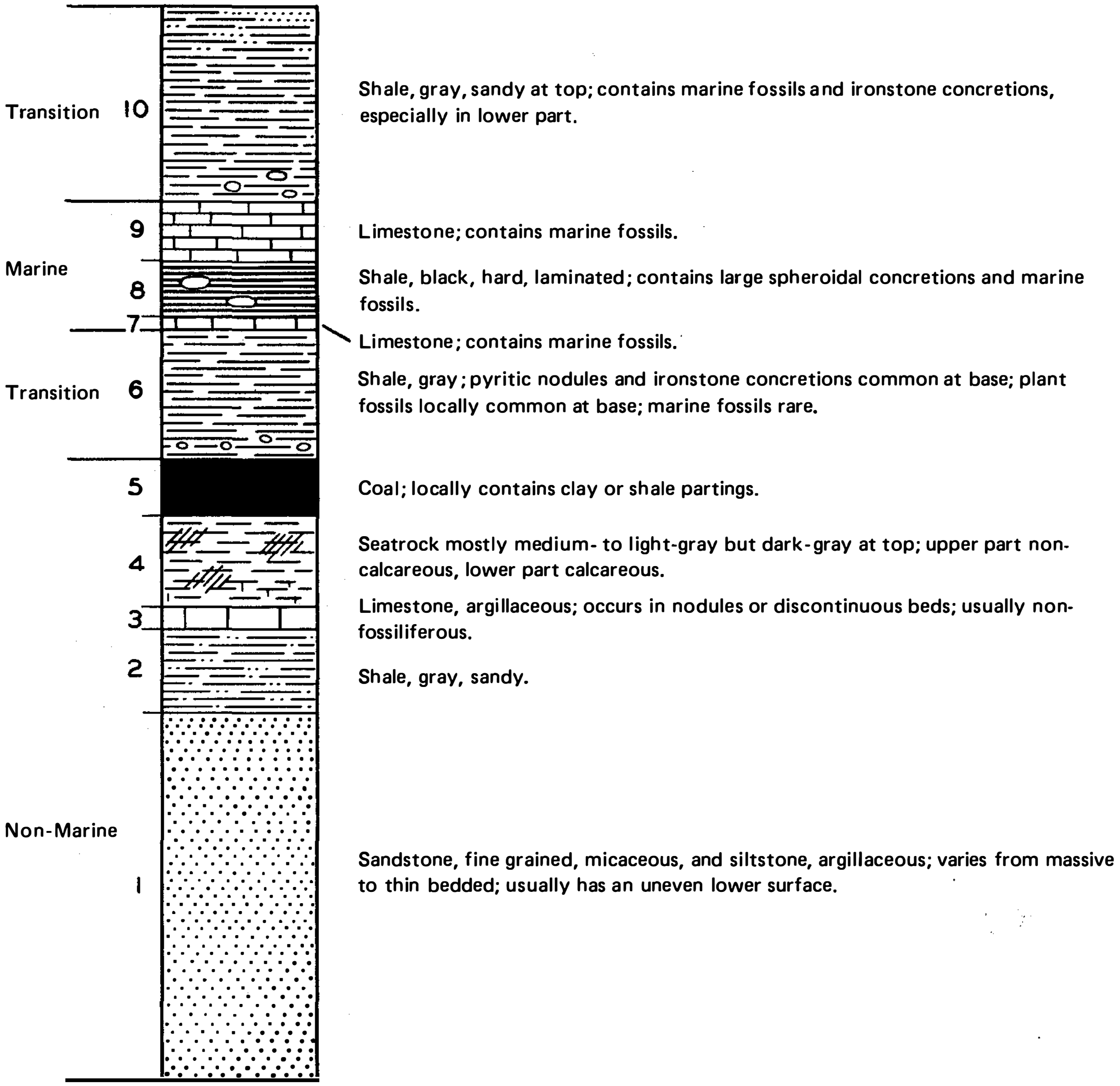
W. Arthur White, chairman
Joseph W. Stucki, professor of soils, University of Illinois

INTRODUCTION

Continental glaciers played an important role in the geologic history of the earth. The effects of glaciation in regions of high latitude and altitude dominated the geomorphic and sedimentologic processes around the world during the Pleistocene and earlier intervals. Cyclic sedimentation of marine and fresh-water deposits during the Pennsylvanian appears to be related to the eustatic rise and fall of the ocean level, which was caused by the retreat and advance of continental glaciers in the southern hemisphere and local tectonic downwarping of parts of the Basin. Wanless and Weller (1932) called one cycle of sediments a cyclothem. In an ideal cyclothem (fig. 1), members 1 through 5 are non-marine; members 6 and 10 are transitional members, and members 7, 8, and 9 are marine. On this trip a fairly complete cyclothem will be seen at Stop 1 and incomplete cyclothems at Stop 4.

One of the goals of this field trip is to illustrate how the study of clay minerals is used in the interpretation of soils, paleosols, glacial deposits, and Pennsylvanian sediments.

Soils, seatrocks, and coal seams share a significance in the study of Pleistocene and Pennsylvanian deposits. They are often used as "key beds" in the description and definition of stratigraphic units. In addition to the normal physical distinctiveness of soils, coal beds, and seatrocks, the clay mineral assemblage within each enables further distinctions from deposits that are unaffected by pedogenesis (weathering) or coal swamp conditions. The various clay mineral types have different sensitivities to different deposition environments and pedogenic conditions. The study of the clays present in sediments can make significant contributions to the interpretations of the provenance of the glacial and sedimentary deposits; such interpretations



Shale, gray, sandy at top; contains marine fossils and ironstone concretions, especially in lower part.

Limestone; contains marine fossils.

Shale, black, hard, laminated; contains large spheroidal concretions and marine fossils.

Limestone; contains marine fossils.

Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.

Coal; locally contains clay or shale partings.

Seatrock mostly medium- to light-gray but dark-gray at top; upper part non-calcareous, lower part calcareous.

Limestone, argillaceous; occurs in nodules or discontinuous beds; usually non-fossiliferous.

Shale, gray, sandy.

Sandstone, fine grained, micaceous, and siltstone, argillaceous; varies from massive to thin bedded; usually has an uneven lower surface.

Figure 1. An ideal complete cyclothem (after Willman and Payne, 1942).

