PARK RIDGE-NORTH SHORE AREA
Cook and Lake Counties

Geological Science Field Trip

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Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Champaign, IL 61820

A GUIDE TO THE GEOLOGY OF THE PARK RIDGE - NORTH SHORE AREA

By

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GEOLOGICAL SCIENCE FIELD TRIPS are free tours conducted by the Educational Extension Unit of the Illinois State Geological Survey to acquaint the public with the geology and mineral resources of Illinois. Each is an all-day excursion through one or several counties in Illinois; frequent stops are made for explorations, explanations, and collection of rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers in preparing earth science units. Grade school students are welcome but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students. A list of available earlier field trip guide leaflets for planning class tours and private outings may be obtained by contacting the Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820. (217) 244-2407 or 333-7372.

A GUIDE TO THE GEOLOGY OF THE PARK RIDGE - NORTH SHORE AREA

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AN OVERVIEW

General Setting and History

The Park Ridge-North Shore Area Geological Science Field Trip will acquaint you with some aspects of the general geology, topography, and mineral resources of a portion of the Chicago Metropolitan Area, home to 7- to 8-million people. The information in this guide leaflet, coupled with your own personal observations, will show you how geology relates to regional land-use planning and urban environmental improvement, to construction problems (structure foundations, highways, etc.), and to locating, developing, and conserving our mineral and water resources. The geographic location and geologic setting of the Chicago Metropolitan Area strongly influenced its growth and development from the early 1800s. Cheap water transportation, via the Great Lakes and the Illinois Waterway and the availability of mineral and water resources, led to the area's early rise to importance. A short time later, a number of railroads converged on the city to strengthen further its national and international importance and influence.

Chicago's rapidly expanding populace has not adjusted easily to its environment. Although many land-use problems have been resolved, others, such as urban sprawl and waste disposal and their interrelationships with the mineral resources of the area, have not been understood. We trust that as awareness and knowledge about the problems and some of their possible solutions become better known, more problems will be resolved so that the area will retain its desirability as a place in which to work and live.

This field trip area is located in the northern part of Cook and the southeastern part of Lake Counties, where most of the present villages and cities were once known as "bedroom communities;" that is, they were ideal residential communities within easy commuting distance of downtown Chicago. The population of the 16 communities embraced by this field trip now totals nearly 500,000 people and the complexion of some of these communities is changing as more offices and industries move to the suburbs, where their workers now live.

Realizing that the economic and natural assets of the metropolitan area would be severely stressed by uncontrolled growth, the General Assembly passed measures that led to the establishment of the Northeastern Illinois Planning Commission to encompass the six counties in this part of the state lying east of the Fox River. The Commission is collecting and integrating data on the physical and environmental characteristics of the counties as a basis for long-range planning. The Geological Survey generated and developed a considerable amount of data, much of it compiled on maps, for the Commission. Such information on the soils, rock materials, groundwater, and surface water contributes to an awareness of the natural assets of the counties and to an understanding of environmental limitations and problems. Development based on such an awareness presumably enhances and protects the physical environment rather than causes its deterioration.

Physiography and Geology

The Park Ridge-North Shore area in northeastern Illinois is situated in the Wheaton Morainal Country and Chicago Lake Plain of the Great Lake Section, Central Lowland Province (fig. 1). The Great Lake Section is separated from the Till Plains Section to the south and west because of the very pronounced, roughly concentric morainal ridges surrounding the Lake Michigan basin, more abundant lakes, and the extent of lacustrine (lake) plains here.

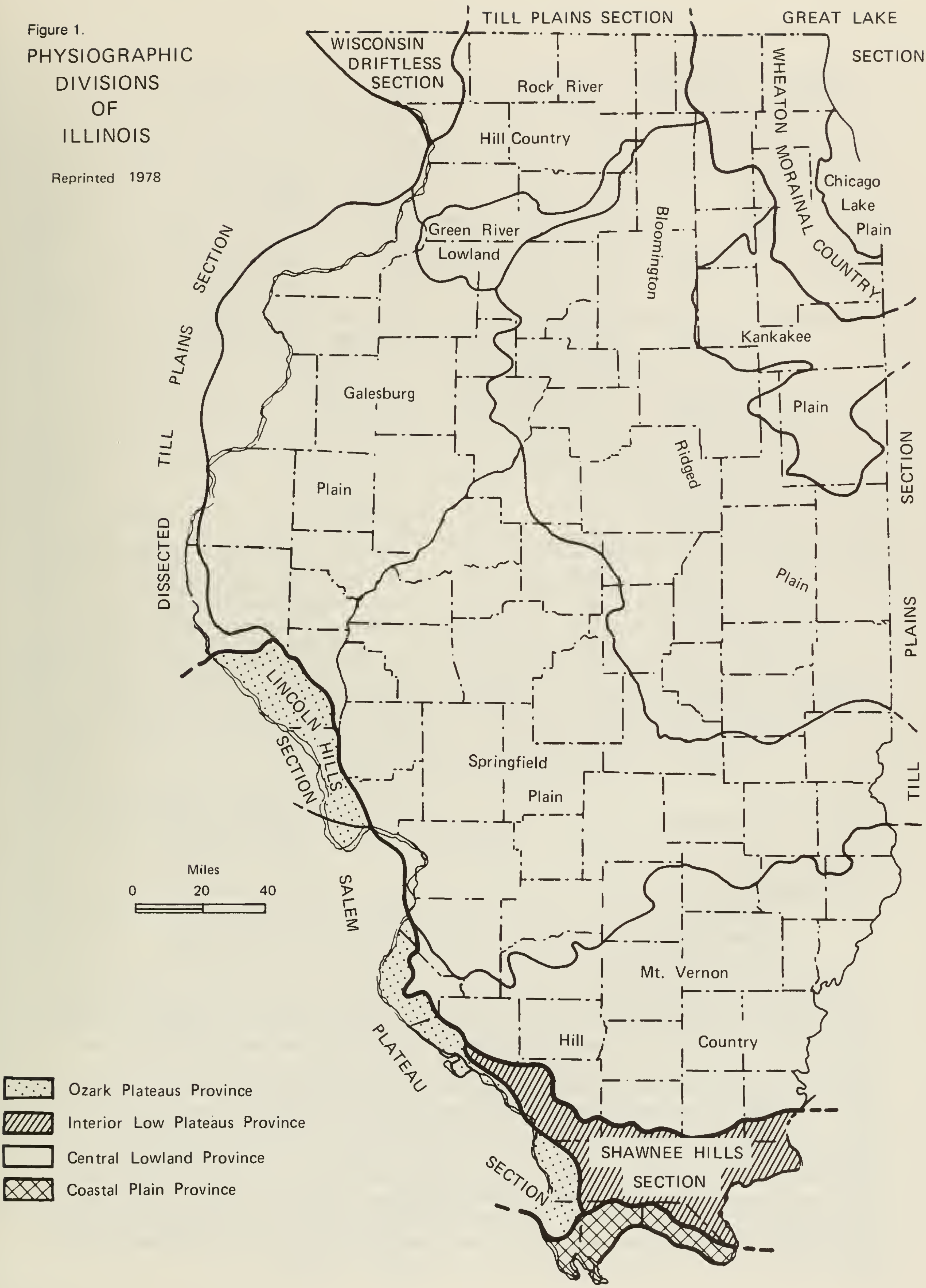
The Chicago Lake Plain forms a relatively flat surface, for the most part underlain by glacial till, that slopes gently lakeward. The numerous glacial moraines of the Wheaton Morainal Country form a more complex topography that contains more lakes and swamps than do the open stretches of the adjacent Till Plains Section.

Geologically, the Park Ridge-North Shore area has undergone many changes throughout millions of years of geologic time. Igneous and possibly metamorphic rocks compose the ancient Precambrian basement that lies deeply buried beneath some 3,100 to 3,600 feet of younger sedimentary rock strata that were deposited in shallow seas that repeatedly covered this part of our continent. Most of these sedimentary bedrock strata are Paleozoic formations ranging in age from Cambrian through Silurian (from about 570 to nearly 408 million years old) (fig. 2). Younger Paleozoic bedrock strata, which are known from outcrops just a few miles away from the field trip area, covered this area at one time. Then, during the millions of years following the close of the Paleozoic Era and before the Pleistocene glaciers advanced into Illinois, 1 to 2 million years ago, an unknown thickness of these strata was eroded away. Paleozoic bedrock strata in the Chicago area are not flat lying or "layer cake" in their attitude. Instead they are gently warped up across the Kankakee Arch, a broad, northwest- to southeast-trending structural arch that connects the Wisconsin and Cincinnati Arches (fig. 3). The Kankakee Arch separates two broad structural basins--the Illinois Basin (fig. 4) to the southwest and the Michigan Basin to the northeast. The field trip area lies along and slightly east of the crest of the Kankakee Arch. The bedrock strata here are tilted slightly toward the northeast about 10 to 15 feet per mile, less than 1^{0} dip and not perceivable by the eye. Locally there are exceptions to these gentle dips. Tilting of the bedrock strata took place several times during the geologic past with the result that the bedrock strata are not parallel to each other.

An unusual geologic feature of this area is the Des Plaines Disturbance, an intensely faulted structure about 5.5 miles in diameter that has displacements of as much as 600 feet (fig. 5). None of this structure, however, is visible at the ground surface; the description and interpretation are based on the records of more than 295 wells in this area. The center of the structure is located about 0.75 miles northwest of the high school parking lot. The bedrock surface of the disturbed area is overlain by 75 to 200 feet of glacial drift. Rocks as old as the Ordovician Oneota Dolomite (fig. 2) have been brought to the bedrock surface near the center of the Disturbance. Mississippian and Pennsylvanian strata have been thrust down and preserved in some of the faulted blocks. These latter rocks have not been found in this area any closer than 50 miles to the south of the Disturbance. As shown in figure 5, strata appear to be horizontal around the periphery of the structure and even within the individual faulted blocks, the strata appear to be only slightly tilted.