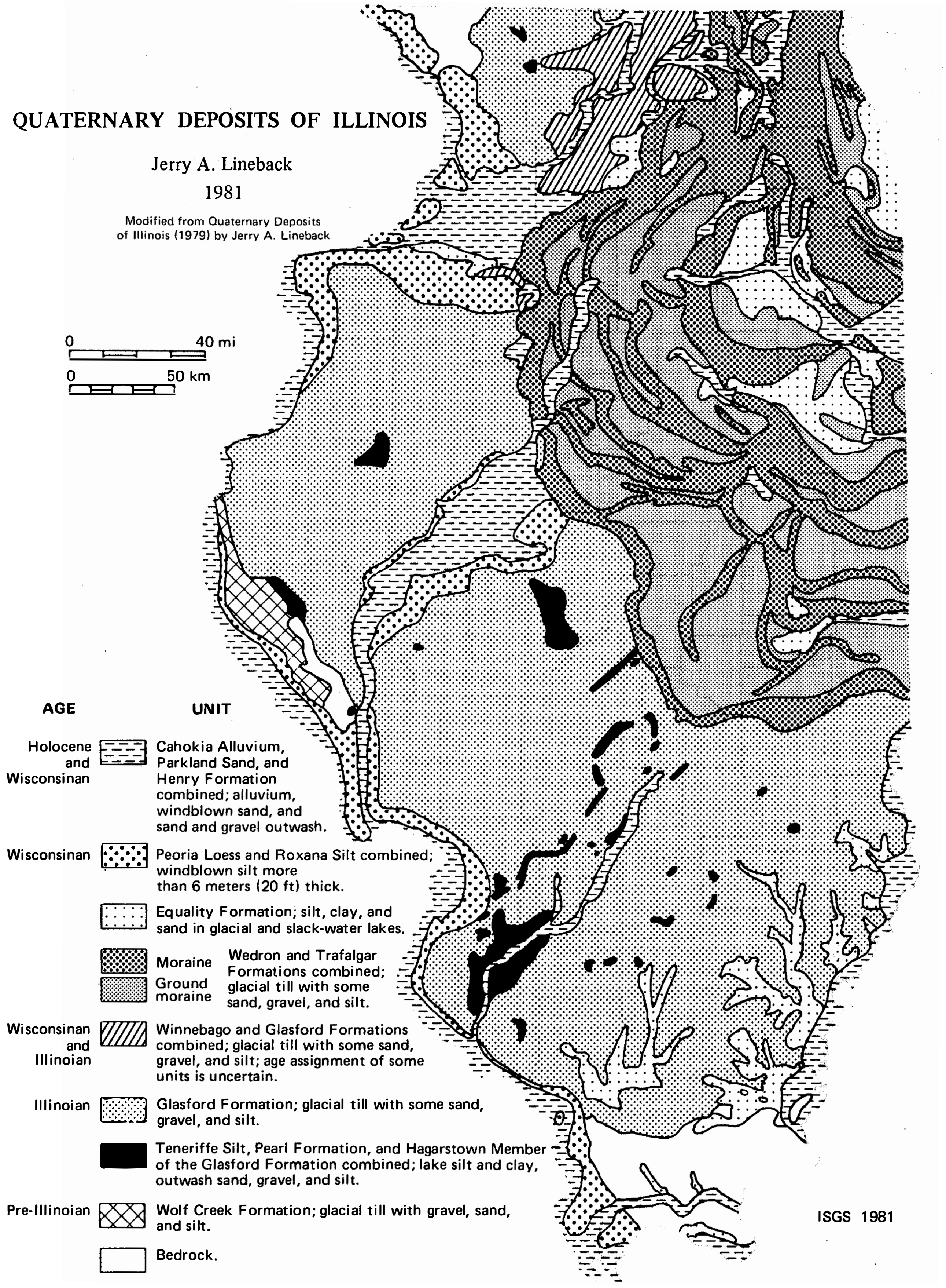


Figure 2. Quaternary deposits of Illinois (Lineback, 1981).

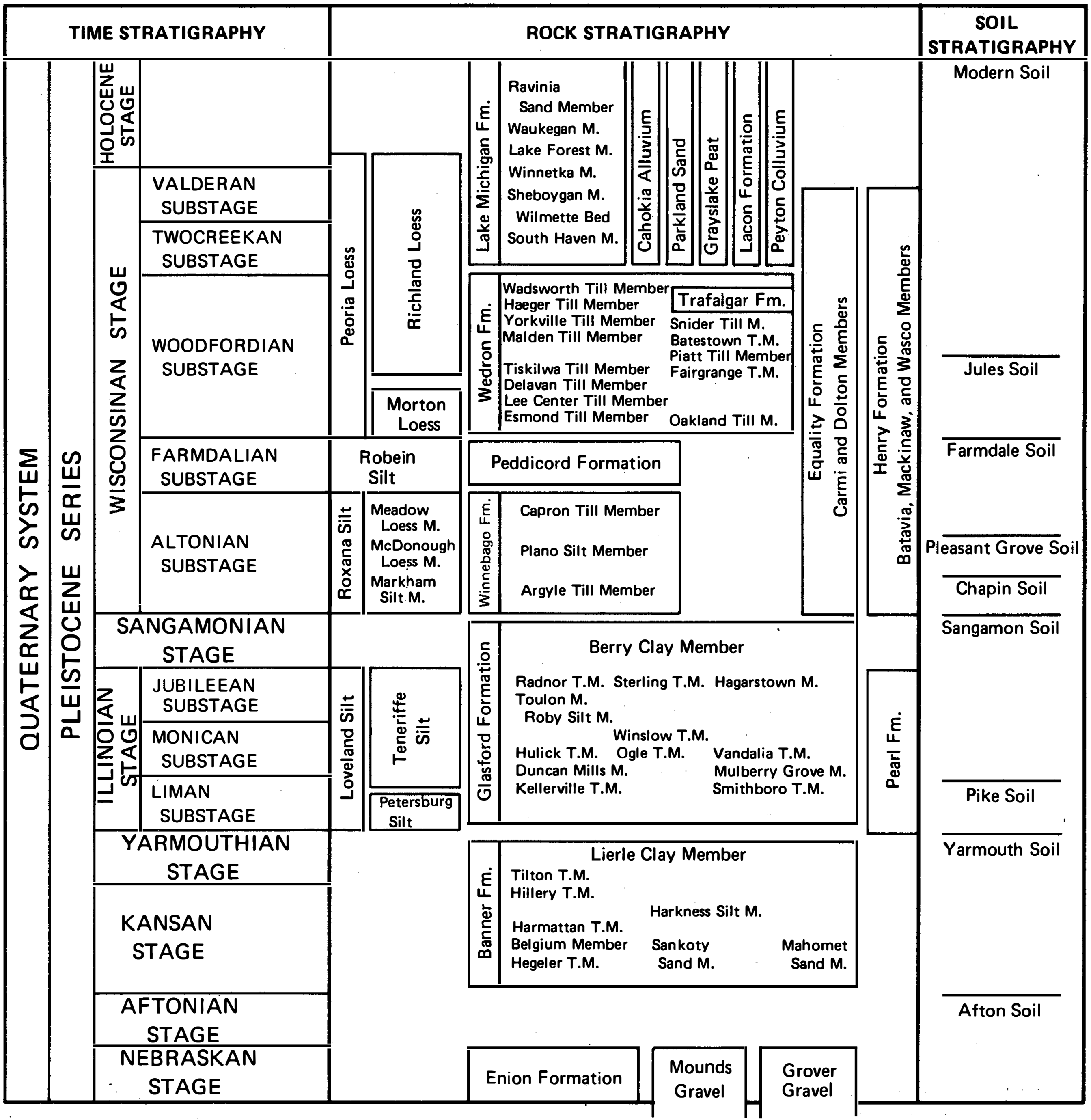


Figure 2a. Stratigraphic classification of the Pleistocene deposits of Illinois (modified from Willman and Frye, 1970).

are important in the correlation and mapping of stratigraphic units.

Glacial and related Pleistocene (Quaternary) sediments in Illinois have been studied in increasing detail over the last 100 years (Willman and Frye, 1970). Considerable progress on the characterization, classification, distribution, and stratigraphy of the glacial deposits in Illinois has been made in recent years (Johnson, 1976). Much of the Pleistocene sediments in the field trip area was eroded and transported by ice from Michigan, Huron, and Erie lake basins. As the glaciers were receding, they left a series of moraines, lakes, and outwash plains (fig. 2), most of which are covered by loess. For more complete discussions of soils, see Follmer et al. (1979); for more information on Pleistocene deposits and events (fig. 2a) see Willman and Frye (1970) and Johnson (1976).

Stratigraphic Section, Stop 1

Cyclothem	Unit	Description	Thickness (ft)
		Pleistocene Till	
		Pennsylvanian System	
		Bond Formation	
Witt Cyclothem		Sandstone, light brown; fine grained; massive; micaceous; cross bedded; weathers dark brown	4 ±
Fithian Cyclothem	10	Shale, dark gray, jointed; slightly calcareous; abundant ironstone concretions, 2 to 20 cm in diameter; discontinuous (0-2 in.) layer of clay at base; becomes sandy near top; weathers yellow-gray.	4.33
	9	Limestone, Reel Limestone Member, light gray, dense, thick bedded at top, thin bedded at base; many burrows parallel to bedding, fossiliferous; insoluble residue 29-32 percent.	0.75 - 1.12
	9	Limestone, light gray; shaly bedded; marl-like; 65-70 percent insoluble residue; argillaceous; fossiliferous.	0.25 - 0.71
	8	Shale, dark gray to black; slightly fossiliferous; calcareous; carboniferous; grades into.	0.17 - 0.25
	8	Shale, black; hard; fissile; fossiliferous; maximum thickness where underlain by coal; minimum thickness where underlain by limestone.	0.29 - 0.58
	7	Limestone, dark blue-gray to black; "clod," abundantly fossiliferous; carboniferous; thick bedded; insoluble residue 37-42 percent; irregular and local in occurrences within a single outcrop.	0.84
	5	Coal, blocky; weathered Flannigan Coal Member	0.58
	4	Seatrock, dark gray; noncalcareous; irregularly iron stained at basal contact.	0.25 - 0.84
	4	Seatrock, dark gray; slightly calcareous; jointed; synaeresis; unfossiliferous; silty; grading into sandstone below.	3.17
	1	Sandstone, light to dark gray; fine grained; thin bedded, argillaceous, micaceous; noncalcareous except for calcareous concretions near the upper contact; base below river level.	4 +

1 **Stop 1 is located about 3½ miles south of Fithian in W½SW¼NW¼ Section 31, T. 19 N., R. 13 W. of Vermilion County, Illinois. The exposure is on the right cutbank of the Salt Fork River (when we face downstream). (Map 3)**

This exposure is the type locality of the Fithian Cyclothem (Wilson, 1944) and also one of the localities for the clay mineral, illite (Grim et al., 1937). The Fithian Cyclothem has been tentatively correlated with the Flat Creek Cyclothem (Peppers, 1964).

Table 1 identifies the clay minerals of each of the lithologic units. In this cyclothem the transitional shale above the coal (unit No. 6 in the ideal cyclothem in fig. 1) is missing. The freshwater limestone (unit No. 3 in fig. 1) is present as nodules in the top of the siltstone, which is unit No. 2 in the ideal cyclothem. Limestone No. 7 is very lenticular. The seatrock (No. 4 in fig. 1) is more or less typical of seatrock below coals near the center of the basin.

2 **Stop 2 is located about 200 m upstream from Stop 1 along the south bank of the Salt Fork River in the NW¼NW¼SW¼ Section 31, T. 19 N., R. 13 W., Vermilion County. (Map 3)**

A typical Hapludalf soil (Gray-Brown Podzolic) of the forested area along the river is exposed at the top of the bank. The soil is developed in about 1 m of Richland Loess overlying Batestown Till Member. The till is one of

TABLE 1. Clay minerals in Fithian Cyclothem, parts in 10—smear technique.[†]

Location	Lithology	I	K	C	Exp	Other minerals present
10b*	Top 1± in.	5-6	1	1-2	2	qtz, P-Feld, clc
10a	Gray shale	7-8	0-1	1-2	0-1	qtz, P-Feld, pyr
9	Limestone acid residue	6	0-1	1-2	1-2	qtz, P-Feld, pyr
8b	Nonfissile black shale	5-6	1	1-2	2	qtz, P-Feld, pyr, clc
8a	Fissile black shale	5-6	0-1	1	3	qtz, P-Feld, pyr
7	Limestone acid residue	6	0-1	1-2	1-2	qtz, P-Feld, pyr
4f	Seatrock 0-2 in.	5-6	t	0-1	3-4	qtz, P-Feld, pyr
4e	Seatrock 4-7 in.	5-6	0-1	0-1	4	qtz, P-Feld, pyr
4d	Seatrock 8-10 in.	4-5	0-1	0-1	5	qtz, P-Feld, pyr, clc
4c	Seatrock 13-15 in.	6-7	0-1	0-1	3	qtz, P-Feld, pyr, clc
4b	Seatrock 16-18 in.	5-6	0-1	0-1	3-4	qtz, P-Feld, pyr, clc
4a	Seatrock 21-30 in.	6-7	0-1	0-1	3	qtz, P-Feld, pyr, clc
1, 2	Sand and siltstone 36-60 in.	6-7	0-1	2	0-1	qtz, P-Feld, sid, pyr, dol

I - illite; C - chlorite; K - kaolinite; Exp - expandable clay minerals; qtz - quartz; P-Feld - plagioclase feldspar; clc - calcite; sid - siderite; pyr - pyrite; dol - dolomite.

*(10b) number of the member in the cyclothem.

[†] Results of the clay mineral analyses, given in tables 1 and 4, are calculated using an estimation of the area of x-ray peaks by width at half height x height from glycol and heated traces of smear slides of the whole sample (except acid residues where the whole residue is used). The increase in area of the illite peak (10A) on heating is calculated as expandable clay minerals. The illite to kaolinite + chlorite (7A) factors are 2.5:1 and the proportioning of kaolinite + chlorite is done by scanning the 25° 2θ region of the diffraction at ½° 2θ per minute assuming a 1:1 ration of kaolinite to chlorite at this position.

several Wisconsinan-age tills that are derived largely from Paleozoic sediments eroded from the Lake Michigan Basin. The loess is principally derived from late Wisconsinan-age melt-water deposits blown from the Illinois River Valley. The clay mineral composition in the loess is greatly affected by smectite believed to be derived from the Cretaceous in the northern Great Plains.

The particle-size and x-ray data show the effects of alteration of the two contrasting deposits (table 2). The stratigraphic boundary between the loess and till is clearly shown by the significant change in the content of sand, expandables, and illite. The developments of the soil has caused pronounced changes in the loess. Eluviation, a dominant process operating in this soil, has caused the

TABLE 2. Particle size and x-ray data of Hapludalf Profile—Stop 2.[†]

Material	Soil horizon	Depth (cm)	Sample no.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Exp (%)	I (%)	K + C (%)
Richland Loess	A1	0-5	2-1	—	—	—	—	29	42	27
	A2	5-15	2-2	t	5	89	6	36	36	28
	A2	15-25	2-3	t	5	74	21	33	37	30
	B1t	25-35	2-4	t	3	72	25	59	25	16
	B1t	35-45	2-5	t	3	72	25	55	29	16
	B2t	45-55	2-6	t	2	77	21	52	29	19
	B2t	55-65	2-7	0	3	71	26	54	29	17
	B2t	65-75	2-8	0	2	69	29	60	25	15
	B2t	75-85	2-9	0	3	65	32	59	28	13
	B2t	85-95	2-10	0	3	65	32	58	27	15
	B3t	95-105	2-11	t	4	66	30	57	32	11
Batestown Till	IIB3	105-117	2-12	t	27	51	22	28	64	8
	IIC2	117-125	2-13	4	31	52	17	10	80	10
	IIC2	150-160	2-14	—	29	57	14	6	81	13
	IIC2	190-200	2-15	10	34	56	10	5	81	14

Exp - expandable clay minerals; I - illite; K + C - kaolinite and chlorite.