Figure 1.
PHYSIOGRAPHIC DIVISIONS OF ILLINOIS

Reprinted 1978



System or series	Stratigraphic units and thickness(ft)	Graphic log	Rock type	Water-yielding characteristics
PLEISTOCENE	Named in figure 6 75 - 300		Unconsolidated glacial deposits, loess, and alluvium	Water yields varied; largest from thick outwash deposits in western part of county
SILURIAN	Niagaran-Alexandrian 0 - 300		Dolomite, silty at base, locally cherty	Yields moderate to large supplies where creviced and more than 50 ft. thick. May contain oil, gas, H_2S
ORDOVICIAN	Maquoketa 125 - 225		Shale, gray or brown; argillaceous dolomite	Yields small supplies from dolomite or fractured shale
	Galena-Platteville 275 - 325		Dolomite, upper part medium-grained, lower part very fine grained	Yields small to moderate supplies where creviced
	Glenwood-St. Peter 100 - 300		Sandstone, fine to coarse; thin dolomite at top; red shale and chert rubble at base	Yields moderate supplies
CAMBRIAN	Potosi 50 - 100		Dolomite, fine-grained	Yields small supplies where creviced
	Franconia 50 - 75		Dolomitic sandstone and shale	Generally not water-yielding
	Ironton-Galesville 150 - 200		Sandstone; upper part dolomitic, lower part well-sorted	Most productive bedrock aquifer in county; yields large supplies
	Eau Claire 400 - 450		Siltstone, sandstone, shale, and dolomite	Generally not water-yielding
	Mt. Simon 1500 - 2200		Sandstone, coarse-to medium-grained	Yields moderate amounts of water; water quality good at top but deteriorates with depth
PRECAMBRIAN			Granite	Not water-yielding

Figure 2. - Generalized column of geologic formations in Lake County.

Considerable discussion as to the origin of the Des Plaines Disturbance has occurred for at least 60 years, with at least five different ideas proferred at one time or another. The most plausible explanation suggests that the structure was formed by a large meteorite impact during post-Pennsylvanian time. Following impact the rocks rebounded elastically past their initial positions and the deformation became "frozen" by rupture of the rocks during this recovery. Subsequently, an unknown thickness of Pennsylvanian strata, probably several hundred feet, and at least 700 feet of Mississippian strata have been eroded from the area so that the current structure represents only the "root" portion of the structure immediately after the impact. Additional well samples collected within the last couple of years have included shatter cones--conical, striated, fractured rock fragments generally believed to have been formed by shock waves generated by meteorite impact.

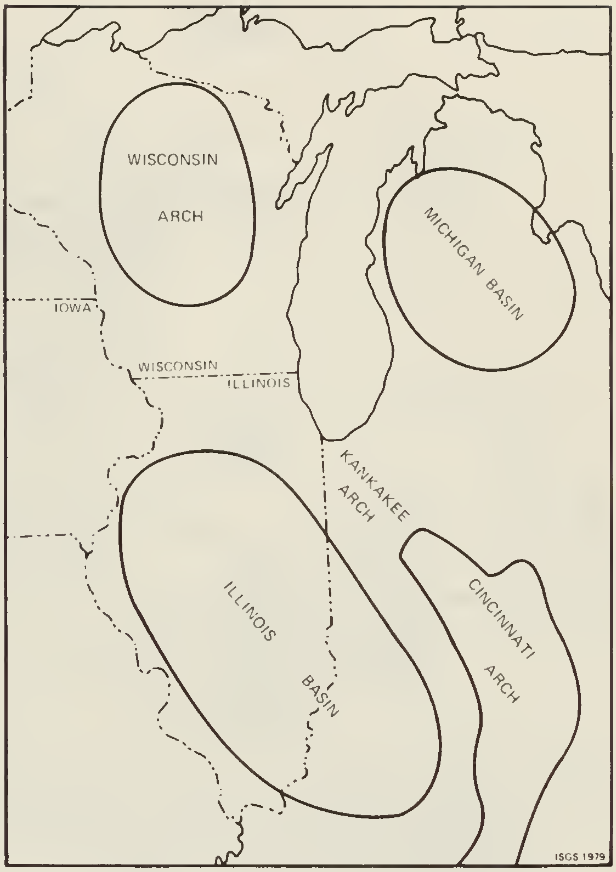


Figure 3. Location of the Kankakee Arch and adjacent structures, Wisconsin Arch, Cincinnati Arch, Illinois Basin, and Michigan Basin, in the north-central Midcontinent Region. (From Reinertsen, 1979.)

The bedrock surface in northeastern Illinois has been modified by the Pleistocene glaciers that repeatedly covered the area during the last 700,000 years. Some of the rills and valleys in the bedrock surface formed by pre-Pleistocene erosion were accentuated by meltwater from the early glaciers; however, many of these valleys were later filled so completely with glacial debris that in many places no surface expression of them is now visible and present-day drainage does not, for the most part, follow them. Bedrock exposures show the well-developed scratches, called striations, which prove that the higher parts of the bedrock surface were scraped, rounded, and ground by the over-riding glacial ice. Rock debris entrained in the ice acted as a giant piece of sandpaper. The ice sheet itself was several thousand feet thick and extremely heavy when it crossed this region. Glacial deposits, being relatively weak, were easily eroded by each succeeding glacier and became incorporated into the newly forming glacial material, called till, that blankets the area. Till is a mixture of rock fragments of many types and sizes. The overall effect of glaciation in this region has been to subdue the pre-Pleistocene topography (also see attached "Pleistocene Glaciations in Illinois").

Although Pleistocene glaciers have covered nearly 85 percent of Illinois at one time or another during the past million years or so, no deposits definitely identified as pre-Illinoian have been found in northeastern Illinois. Illinoian tills to the northwest, west, and southwest of the Chicago area indicate that Illinoian glaciers did advance southward through the Lake Michigan Basin and did cover this region. Subsequent weathering and erosion, followed by Wisconsinan glaciation, obliterated all traces of Illinoian glaciation from the field trip area.

Wisconsinan tills of the Woodfordian Substage deposited from about 12,000 to 14,000 years ago underlie this area; here the till of the Wedron Formation ranges from less than 100 feet to more than 200 feet thick (fig. 6).

As the Woodfordian glacier melted, a series of lakes formed filling low areas between the ice margin and the adjacent higher land of the end moraines surrounding what is now the Lake Michigan Basin. Some of these lakes were larger than present-day Lake Michigan, which was developed about 1,800 years

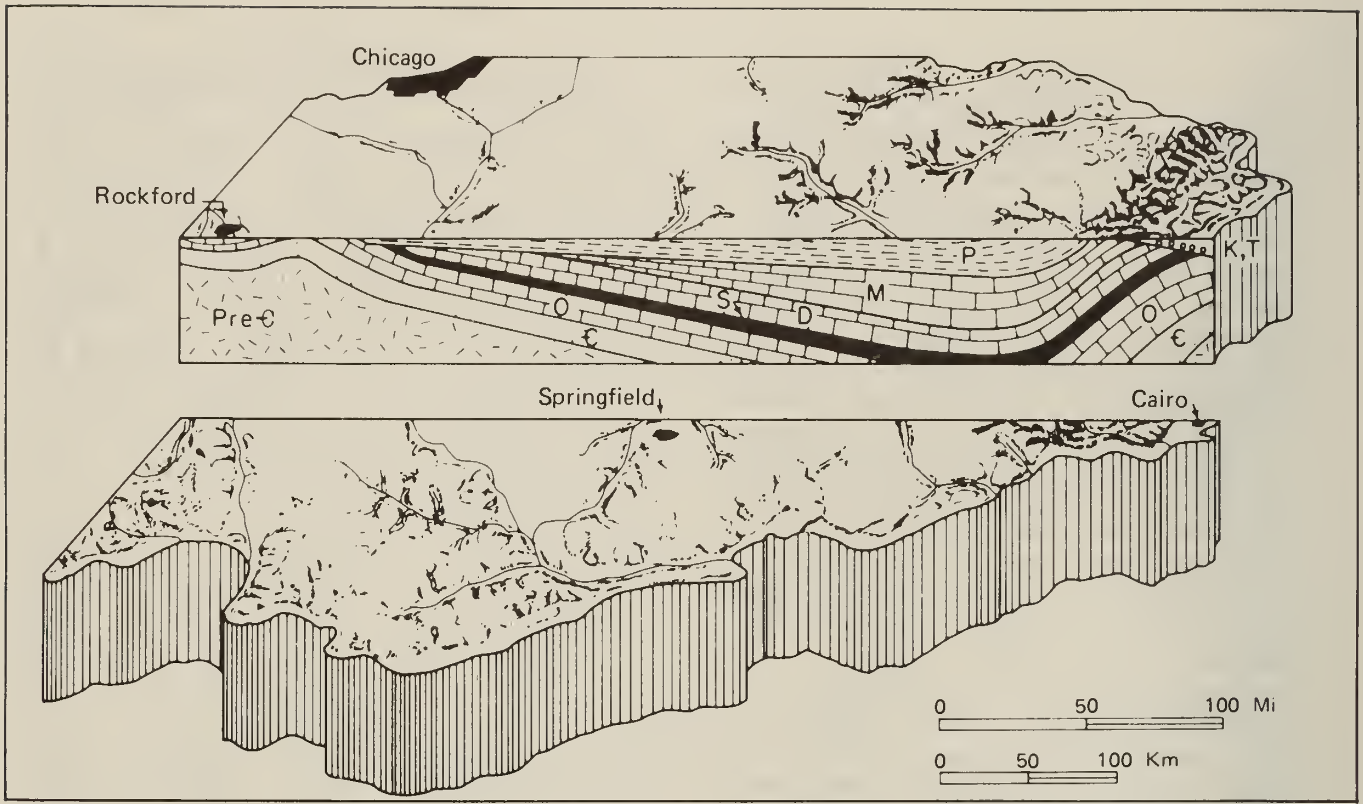


Figure 4. Stylized north-south cross section shows the structure of the Illinois Basin. In order to show detail, the thickness of the sedimentary rocks has been greatly exaggerated and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-C) granites. They form a depression that is filled with layers of sedimentary rocks of various ages: Cambrian (C), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). The scale is approximate.

ago to its present level. The glacial deposits underlying the lakes have been reworked by waves and currents; those deposits not inundated by the lakes have been subjected to the wind and running water to produce the land forms seen today.

Mineral Production

During 1984, the last year for which complete mineral production records are available, of the 102 Illinois counties, 99 reported mineral production. The total value of all minerals extracted from Illinois increased by 9.5 percent to $3.138 billion. The total value of all minerals extracted, processed, and manufactured in the state was more than $3.9 billion. Coal continued to be the leading commodity in terms of value; oil ranked second; stone and sand and gravel ranked third and fourth; fluorspar was fifth.

Nationally, Illinois ranked eighteenth in value of nonfuel mineral production. It remained the principal U.S. producer of fluorspar, tripoli, and industrial sand and led in the manufacture of iron-oxide pigments. In stone and peat production, the state ranked fourth.

Mineral resources extracted from Cook County in order of value are: stone, sand and gravel, peat, and groundwater. In addition, several mineral

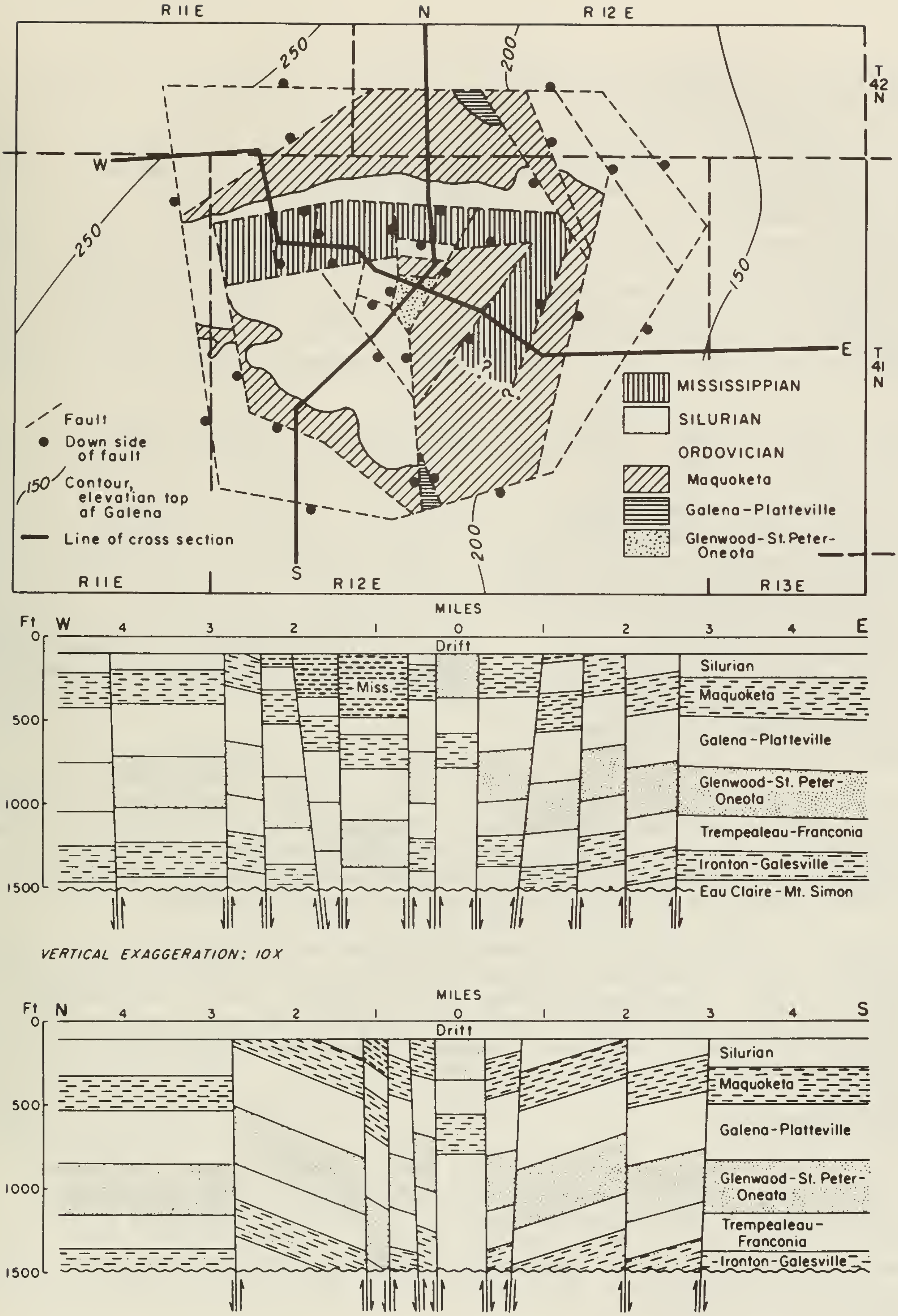


Figure 5. - Geologic map and cross sections of the Des Plaines Disturbance (after Emrich and Bergstrom, 1962).

materials that originate outside the state are processed here; in order of value they are: expanded perlite, slag, pig iron, and secondary slab zinc. Mineral products manufactured here, in order of value, are: lime, clay products, and metallurgical coke. Cook County mineral extraction and processing had a value of $111,040,000 for 1984, which ranks 7th in the state based on that value.

Mineral resources extracted from Lake County in order of value are: sand and gravel, peat, and groundwater. In addition, several mineral materials that originate outside the state are processed here; in order of value they are: calcined gypsum, crude iodine, and columbium. Clay products are manufactured here. Lake County mineral extraction and processing had a total value of $10,272,000 for 1984, which ranked it 43rd based on that value.

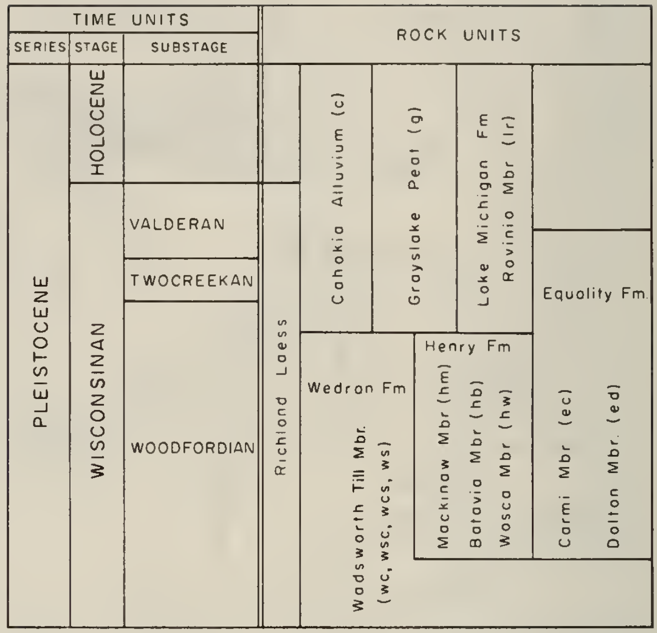


Figure 6. Geological classification and field relations of surficial materials in Lake County. Symbols for rock units are those used on plate 1.

The close proximity of sand and gravel and peat pits to the large market area in northeastern Illinois greatly reduces the shipping costs of these high-bulk materials. To conserve construction materials, long-range planning is necessary so that future pit sites having thin overburden do not become covered and lost to housing developments and shopping centers.

Abundant groundwater and surface water supplies are readily available in the Chicago area. It would be extremely difficult, if not impossible, to place values on them. Thus, although they are included in the list of mineral resources extracted for both counties, no monetary value was assigned to them. They probably should be listed as first in value for both counties, however.

Water Resources

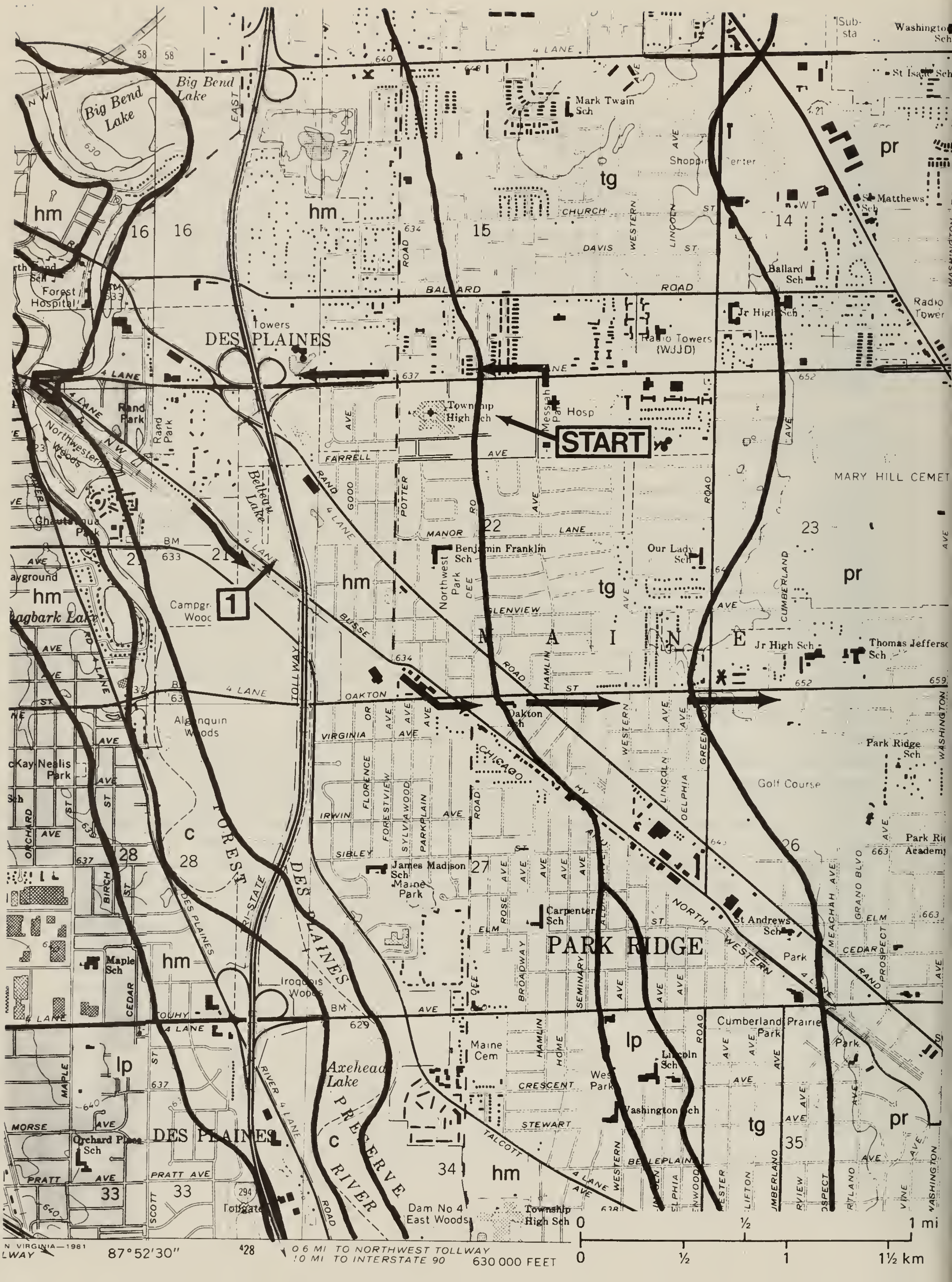
Part of the precipitation striking the Earth's surface percolates downward into the open spaces in unconsolidated earth materials and the underlying bedrock strata. The open spaces range in size from minute pores to open joints and cracks and large crevices. Rocks are saturated with water below a certain depth and form the groundwater reservoir, the top of which is commonly called the "water table." Aquifers are earth materials that contain water and readily yield it to wells.