[†]Results of the clay mineral analyses in tables 2, 3, 6, and 7 are calculated using x-ray peak heights from a <2μm sedimented slide. The data are normalized from the glycol trace using the form factors 1.4x for expandable clay minerals (17Å), 4x for illite (10Å), and 1.8x for kaolinite + chlorite (7Å). These factors apply for linear traces (using a log scale they are 1 expandables, 3 illite, 2 kaolinite + chlorite).

reduction of clay and expandable values and the increase of illite and chlorite values in the A horizon; eluviated materials, clay, and expandables have accumulated in the B horizon. The values for expandables have not really changed much because the original loess probably contained about the same amounts.

3 **Stop 3 is located about two miles southwest of Fairmount, Illinois, near the NE/cNW¼NW¼ Section 17, T. 18 N., R. 13 W. A profile was studied near the middle of a long highwall of an inactive pit of a limestone quarry operated by Material Service. The site is immediately south of an abandoned gravel road. (Map 3)**

Typical grassland soils (Haplaquolls and Argiudolls) of east-central Illinois are exposed at the top of the highwall. The site is located in a frontal position on the Urbana Moraine within a subtle kettle. A complete section of Batestown Till is present here and is overlain by ice-contact deposits (outwash), lacustrine silts, and Richland Loess, and accreted deposits that cannot be differentiated from loess at this site.

A complete weathering sequence can be seen in the highwall. Unaltered till occuring below about 5 m, has a lithology (table 3) that can be traced over an area of about 1200 sq mi of east-central Illinois. The unaltered horizon, C4, contains oxidizable materials such as pyrites, shredded organic matter and spore-like bodies of the genus *Tasmanites.* The first evidence of alteration appears as a color change from gray to olive, or as iron stains along joints, and by the loss of pyrite and chlorite. As a result of this slight oxidation, the illite value increases. The zone of transition toward greater alteration is called the C3 horizon. The C2 is a zone in which the easily altered components have more or less reached an equilibrium with the ambient oxidizing or reducing conditions. The C2 is a major horizon in all weathering profiles and is often 2 to 3 m thick. At this site, the C2 shows the upward blending of the illitic glacial deposits with the smectitic loess.

The modern soil at this site is a Haplaquoll that formed in a reducing environment (i.e., gleyed because of the presence of organic matter in a wet environment). This condition produces the high expandable values that decrease downward. Clay accumulated in the surface horizon faster than eluviation could occur. At 150 cm we sampled a krotovina (K), the infilling of a crayfish burrow; the analysis showed that it contained the clay mineral composition of the overlying loess from which it was derived.

TABLE 3. Particle size and x-ray data of Fairmount Quarry Profile—Stop 3.†

Material	Soil horizon	Depth (cm)	Sample no.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	VI	Exp (%)	I (%)	K + C (%)	DI	Cal (cps)	Dol (cps)
Richland Loess	AP	10	3-1	t	2	67	31	—	65	27	8	2.2	0	0
	A3	25	3-2	0	1	63	36	40>	90	6	4	1.0	0	0
	Bg	50	3-3	0	1	65	34	38>	81	14	5	1.8	0	0
	Bg	75	3-4	t	t	69	31	29>	87	9	4	1.5	0	0
	B/C	100	3-5	t	t	73	27	33>	80	15	5	2.0	?	?
Loess and Lacustrine	IIC2	125	3-6	0	1	82	17	23>	62	33	5	3.9	?	20
	K	150	3-7	—	—	—	—	34>	84	12	4	2.1	?	?
	IIC2	150	3-8	0	1	78	21	18>	58	36	6	3.8	?	21
	IIC2	200	3-9	0	1	75	24	11>	35	56	9	3.8	20	35
	IIC2	235	3-10	0	1	75	24	5>	15	74	11	4.4	?	?
Ice Contact	IIIC2g	250	3-11	0	7	73	20	0	16	76	8	6.2	?	?
	IIIC2	265	3-12	8	34	54	12	22<	13	84	13	4.3	18	25
	IIIC2	300	3-13	6	44	45	11	23<	13	82	15	3.6	19	35
	IIIC2	325	3-14	—	—	—	—	32<	2	75	23	2.2	?	46
Batestown Till	IVC2	350	3-15	6	28	56	16	27<	1	74	23	2.1	?	29
	IVC2	400	3-16	3	28	57	15	26<	1	82	17	3.3	?	?
	IVC3	450	3-17	4	27	56	17	27<	1	82	16	3.6	?	32
	IVC3	500	3-18	7	26	59	15	41<	1	82	16	3.4	20	50
	IVC4	550	3-19	4	28	56	16	29<	1	78	20	2.5	15	36
	IVC4	600	3-20	3	27	58	15	34<	1	73	25	1.9	20	65

VI - Vermiculite index, peak height of 14Å greater or less than 10Å in mm; Exp - expandable clay minerals; I - illite; K + C - kaolinite and chlorite; DI - peak height ratio, 10Å/7Å; Cal - calcite; Dol - dolomite.

† See footnote, table 2.

Stratigraphic Section, Stop 4

Cyclothem	Unit	Description	Thickness (ft)
		Pleistocene Series	
		Rotational landslides - a method of valley widening	30 ±
		Pennsylvanian System	
		Carbondale Formation	
	20	Shale, Energy Shale Member, rusty gray, silty noncalcareous	4 ±
	19	Coal, Herrin No. 6 Coal Member, weathered	5.5
Brereton Cyclothem	18	Seatrock, dark gray, mudstone, noncalcareous	0.25
	17	Seatrock, medium gray, mudstone	0.5
	16	Seatrock, gray, mudstone	0.92
	15	Seatrock, gray, mudstone	1.0
	14	Limestone, gray, rust stained on joints (algal, fresh-water origin), argillaceous, lenticular, represented by concretions laterally; where concretions have weathered, it is represented by a rusty mesh of crystals mixed with gray mudstone; limestone lenses contain synaeresis structures.	0.42 - 3.0
	13	Mudstone, reddish brown, plastic	0.21
St. David Cyclothem	12	Mudstone, brownish gray, plastic	2.0
	11	Coal Springfield No. 5 Coal Member, lenticular grades laterally into a black organic-rich claystone	0.08 - 0.83
	10	Seatrock, dark gray, slickensided mudstone; iron-stained along slickensides; grading into	1.0
	9	Seatrock, gray, reddish-brown mottling scattered throughout the bed; becomes harder and black downward	1.0
	8	Limestone, gray with brown patches (algal, freshwater origin); lenticular; represented laterally by concretions embedded in a grey mudstone, polygonal-synaeresis structures.	0 - 2.0
Unnamed Cyclothem	7	Mudstone, dark gray at top, becoming lighter gray downward (coal and seatrock members?)	1.0
	6	Mudstone, gray, iron-stained along slickensides and fissures (seatrock member?)	0.5 - 1.0
	5	Limestone, gray with red and maroon iron-staining along sides of polygons-synaeresis structure, lenticular grading laterally into mudstones containing concretions—sand size and larger (algal, fresh-water origin)	0 - 5.0
	4	Mudstone, gray with red iron staining along slickenside and synaeresis cracks	0.75 - 1.0
Summum Cyclothem	3	Shale, red, platy, mudstone grading down into	0.08 - 0.67
	2	Shale, greenish-gray and maroon mottling, vertical fissures surround polygons with 3 to 6 sides which vary from 1 to 3 feet in lateral cross section. The outer inch of shale in the polygons is green and the interiors of the polygons are mottled red-army green. The fissure fillings are rusty brown on outside and green and brown inside. The fillings are composed of siderite or dolomite. The siderite fillings contain 2 generations of synaeresis cracks. The first generation is filled with ferroan dolomite which in turn cracked and those cracks are filled with calcite. The dolomite crack filling contains one generation of cracks which are filled with calcite	10 ±
	1	Shale, gray, well laminated with layers of ironstone concretions. The jointing is synaeresis in origin.	10 ±
		Creek level.	