The aquifers of Lake and Cook Counties have supplied large quantities of water for industrial, metropolitan, and domestic needs for many years. There are two major water-yielding systems: the shallow system, consisting of the glacial drift aquifers and the shallow Silurian dolomite aquifer; and the deep sandstone system, consisting of the Ordovician Glenwood-St. Peter Sandstone and the Cambrian Ironton-Galesville Sandstone and the Mt. Simon Sandstone. The shallow aquifer system is recharged by local rainfall; the deeper aquifer system by precipitation seeping downward through overlying rocks in the west and southwest in McHenry, Boone, De Kalb and Kane Counties. However, the rapid development of the Chicago region has severely overtaxed the capacity of the deep aquifers in the region. Water levels in deep wells in the region have declined as much as several hundred feet, indicating that the groundwater resource is being "mined"--extracted faster than it can be replaced by natural recharge.

Contrary to popular myth, the groundwater reservoir in Illinois is not recharged with water from Lake Superior.

Although groundwater resources are available throughout Lake and Cook Counties, abundant quantities of good quality water in the field trip area occur mainly in the deep aquifer system. However, in some parts of Kane and westernmost Cook Counties, these deep aquifers contain naturally occurring quantities of dissolved barium and/or radium that exceed the USEPA drinking water standards. Geological Survey scientists are using seismic and electrical earth resisitivity geophysical methods to locate new groundwater resources in the shallow glacial materials to supplement and dilute the groundwater produced from the deep aquifers for communites in these areas. It is more imperative now than ever before that we protect our groundwater supplies from contamination and from overuse, so that adequate supplies of good quality water will be available in the future.

Several communities along the east edge of the county draw their water supplies from Lake Michigan. Lake County municipalities withdraw about 50.4 million gallons of water per day (mg/d). A 1966 U.S. Supreme Court ruling set a limit on the amount of water that Illinois communities could withdraw from the lake 3,100 cubic feet per second (a cubic foot of water equals 7.5 gallons) for water supply and for diversion for the Chicago Sanitary and Ship Canal. Most of the diverted water (3,100 cubic feet per second) has been preempted by the City of Chicago and the Metropolitan Sanitary District. Only 100 cubic feet per second (64.6 mg/d) are left from the State's allotment for other Illinois users. Lake County has filed a report with the State noting that by the year 2000 the county will need 32.8 percent more water from Lake Michigan than it is now diverting. Interestingly enough, the current Chicago usage of lake water is estimated to draw down the lake level only about 0.5 inch annually!



START
1
Big Bend Lake
DES PLAINES
Towers
Township High Sch
Messiah
Hosp
Mark Twain Sch
Shopping Center
St Matthews Sch
WT
Ballard Sch
Jr High Sch
Radio Towers (WJJD)
Radio Tower
St Isaac Sch
Washington Sch
Sub-sta
Forest Hospital
Rand Park
Northwestern Woods
Chautauqua Park
Campgr Wooc
Belleau Lake
Benjamin Franklin Sch
Northwest Park
Our Lady Sch
MARY HILL CEMET
M A I N E
Jr High Sch
Thomas Jefferson Sch
Oakton Sch
Algonquin Woods
Park Ridge Sch
Golf Course
Park Ridge Academy
McKay Nealis Park
James Madison Sch
Maine Park
Carpenter Sch
St Andrews Sch
PARK RIDGE
Maple Sch
Iroquois Woods
Cumberland Prairie Park
Maine Cem
Lincoln Sch
West Park
Washington Sch
Axehead Lake
Orchard Place Sch
DES PLAINES
Tollgate
Dam No 4 East Woods
Township High Sch
FOREST PRESERVE
DES PLAINES RIVER
TRI-STATE TOLLWAY
BALLARD ROAD
CHURCH
DAVIS
OAKTON ST
TOUHY AVE
BUSSE
RAND ROAD
CHICAGO NORTH WESTERN
TALCOTT
GLENVIEW
FARRELL AVE
MANOR LANE
4 LANE
hm
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16
15
14
21
22
23
26
27
28
33
34
35
87°52'30"
428
0.6 MI TO NORTHWEST TOLLWAY
1.0 MI TO INTERSTATE 90
630 000 FEET
0
½
1 mi
0
½
1
1½ km

A GUIDE TO THE ROUTE

Line up along the north side of the parking area; not in the driveway, but in the parking area on the east side of Main East Township High School. Mileage figures begin at the exit from the parking lot. **NOTE:** You are on your own to get to Stop 1. Obey all traffic lights, signs, and directions.

Miles to next point	Miles from start	
0.0	0.0	TURN LEFT (north) on Dee Road and prepare to turn left at the stoplight.
0.05-	0.05-	CAUTION: STOP LIGHT - Dempster Street (U.S. 14). TURN LEFT (west). Use EXTREME CAUTION. Stay in the inside lane.
0.25	0.3-	CAUTION: STOP LIGHT - Potter Road. CONTINUE AHEAD (west).
0.1	0.4-	Enter the City of Des Plaines.
0.3+	0.7+	Underpass: Tri-State Tollroad (Interstate 294). CONTINUE AHEAD.
0.15-	0.85	CAUTION: STOP LIGHT - Rand Road/Northwest Highway. CONTINUE AHEAD (west).
0.4+	1.25+	Des Plaines River to the right. CONTINUE AHEAD. Prepare to turn left.
0.15	1.4+	TURN LEFT (southeast) on Busse Highway. This is a lop-sided T-road intersection: no stoplights or stop signs. USE EXTREME CAUTION.
0.9-	2.3+	TURN LEFT with caution into Belleau Lake Forest Preserve and park.
0.05	2.35+	**STOP 1.** Discussion of valley train deposits at Belleau Lake Forest Preserve.
0.0	2.35+	Leave Stop 1.
0.05	2.4+	CAUTION: reenter Busse Highway. TURN LEFT (southeast).
0.1	2.5+	Underpass: Tri-State Tollroad.
0.35	2.85+	CAUTION: STOP LIGHT - Potter Road. This is a T-road and a curve. Do NOT turn onto Potter Road. CONTINUE AHEAD with a curve on Busse Highway (southeast).
0.2+	3.1-	CAUTION: STOP LIGHT - Oakton Street. TURN LEFT (east).

Explanation of letters on the following route maps

c = Cahokia Alluvium

g = Grayslake Peat (and muck)

pl = Parkland Sand (dunes, etc.)

lp = lake plain

ed = Dolton Member of Equality Formation (shallow-water, near-shore sediments: beaches, bars, spits, and deltas)

hm = Mackinaw Member of Henry Formation (sand and gravel; valley train deposits)

Lake Border Morainic System

zi = Zion City Moraine

hp = Highland Park Moraine

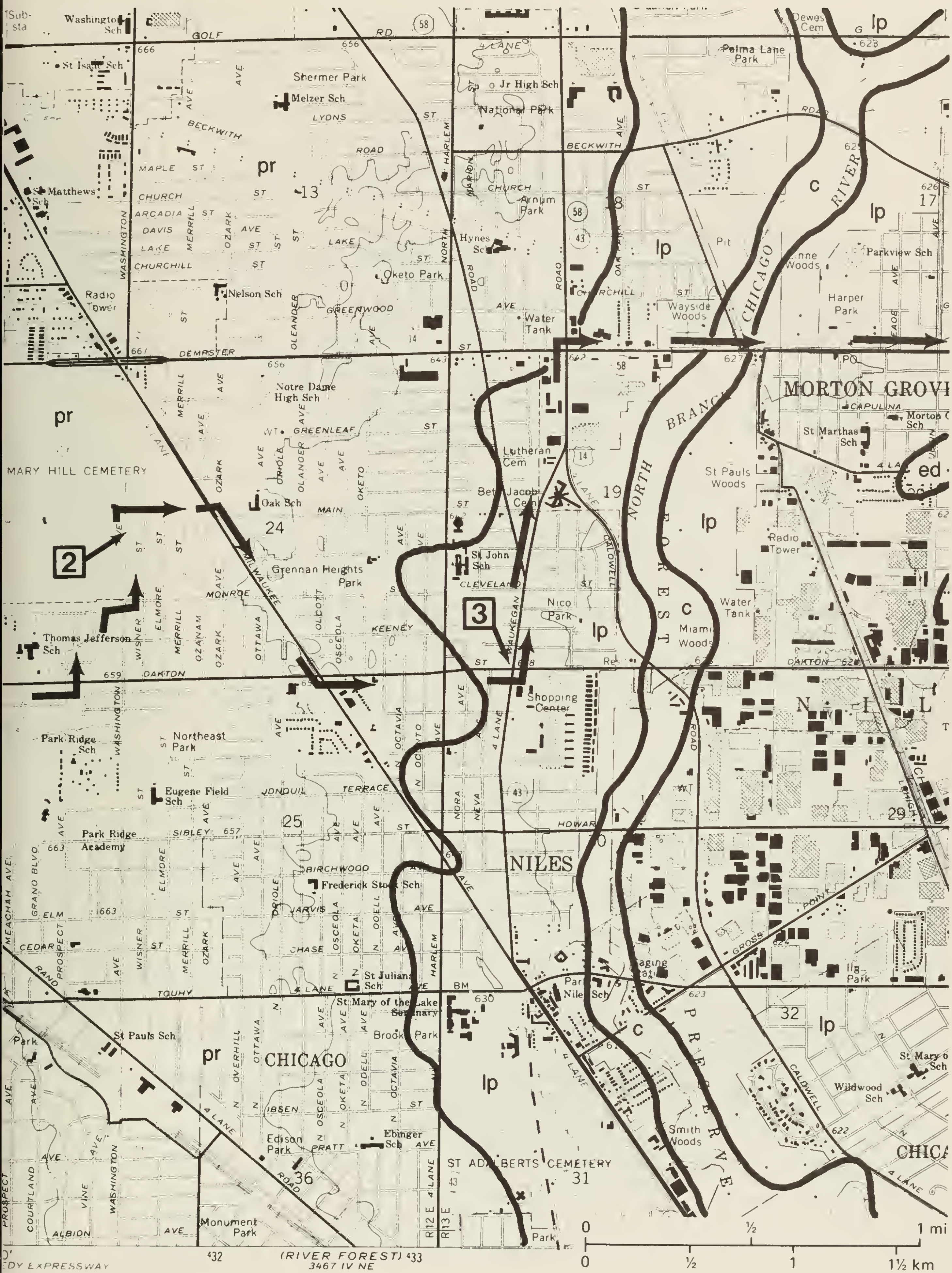
b = Blodgett Moraine

d = Deerfield Moraine

pr = Park Ridge Moraine

lbg = Lake Border Groundmoraine

tg = Tinley Groundmoraine



Sub-sta
Washington Sch
GOLF RD
St Isaac Sch
Shermer Park
Melzer Sch
LYONS
Jr High Sch
National Park
Palma Lane Park
Dews Cem
BECKWITH
ROAD
MAPLE ST
pr
13
CHURCH
ARCADIA
DAVIS
LAKE
CHURCHILL
St Matthews Sch
Arnum Park
Hynes Sch
Oketo Park
18
lp
c
CHICAGO RIVER
Pit
Linne Woods
Parkview Sch
Harper Park
17
Radio Tower
Nelson Sch
GREENWOOD AVE
Water Tank
Wayside Woods
DEMPSTER ST
Notre Dame High Sch
MORTON GROVE
St Marthas Sch
NORTH BRANCH
FOREST PRESERVE
MARY HILL CEMETERY
Lutheran Cem
St Pauls Woods
Beth Jacob Cem
19
Oak Sch
MAIN
24
2
MILWAUKEE
Grennan Heights Park
St John Sch
CLEVELAND
3
WAUKEGAN
Nico Park
Water Tank
Miami Woods
KEENEY
Thomas Jefferson Sch
DAKTON
Shopping Center
NILES
Park Ridge Sch
Northeast Park
Eugene Field Sch
JONQUIL
TERRACE
25
Park Ridge Academy
SIBLEY
HOWARD
BIRCHWOOD
Frederick Stock Sch
JARVIS
29
ELM
CEDAR
CHASE
GROSS POINT
St Juliana Sch
TOUHY
St Mary of the Lake Seminary
Park Niles Sch
Brook Park
32
St Pauls Sch
CHICAGO
lp
St Mary Sch
Wildwood Sch
CALDWELL
IBSEN
Edison Park
PRATT
Ebinger Sch
36
ST ADALBERTS CEMETERY
31
Smith Woods
Monument Park
CHICA
0 ½ 1 mi
0 ½ 1 1½ km
EDY EXPRESSWAY
432
(RIVER FOREST) 433
3467 IV NE

Miles to next point	Miles from start	
0.05+	3.15+	CAUTION: STOP LIGHT - Dee Road. CONTINUE AHEAD (east) on Oakton.
0.15+	3.35	CAUTION: STOP LIGHT - Rand Road/Northwest Highway. CONTINUE AHEAD (east) and cross Tinley Ground Moraine.
0.55+	3.9+	CAUTION: STOP LIGHT - Greenwood Avenue. CONTINUE AHEAD (east) and ascend gentle frontal slope of Park Ridge Moraine.
0.55+	4.45+	CAUTION: STOP LIGHT - Prospect Avenue. TURN LEFT (north); near crest of Park Ridge Moraine.
0.1	4.55+	CAUTION: Y-intersection. BEAR RIGHT (northeast).
0.3	4.85+	STOP: 2-way. TURN LEFT (north) on Washington Street.
0.2	5.05+	Park along side of Washington Street. Do NOT block driveways. CAUTION: watch traffic.
		STOP 2. Discussion of Lake Border Morainic System.
0.0	5.05+	Leave Stop 2. CONTINUE AHEAD (north).
0.05	5.1+	TURN RIGHT (east) on Main Street.
0.25+	5.35+	CAUTION: STOP LIGHT - Milwaukee Road (State Route [SR] 21). TURN RIGHT (southeast).
0.55+	5.95+	CAUTION: STOP LIGHT - Oakton Street. TURN LEFT (east) and descend gentle backslope of the Park Ridge Moraine. Stay in INSIDE LANE.
0.4	6.35+	CAUTION: STOP LIGHT - Harlem Avenue (SR 43) CONTINUE AHEAD (east) and prepare to turn left.
0.2+	6.55+	CAUTION: STOP LIGHT - Waukegan Road. TURN LEFT (north) into outside lane on SR 43.
0.05-	6.6+	CAUTION: just beyond the left turn, TURN RIGHT into the parking area.
		STOP 3. Discussion of ancient Lake Chicago
0.0	6.6+	Leave Stop 3. TURN RIGHT (north) on Waukegan Road and drive along the approximate position of the Glenwood Shoreline.

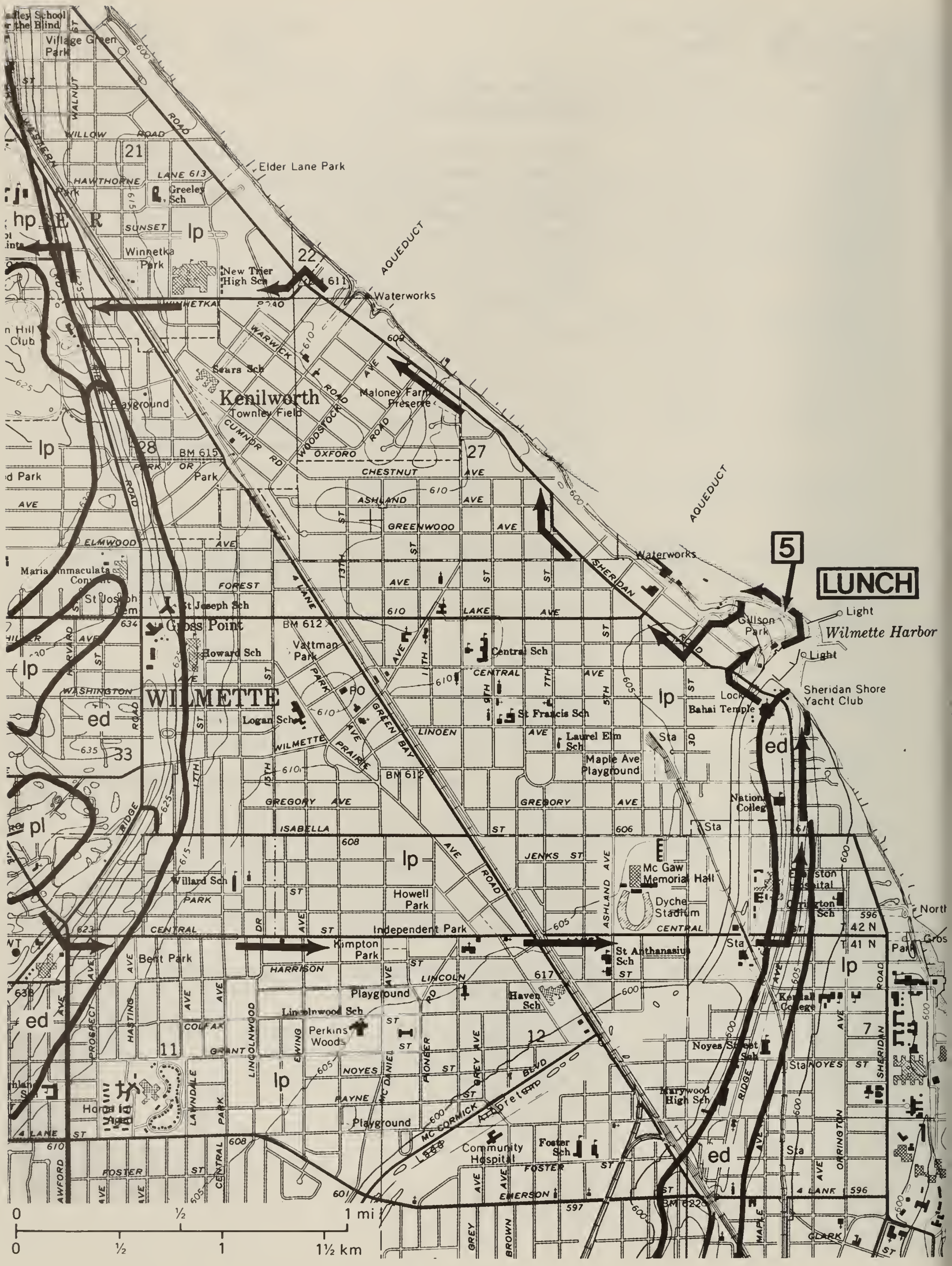
Miles to next point	Miles from start	
0.5-	7.1-	Enter Morton Grove.
0.2+	7.3	CAUTION: STOP LIGHT - angle intersection with Caldwell Avenue (U.S. 14). BEAR LEFT (north). Get in the OUTSIDE LANE.
0.3+	7.6+	CAUTION: STOP LIGHT - Dempster Street (SR 58). TURN RIGHT (east).
0.1+	7.7+	CAUTION: STOP LIGHT - Entrance to shopping center on the right. CONTINUE AHEAD down across the lake plain.
0.4+	8.15-	CAUTION: STOP LIGHT - Lehigh Avenue. CAUTION: Just beyond are two guarded tracks on the SOO Railroad. CONTINUE AHEAD (east) and cross the North Branch of the Chicago River.
0.2-	8.3+	CAUTION: STOP LIGHT - Ferris Avenue. CONTINUE AHEAD.
0.1+	8.45+	CAUTION: STOP LIGHT - Fernald Avenue. CONTINUE AHEAD.
0.3+	8.75+	CAUTION: STOP LIGHT - Austin Avenue. CONTINUE AHEAD (east).
0.25	9.0+	CAUTION: STOP LIGHT - Menard Avenue. CONTINUE AHEAD.
0.25	9.25+	CAUTION: STOP LIGHT - Central Avenue, beyond which is the interchange for Interstate 94. CONTINUE AHEAD (east) on Dempster. This interchange is located on one of the fingers of the Wilmette Spit.
0.15+	9.45	Overpass of I 94. CONTINUE AHEAD (east).
0.2-	9.65-	CAUTION: STOP LIGHT - Lockwood Avenue. CONTINUE AHEAD and prepare to turn left.
0.15	9.8-	CAUTION: STOP LIGHT - Gross Point Road. TURN LEFT (northeast).
0.25+	10.05	CAUTION: Chicago and Northwestern (C & NW) Railroad crossing, 1-track guarded. CONTINUE AHEAD along the Wilmette Spit, a near shore lake deposit formed during Glenwood time.