4

Stop 4 is in the Forest Glen Preserve, a public park. Disturbing plants, animals, and natural areas is prohibited here, and permission should be obtained before collecting. The study area is along the west line of the NE¼SE¼SW¼ and in SE¼SW¼NE¼SW¼ Section 14, T. 18 N., R. 11 W., Vermilion County. This stop includes lunch. (Map 4)

In the bluff of Willow Creek across from the lodge and Interpretative Center, rotational landslides occurred in the Pleistocene sediments. It is not known at present whether the glide plane is between the Pleistocene and the Energy Shale Member (Pennsylvanian) or whether it extends through the Pennsylvanian sediments.

Downstream, Pennsylvanian mudstones, shales, lime-

TABLE 4. Clay minerals in the members of Carbondale Formation that crop out in Forest Glen Preserve—parts in 10, by smear technique.[†]

Unit	Lithology	I	K	C	Exp	Other minerals present
20*	Shale	6-7	1	0-1	2	Exp = verm, qtz
18	Seatrock	4	1	0-1	4-5	qtz
17	Seatrock	4	2	0-1	3-4	qtz, marc
16	Seatrock	3-4	2-3	0-1	3-4	qtz, P-Feld - t, marc
15	Seatrock	3	2-3	0-1	4-5	
14	Limestone acid residue	5	2	0-1	3	qtz, P-Feld, marc
13	Seatrock	5	2-3	0-1	2-3	qtz, P-Feld, marc, gyps
11-12	Coal and mudstone	3-4	1-2	0-1	5	qtz, gyps
9-10	Seatrock	3	1	t	6	qtz, pyr, gyps
8	Limestone acid residue	3-4	1	0-1	5-6	sid, qtz, P-Feld
7	Coal and seatrock (?)	4	1-2	0-1	4	qtz, P-Feld
6	Seatrock (?)	5	1-2	0-1	3	qtz, P-Feld, sid, apat
5a	Limestone acid residue	5-6	1-2	0-1	2-3	qtz, P-Feld
5	Concretion	4	3	0-1	2-3	qtz, P-Feld
4	Shale	5	1-2	0	3	qtz, P-Feld, sid, apat
3	Shale	6-7	1	1	1-2	qtz, P-Feld, marc
2	Shale	6-7	1	1	1-2	qtz, P-Feld
1	Shale	7	1	1	1	qtz, P-Feld, marc

I - illite; C - chlorite; K - kaolinite; Exp - expandable clay minerals; qtz - quartz; P-Feld - plagioclase feldspar; marc - marcasite; sid - siderite; apat - apatite; pyr - pyrite; gyps - gypsum; t - trace; verm - vermiculite

*Unit in lithologic column description.

[†] See footnote, table 1.

stones, seatrocks, and coals of the Brereton, St. David, unnamed and Summum Cyclothems crop out beneath the Pleistocene drift. These exposures provide an excellent opportunity to study lithologic units through several cycles of deposition and to compare and contrast seatrock development in each. The clay mineral assemblages for each lithologic unit (table 4) and mineralogy of the limestone members (table 5) make such comparison easier. The data in these tables are keyed to the following outcrop description by reference to the bed numbers. The Pennsylvanian sediment contain synaeresis structures which have 3, 4, 5, and 6 sided polygons (see cover). They are best developed in the upper part of the shale above the Summum (No. 4) Coal of the Summum Cyclothem. The cracks around the plygons are filled with siderite and dolomite. In the limestone, the cracks around the polygons were filled with calcite.

5 **Stop 5 is located about 2 miles west of Danville along a cutbank of a branch of Hungry Hollow, a tributary of the North Fork Vermilion River, in the SE¼NE¼NE¼ Section 2, T. 19 N., R. 12 W., Vermilion County. (Map 5)**

At this stop we will look at a strongly developed paleosol, the Yarmouth Soil, within the glacial deposits. Also, for comparison, the Yarmouth here has some remarkable similarities to the seatrock (underclay) profile below the Flannigan Coal at Stop 1. This section has changed over the years because of erosion that has eliminated some stratigraphic features (fig. 3) but revealed others. The upper part of the section, as now exposed, is largely composed of sand and gravel, with less Vandalia than before (Johnson, et al., 1972). The Yarmouth Soil is present under a thin cover of talus.

TABLE 5. Peak heights on x-ray diffractograms of the carbonate minerals in limestone (cps).

Unit and lithology		Calcite	Dolomite	Siderite	Quartz
14*	Brereton Limestone	600	t	t	25
8	St. David Limestone	15	175	65	
8A	Taken 10 ft upstream from 8	t	60	260	
5	Bottom limestone	285	35	118	
5A	Concretion, taken 6 ft upstream	290	380	35	

cps - counts/sec; t - trace

*Unit in lithologic column description.

Yarmouth Soil

Horizon	Depth (in.)	P-No.		Thickness (ft)
A	0-5	11764	Silt; dark grayish brown (10YR4/2) silt loam with many red stains and few reddish black stains along joints; firm; massive to weak, coarse, angular block structure	1.3
	5-10	11765		
	10-15	11766		
IIB(?)	15-20	11767	Silt, sandy; very dark grayish brown (10YR3/2) silty clay loam to clay loam, common red and black stains along joints; firm; few large carbonate concretions; weak, coarse, angular blocky structure	2.5
	20-25	11768		
	25-30	11769		
	30-35	11770		
	35-40	11771		
	40-45	11772		
IIB21g	45-50	11773	Sand; greenish gray (5GY5/1) loam with few continuous red and black stains along joints; few indistinct krotovina filled with silty material; firm; massive	0.7
	50-54	11774		
IIB22g	54-60	11775	Gravel; greenish gray (5GY5/1) loam with few continuous red and black stains; firm; massive; slightly cemented	1.0
	60-66	11776		
IIIB3	66-72	11777	Tilton Till; yellowish brown (10YR5/4) loam with yellowish red stains; many large gray mottles in upper 6 inches; few krotovina; few dark brown (7.5YR3/2) clay coatings; friable; weak, angular, blocky structure	2.0
	72-78	11778		
	78-84	11779		
	84-91	11780		
IIIC1	91-96	11781	Tilton Till; very dark grayish brown (2.5Y3/2) ped interiors with lighter colored (2.5Y4/2) exteriors; loam; few yellowish red and black stains; few dark (10YR4/2) clay coatings; firm; massive to weak, coarse, angular blocky structure; leached	1.0
	96-101	11782		
IIIC2	101-105	11783	Tilton Till, dark grayish brown (1Y4/2) loam with many dark gray stains; yellowish brown mottles common; firm, brittle; weak, coarse, angular, blocky structure; calcareous	2.0
	105-110	11784		
	110-115	11785		
	115-125	—		
IVC2	125-143	—	Sand; yellowish brown (10YR5/6) fine gravel at top grading to fine sand at base; calcareous	1.5