WILMETTE
SKOKIE
FOREST PRESERVE
NILES
4
lp
ed
pl
c
d
Avoca West Sch
Water Tank
Regina High Sch
Romona Sch
Jr High Sch
High Crest Sch
St Joseph Cem
Roemer Park
Westmoreland Country Club
Cunliff Park
Harms Woods
North Division High Sch
MEMORIAL PARK CEMETERY
Old Orchard Shopping Center
Skokie Valley Hospital
Highland Sch
Bent Park
Home for Aged
Shopping Center
Terminal Park
Old Orchard Jr High Sch
Sequoia Park
Stenson Sch
Mansfield Park
Devonshire Sch
Devonshire Park
Timber Ridge Sch
Timber Ridge Park
Lockwood Park
St Pauls Cem
Orchard Sch
Evanston Golf Club
Senecar Park
Shawnee Park
Navajo Park
Wright Park
Kenton Sch
Pawnee Park
Austin Park
Madison Sch
Winnebago Park
McNally Park
Thomas A Edison Sch
St Peters Sch
Searle Park
Cleveland Sch
St Lambert Sch
Playground
Oakview Jr High Sch
Oakton Park
Lincoln Sch
GLENVIEW ROAD
HARRISON ST
SIMPSON ST
CHURCH ST
DEMPSTER ST
OAKTON ST
EDENS EXPRESSWAY
GROSS POINT ROAD
0 ½ 1 mi
0 ½ 1 1½ km

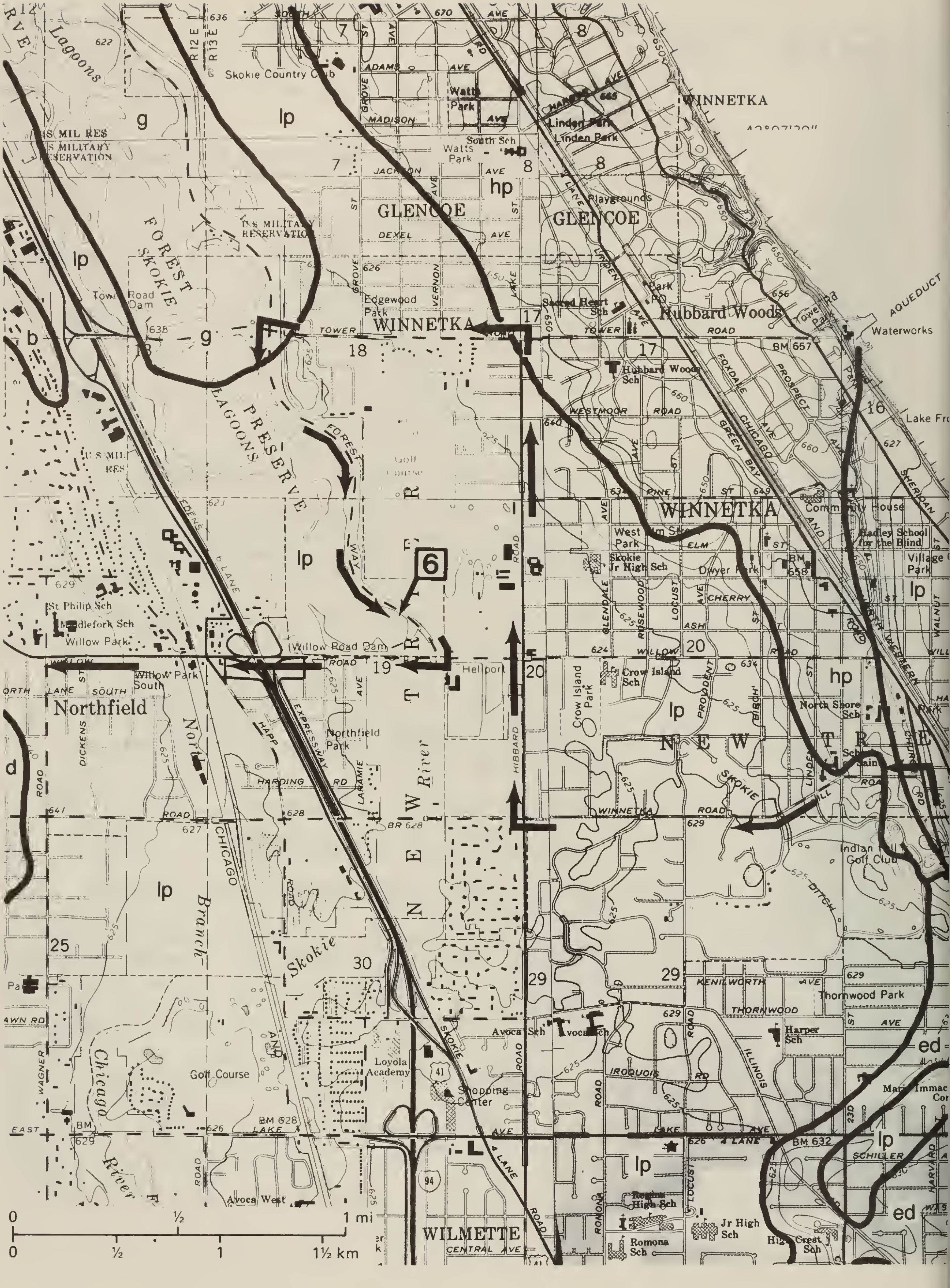
Miles to next point	Miles from start	
0.35+	10.4+	CAUTION: STOP LIGHT - Church Street. CONTINUE AHEAD (northeast) on Gross Point Road.
0.15	10.55+	CAUTION: STOP LIGHT - Skokie Boulevard. CONTINUE AHEAD (northeast) on Gross Point Road.
0.5+	11.1-	CAUTION: STOP LIGHT - Golf Road (Simpson). TURN LEFT (west) and move toward the outside lane. To the right, after the turn, is the Rush North Shore Medical Center. This site used to be a large gravel pit; an example of sequential land use.
0.35	11.45-	CAUTION: STOP LIGHT - Skokie Road (U.S. 41). TURN RIGHT (north).
0.1+	11.55	CAUTION: STOP LIGHT. CONTINUE AHEAD (north). Old Orchard Shopping Center to the left.
0.15-	11.7-	CAUTION: STOP LIGHT. CONTINUE AHEAD.
0.15+	11.85+	CAUTION: STOP LIGHT. CONTINUE AHEAD.
0.05+	11.9+	CAUTION: STOP LIGHT - Old Orchard Road (Harrison Street). CONTINUE AHEAD (north).
0.15+	12.1-	Enter Wilmette.
0.05+	12.15+	CAUTION: STOP LIGHT - Old Glenview Road. TURN RIGHT (east). You are ascending a gravel hill that is capped by sand eastward.
0.3	12.45	Alongside the golf course the soil is quite sandy. Not all of the hills to the right are artificial; some are small dunes that have been grassed over and stabilized.
0.45+	12.95-	CAUTION: TURN LEFT at the east entrance (third from west) to Centennial Park of the Wilmette Park District. Do NOT block driveways when parking, then walk a short distance north along the east side of the swimming pool and down a slope to a garden area.
		STOP 4. Discussion of Parkland Sand and nearby dunes.
0.0	12.95-	Leave Stop 4 and TURN LEFT (easterly) on Old Glenview Road.

Miles to next point	Miles from start	
0.05+	13.0-	CAUTION: STOP LIGHT - Crawford Avenue. TURN RIGHT (southeasterly). Move to the inside lane as you go south.
0.3+	13.3+	CAUTION: STOP LIGHT - Gross Point Road. CONTINUE AHEAD (southeasterly) on Crawford and prepare to turn left just beyond Gross Point Road. Ahead is the pronounced frontal slope of the Wilmette Spit formed during the Glenwood II Phase (12,900-12,700 BP).
0.05-	13.35+	CAUTION: STOP LIGHT - Central Street. TURN LEFT (east). Coming down the Glenwood Shoreline onto the lake plain.
0.1+	13.5-	Outer lower edge of Wilmette Spit during the Calumet Phase.
0.35+	13.85+	CAUTION: STOP LIGHT - Central Park Avenue. CONTINUE AHEAD across the lake bottom during the Calumet Phase.
0.1+	14.0-	CAUTION: STOP LIGHT - Lincolnwood Drive. CONTINUE AHEAD (east).
0.35+	14.35+	CAUTION: STOP LIGHT - McDaniel Street. CONTINUE AHEAD.
0.25-	14.6-	CAUTION: Hartrey Avenue, T-Street. CONTINUE AHEAD (east).
0.25-	14.8+	CAUTION: STOP LIGHT - Green Bay Road. CONTINUE AHEAD under C & NW railroad tracks.
0.25+	15.05+	CAUTION: STOP LIGHT - Ashland Avenue. CONTINUE AHEAD. Dyche Stadium, Northwestern University to the left.
0.25-	15.3+	CAUTION: STOP LIGHT - Asbury Avenue. CONTINUE AHEAD (east).
0.1	15.4+	Cross the North Shore Channel constructed to conduct lake water southward to augment flow in the lower part of North Branch Chicago River.
0.1-	15.5+	CAUTION: Rapid Transit overpass and STOP LIGHT - Gerard Avenue. CONTINUE AHEAD (east) and ascend Rose Hill Spit formed during the Calumet Phase (11,800-11,200 BP).

Miles to next point	Miles from start	
0.1+	15.6+	CAUTION: STOP LIGHT - Ridge Avenue. TURN LEFT (northeasterly).
0.1+	15.7+	Evanston Hospital to the left. CONTINUE AHEAD. The side streets to the right look down to the lake side of the Rose Hill Spit. The base is the approximate position of the Toleston Shoreline formed during the Nipissing I Phase (4,500 BP).
0.2	15.9+	CAUTION: STOP LIGHT - Isabella Street. CONTINUE AHEAD (north) on Sheridan Road.
0.1	16.0+	National College of Education to left.
0.1+	16.15-	Enter Wilmette.
0.15+	16.3	Bahai Temple to left. CONTINUE AHEAD around the curve and descend the back slope of the Rose Hill Spit.
0.15	16.45	Cross the North Shore Channel.
0.05+	16.5+	CAUTION: TURN RIGHT on Michigan Avenue. CONTINUE TURN TO RIGHT into Gillson Park. Keep to the right past the Coast Guard Station and the Sheridan Shore Yacht Club.
0.05+	16.55+	Wilmette Coast Guard Station to the right.
0.25-	16.8	STOP 5. Lunch and discussion of some of the lakeshore features in the southern part of the field trip area near Wilmette Harbor.
0.0	16.8	Leave Stop 5 and CONTINUE AHEAD (westerly) on the park drive.
0.15+	16.95+	STOP: 1-way, T-road intersection. TURN LEFT and ascend dune. You will encounter several drives from the left, none of which you can legally turn into so continue winding to the right until you get to the park exit.
0.15	17.1	STOP: 2-way, crossroad - Michigan Avenue. CONTINUE AHEAD (southwest) on Washington Avenue.
0.05+	17.15+	STOP: 3-way, 5-point intersection. TURN RIGHT (northwest) on Sheridan Road.


Village Green Park
WALNUT
WILLOW
ROAD
21
LANE 613
HAWTHORNE
Greeley Sch
Elder Lane Park
SUNSET
lp
hp
Winnetka Park
AQUEDUCT
22
New Trier High Sch
611
Waterworks
WINNETKA
609
WARWICK
Sears Sch
Kenilworth
Townley Field
Maloney Farm Preserve
Playground
ROAD
AVE
WOODSTOCK
CUMNOR RD
OXFORD
BM 615
28
27
Park
CHESTNUT
AVE
ASHLAND
GREENWOOD
ELMWOOD
AVE
Maria Immaculata Convent
FOREST
4 LANE
SHERIDAN
Waterworks
5
LUNCH
Light
Wilmette Harbor
Light
Gillson Park
St Joseph Sch
Gross Point
BM 612
LAKE
Howard Sch
Vattman Park
Central Sch
CENTRAL
WASHINGTON
WILMETTE
PO
Logan Sch
GREEN BAY
St Francis Sch
Lock
Bahai Temple
Sheridan Shore Yacht Club
ed
LINDEN
Laurel Elm Sch
Sta
Maple Ave Playground
WILMETTE
PRAIRIE
BM 612
33
pl
GREGORY AVE
GREGORY
AVE
National College
ISABELLA
608
JENKS ST
606
Sta
Mc Gaw Memorial Hall
Willard Sch
PARK
Howell Park
Dyche Stadium
ASHLAND AVE
Evanston Hospital
Orrington Sch
596
CENTRAL
Independent Park
Kimpton Park
St Athanasius Sch
T 42 N
T 41 N
Bent Park
HARRISON
LINCOLN
617
Playground
Lincolnwood Sch
Haven Sch
Kendall College
Perkins Woods
COLFAX
GRANT
11
12
7
LINCOLNWOOD
EWING
PIONEER
NOYES
Noyes Street Sch
NOYES
MC DANIEL
MC CORMICK
BLVD
PAYNE
Marywood High Sch
RIDGE
Home for Aged
Playground
Community Hospital
Foster Sch
4 LANE
608
610
FOSTER
FOSTER
CENTRAL
EMERSON
597
BM 622
4 LANE
596
MAPLE
ORRINGTON
SHERIDAN
CLARK
GREY
BROWN
PROSPECT
HASTINGS
LAWNDALE
0
½
1 mi
0
½
1
1½ km

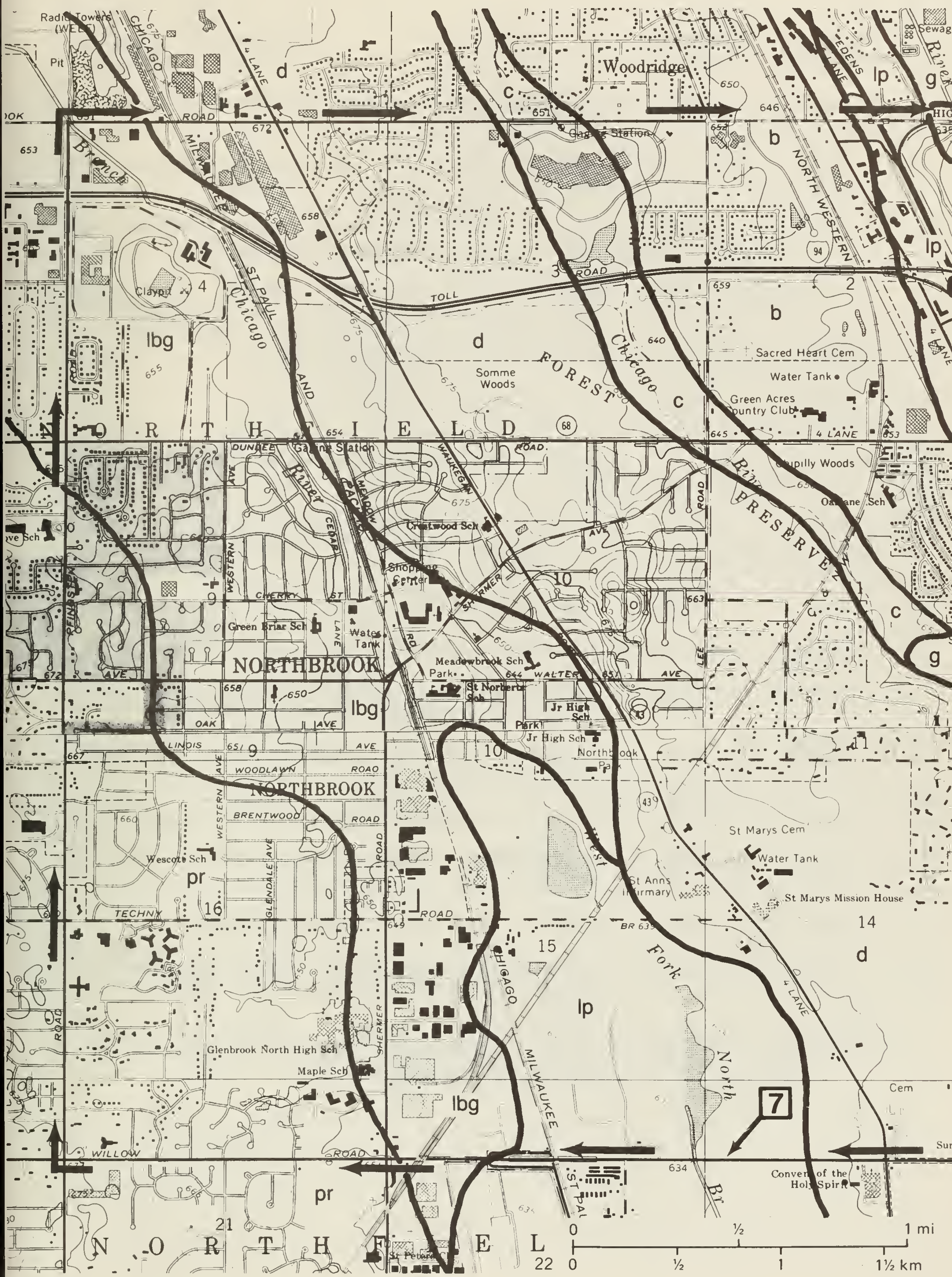
Miles to next point	Miles from start	
0.15	17.3+	CAUTION: STOP LIGHT - Lake Avenue. CONTINUE AHEAD (northwest).
0.7	18.0+	CAUTION: STOP LIGHT - Westerfield Road. CONTINUE AHEAD (northwest).
0.2+	18.25	Enter Kenilworth at the stone piers
0.4+	18.65+	CAUTION: STOP LIGHT - Kenilworth Avenue. CONTINUE AHEAD (northwest).
0.15+	18.85+	Winnetka Avenue - TURN LEFT (southwest). Not well marked - no stoplight or stop sign.
0.05+	18.9+	BEAR RIGHT (west).
0.3+	19.25	New Trier High School to right.
0.15+	19.4+	C & NW Railroad underpass. CONTINUE AHEAD.
0.05	19.45+	CAUTION: STOP LIGHT - Green Bay Road. CONTINUE AHEAD (west) ascending the rather steep sea cliff of the Highland Park Moraine, the source of sediment for the Wilmette Spit 0.25 miles south.
0.15-	19.6+	STOP: 3-way; T-road. TURN RIGHT (north) on Church Road.
0.1+	19.75	STOP: 3-way; T-road. TURN LEFT on Hill Road.
0.25	20.0	CAUTION: crossroad. BEAR LEFT at angle and descend Hill Road across the front of the Highland Park Moraine.
0.25	20.25	BEAR RIGHT (west) on Hill Road/Winnetka Road.
0.3-	20.5+	STOP: 4-way. CONTINUE AHEAD (west).
0.5+	21.05-	CAUTION: STOP LIGHT - Hibbard Road. TURN RIGHT (north).
0.5	21.55-	CAUTION: STOP LIGHT - Willow Road. CONTINUE AHEAD (north).
0.3+	21.85+	CAUTION: STOP LIGHT - Elm Street. CONTINUE AHEAD (north).
0.7-	22.5+	STOP: 3-way; T-road. TURN LEFT (west) on Tower Road.