Hillery Till Member

	Thickness (ft)
Till, calcareous, dark reddish brown (5YR3/3), very hard; base not exposed. P-5472 (top) to P-5473 (base)	1.5
Total section	36.0

The following information on Stop 5 is taken from Illinois State Geological Survey Guidebook 9 (Johnson et al., 1972, Stop 5). Because the section is located in a valley below the level of the upland, the Wisconsinan tills, which we will see at the next stop, are absent here. The glacial materials beneath the loess are Illinoian age outwash and till (fig. 4). The till rests on carbonaceous silt and clayey silt (the Mulberry Grove Silt Member) that have been distorted somewhat by the overriding Illinoian glacier that deposited the Vandalia Till. Wood from this zone yielded a date of >40,000 radiocarbon years B.P. (ISGS 23).

The Mulberry Grove Member overlies a thin, silty till that is correlated with the Smithboro Till Member of south-central Illinois. In addition to its silty character, the till contains abundant wood and a few molluscan fossils. The Smithboro Till rests on a thick soil, the lower part of which is developed in the Tilton Till Member. The soil is correlated with the Yarmouth Soil on the basis of its stratigraphic position and degree of development. The soil is complex, and more than one interpretation of the origin of the materials in the upper part of the soil is possible.

The upper 15 inches of the Yarmouth have weak A Horizon characterisitcs but appear also to be part of a depositional unit (see the above description of Yarmouth Soil). From 15 inches to 66 inches down, the Yarmouth

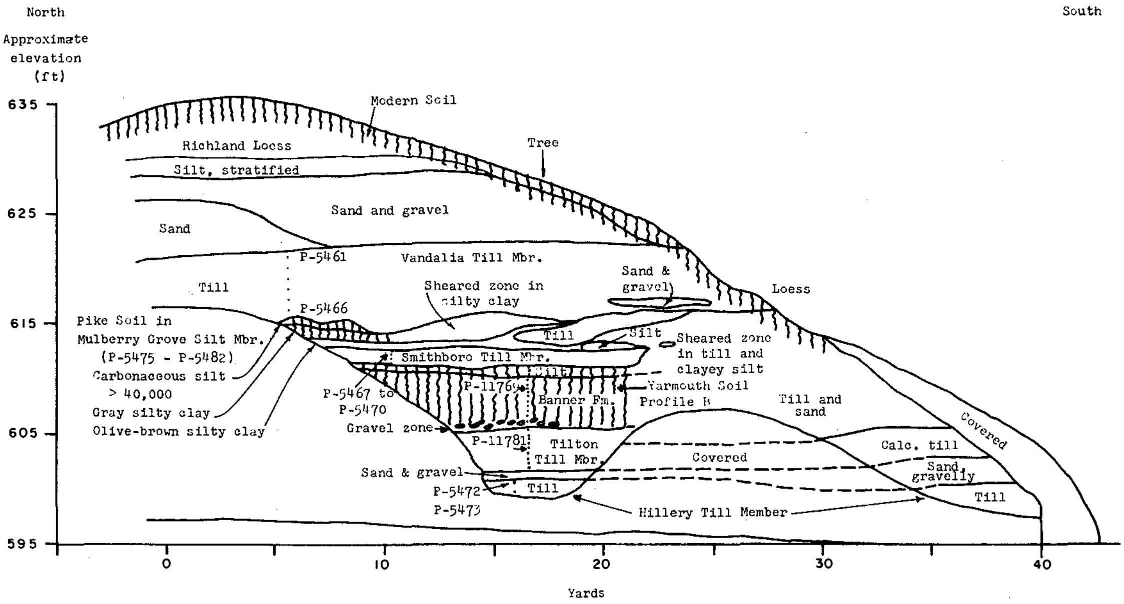


Figure 3. School House Branch Section of Hungry Hollow (Johnson et al., 1972).

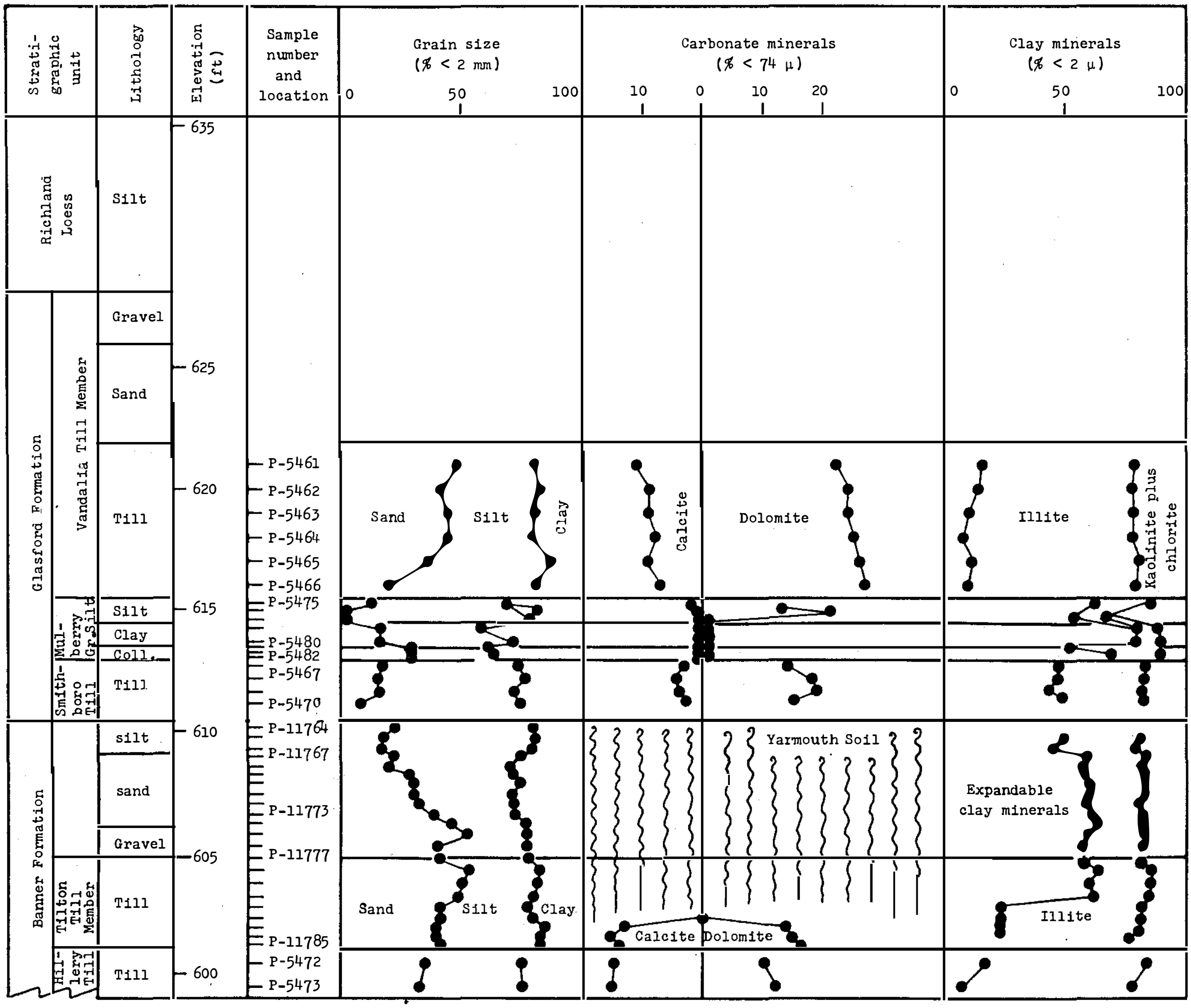


Figure 4. Grain size, carbonate mineral, and clay mineral data for the School House Section of Hungry Hollow (Johnson et al., 1972).

appears to be developed in materials of alluvial origin. The basal zone of this segment is a coarse gravel, overlain by sandy zone, over which is a sandy silt, and finally the upper 15 inches of silt. The sorting and fining-upwards characterisitic of the sediments, their dark color, and the position of the sediments in a former valley indicate an alluvial origin for the deposits. They were probably deposited during the Yarmouthian Stage and are included in the Banner Formation.

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

The profile has lost much of its original pedologic morphology and appears somewhat like unweathered material. Apparently, conditions after burial were such that retrogressive morphologic development took place (Follmer et al., 1979), and the best indications of weathering are the clay accumulation in the B horizon, the depth of leaching, and the alteration of the clay minerals to the expandable type characterisitc of the B zones of well-developed buried soils in Illinois (Willman, Glass, and Frye, 1966). Large, isolated carbonate concretions have been found in the middle of the +6 B horizon which resemble those found at the base of the seatrock (paleo-B horizon) in the Fithian Section.

6 **Stop 6 is located about 5 miles west of Danville in the eastern part of Kickapoo State Park in the SW¼SW¼ Section 33, T. 20 N., R. 12 W., Vermilion County. The section is along a gravel road that was cut down into the glacial deposits for a coal strip mine. (Map 6)**

The till stratigraphy here has been extensively studied (Johnson et al., 1972, Guidebook 9). Information on the soil profile was prepared for this trip; the following discussion on till stratigraphy is from Johnson et al. (1972).

The section is a long north-south exposure located at the frontal margin of the Illiana Morainic System. The purpose of the stop is to show the type section of the three Wisconsinan tills, relations between the Snider Till Member and the Illiana Morainic System, and the unusual situation where Wisconsinan till rests directly on Kansan till (in this case, the Tilton Till Member).

The north end of the section exposes the Batestown, Glenburn, and Tilton Till Members (figs. 5 and 6). Sand and silt inclusions, probably resulting from ice contact sedimentation, are particularly prominent in the upper part of the Batestown. The contact between the Glenburn and the Tilton is distinct but rather subtle, and the difference in the calcite content of the two tills can be noted in the field by the rate and degree of effervescence.

The south end of the section is higher topographically and exposes the Snider and Batestown Tills. The front of the Illiana Morainic System occurs north of the highway, and the southward slope of the top of this part of the exposure corresponds to the frontal slope of the Newtown Moraine. Therefore, the morainic front corresponds to the

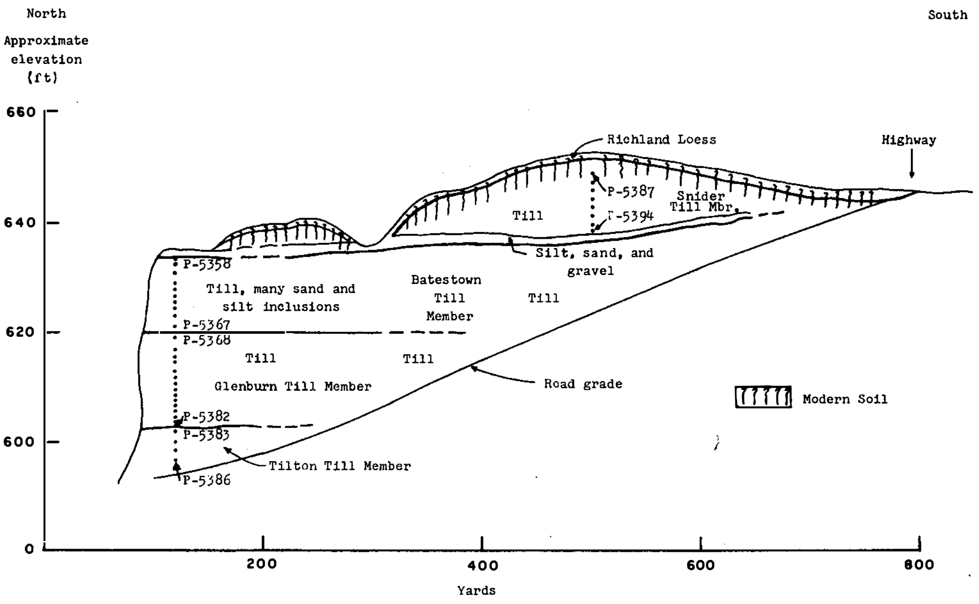


Figure 5. Emerald Pond Section (Johnson et al., 1972).

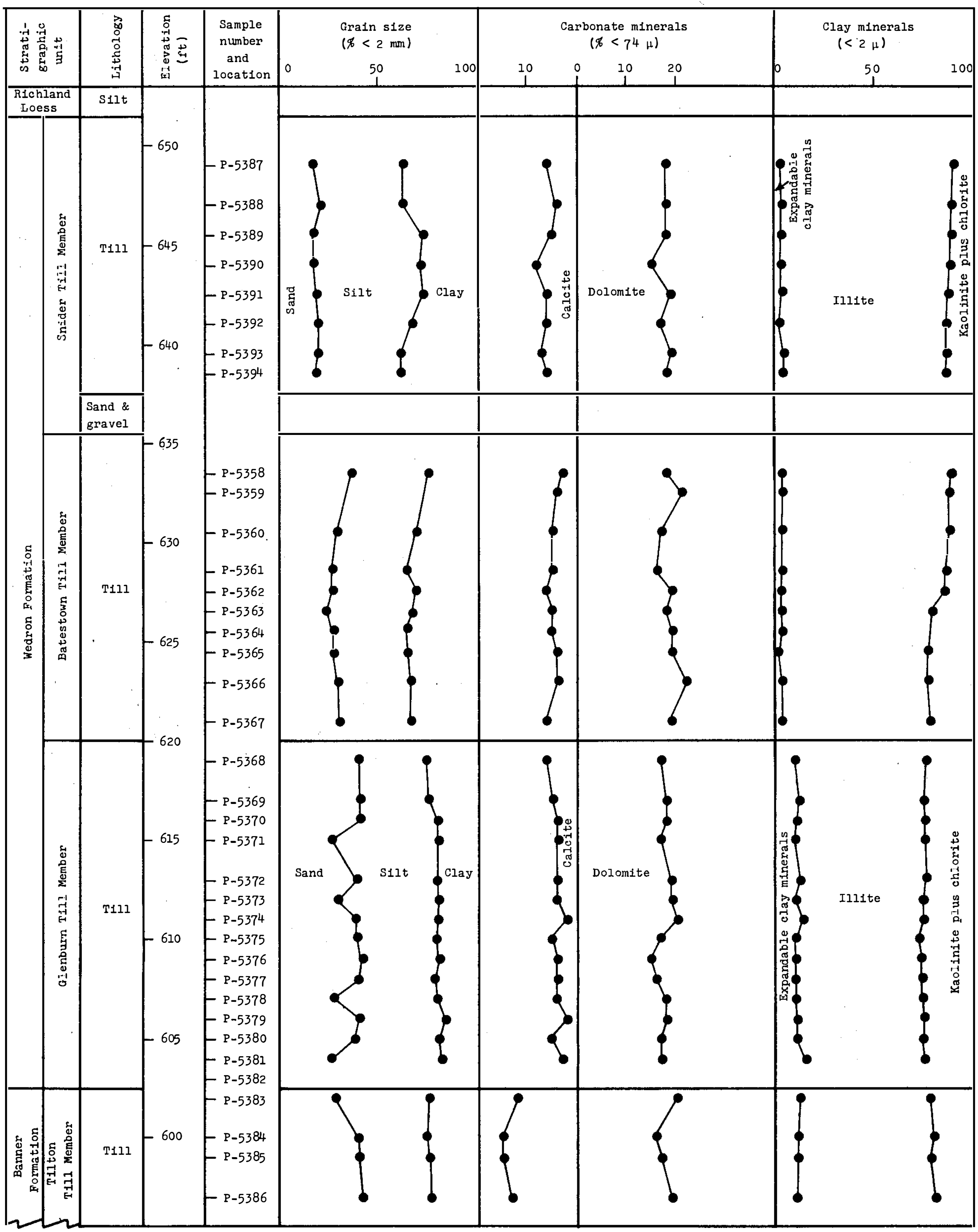


Figure 6. Grain size, carbonate mineral, and clay mineral data for the Emerald Pond Section (Johnson et al., 1972).

TABLE 6. Particle size and x-ray data of Hapludalf Profile—Stop 6.[†]

Material	Soil horizon	Depth (cm)	Sample no.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Exp (%)	I (%)	K + C (%)	DI
Richland Loess	A1	0-2	6-1	0	11	74	15	48	42	10	1.9
	A2	2-20	6-2	0	12	71	17	44	43	13	1.5
	A2	20-35	6-3	0	15	61	24	41	43	21	0.8
	B1	35-50	6-4	t	23	50	27	40	45	16	1.3
	B1	50-60	6-5	t	32	37	31	34	55	11	2.2
Silty sand	IIB2t	60-80	6-6	4	50	21	29	39	50	12	1.8
	IIB2t	80-100	6-7	2	66	12	22	46	44	10	2.0
	IIB2t	100-120	6-8	1	66	10	24	48	42	10	2.0
Snider Till	IIIB3t	120-138	6-9	2	20	45	35	24	68	8	3.9
	(Skins)	138-150	6-10	—	—	—	—	45	48	7	2.6
	IIIC2	150-175	6-11	4	16	52	32	8	80	12	3.2
	IIIC2	175-200	6-12	4	15	55	30	6	83	11	3.3
	IIIC2	200-225	6-13	6	17	55	28	6	84	10	3.7
	IIIC2	225-235	6-14	7	17	56	27	5	85	10	3.7
Silt	IVC2	235-255	6-15	1	18	67	15	3	89	8	5.0
Batestown Till	VC2	255-265	6-16	6	23	53	24	5	84	11	3.3
	VC2	265-275	6-17	4	20	56	24	6	84	10	3.7

Exp - expandable clay minerals; I - illite; K + C - kaolinite and chlorite; DI - peak height ratio, 10Å/7Å.

[†] See footnote, table 2.

margin of the Snider Till, and the end moraine is the result of deposition of the Snider.

Figure 5 shows the location of two sets of samples that are described in Guidebook 9. A new set of samples (table 6) was collected for this trip near the sample series starting with P-5387. At this location we sampled the soil profile that is developed in loess overlying sandy ice-contact deposits (?) and Snider Till. Below the soil, the silt bed shown in figure 5 and the underlying Batestown Till were also sampled.

The clay mineral trends (table 6) in this profile are similar to those at previous stops. The loess and underlying weathered material have relatively high expandable contents. We sampled a thick clay skin (sample 6-10) in the upper

TABLE 7. Particle size and x-ray data of Argiudoll Profile—Stop 7.[†]

Material	Soil horizon	Depth (cm)	Sample no.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Exp (%)	I (%)	K + C (%)
Richland Loess	A1	0-16	7-1	7	16	54	30	55	30	15
	A3	16-26	7-2	4	12	56	32	56	29	15
	B1	26-40	7-3	5	12	60	28	53	30	17
	B2t	40-50	7-4	3	9	64	27	55	23	18
	B2t	50-60	7-5	1	16	52	32	67	20	13
	B2t	60-71	7-6	4	23	47	30	72	18	10
Henry Fm (Sand and gravel)	IIB3t	71-85	7-7	22	40	30	30	67	24	9
	IIB3t	85-100	7-8	24	36	36	28	63	25	12
	IIB3t	100-120	7-9	4	21	52	27	60	29	11
	IIB3t	120-145	7-10	20	71	14	15	58	33	9
	IIB3t	145-170	7-11	24	58	26	16	44	46	10
	B/C2	170-175	7-12	18	41	47	12	10	79	11
	B/C2	175-190	7-13	31	53	38	9	13	76	11
	IIC2	—	7-14	35	65	29	6	13	75	12
	IIC2	—	7-15	28	81	14	5	3	85	12

Exp - Expandable clay minerals; I - illite; K + C - kaolinite and chlorite.

[†] See footnotes, table 2.

part of the Snider Till and found a mineralogy similar to the upper horizons. A large part of this clay probably came from the B1 horizon which has the morphological appearance of strong eluviation (highly porous and very light in color). The Snider and Batestown Tills are rich in illite. The top of the Snider is altered somewhat, but the main cause of the intermediate illite value is due to eluviation of expandable clays from above. Clay skins can be traced along ped faces (joints) from the IIB2 down into the IIIC2; where the clay skins fade out, secondary calcite can be found, generally along joints that are gray (gleyed). The silt bed has a slightly higher illite value because it contains less fine clay and less chlorite than the tills.

7 **Stop 7 is at a pit in sandy deposits of a classic loess-covered outwash plain in front of a moraine composed of clayey till. (Map 6)**

At this stop a typical grassland soil (Argiudoll) developed in loess, and outwash can be seen. The clay mineral results show the illitic character of the outwash and the relatively high values of expandable minerals in the weathered loess (table 7).

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