Skokie Country Club
Lagoons
US MIL RES
US MILITARY RESERVATION
FOREST SKOKIE PRESERVE
LAGOONS
U.S. MILITARY RESERVATION
Tower Road Dam
Willow Road Dam
Heliport
GLENCOE
WINNETKA
Hubbard Woods
Watts Park
South Sch
Linden Park
Playgrounds
Edgewood Park
Sacred Heart Sch
Hubbard Woods Sch
Waterworks
AQUEDUCT
Community House
Hadley School for the Blind
Village Park
West Elm Street Park
Skokie Jr High Sch
Dwyer Park
Crow Island Park
Crow Island Sch
North Shore Sch
Indian Hill Golf Club
Thornwood Park
Harper Sch
Avoca Sch
Loyola Academy
Shopping Center
Golf Course
Northfield
Northfield Park
St Philip Sch
Middlefork Sch
Willow Park
Willow Park South
Avoca West
Regina High Sch
Romona Sch
Jr High Sch
High Crest Sch
WILMETTE
NEW TRIER
Skokie River
North Branch Chicago River
EDENS EXPRESSWAY
TOWER ROAD
WILLOW ROAD
WINNETKA ROAD
HARDING RD
LAKE AVE
HIBBARD ROAD
GREEN BAY ROAD
SHERIDAN
KENILWORTH AVE
THORNWOOD
IROQUOIS RD
CENTRAL AVE
WAGNER ROAD
DICKENS
SKOKIE DITCH
lp
hp
g
b
d
ed
6
0 ½ 1 mi
0 ½ 1 1½ km

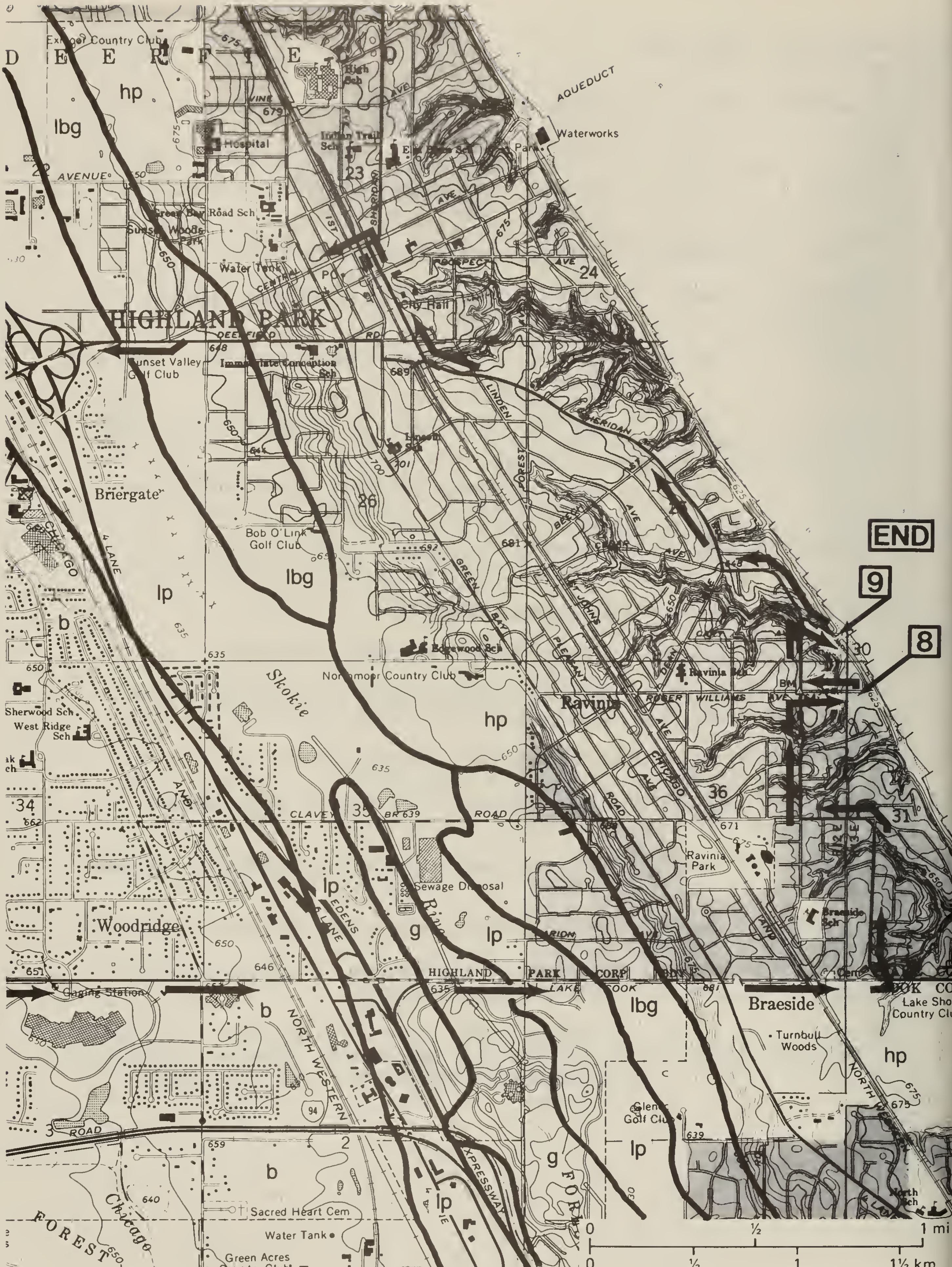
Miles to next point	Miles from start	
0.8-	23.3+	STOP: 4-way. TURN LEFT (south) on Forest Way. This is the area of the Skokie Lagoons. The area to the northwest for a short distance is underlain by muck and peat materials.
1.05+	24.35+	STOP 6. Skokie Lagoon and discussion of lake plain sediments deposited during Glenwood Lake levels.
0.0	24.35+	Leave Stop 6 and CONTINUE AHEAD (south).
0.2	24.55+	STOP: 1-way; T-road intersection with Willow Road. TURN RIGHT (west) on Willow Road and enter Northfield.
0.1+	24.65+	Cross Skokie River.
0.05-	24.7+	CAUTION: STOP LIGHT - Lagoon Drive. CONTINUE AHEAD (west).
0.4+	25.1+	Overpass Interstate 94. CONTINUE AHEAD (west).
0.15+	25.25+	CAUTION: STOP LIGHT - Central Avenue. CONTINUE AHEAD.
0.05-	25.3+	CAUTION: Single C & NW railroad track. CONTINUE AHEAD.
0.05+	25.35+	CAUTION: STOP LIGHT - Old Willow Road. CONTINUE AHEAD (west).
0.05+	25.45	Cross North Branch of Chicago River.
0.35-	25.8-	CAUTION: STOP LIGHT - Wagner Road. CONTINUE AHEAD (west).
0.6-	26.4-	CAUTION: STOP LIGHT - Sunset Ridge Road. CONTINUE AHEAD (west) and ascend the back slope of the Deerfield Moraine.
0.45	26.85-	CAUTION: STOP LIGHT - Waukegan Road. This is the crest of the Deerfield Moraine. CONTINUE AHEAD (west) and descend the frontal slope of the Deerfield Moraine.
0.25+	27.1	Approximate boundary between Deerfield Moraine and Glenwood lake plain sediments.

Miles to next point	Miles from start	
0.1	27.2	CAUTION: PARK on road shoulder. DO NOT walk or stand on Willow Road - fast traffic.
		STOP 7. Discussion of sanitary landfills.
0.0	27.2	CAUTION: leave Stop 7 and reenter Willow Road.
0.2+	27.4+	Cross West Fork North Branch of Chicago River.
0.1+	27.55-	CAUTION: entrance to Lake Landfill on right. Watch for cross traffic and CONTINUE AHEAD (west).
0.1+	27.65	CAUTION: STOP LIGHT - Old Willow Road. CONTINUE AHEAD.
0.2+	27.85	SOO Railroad overpass. Glenview Naval Air Station to left at 10 o'clock.
0.2-	28.05	CAUTION: flashing runway approach lights to left and possibility of large, low-flying aircraft. DO NOT STOP. CONTINUE AHEAD (west) across Park Ridge Groundmoraine.
0.2+	28.25+	C & NW Railroad underpass
0.1+	28.4-	CAUTION: STOP LIGHT - Shermer Road. CONTINUE AHEAD (west) up the gentle back slope of the Park Ridge Moraine. This is a wider moraine than the other lake border moraines in this vicinity.
0.5+	28.9	CAUTION: STOP LIGHT Greenwood Road. CONTINUE AHEAD.
0.5	29.4	CAUTION: STOP LIGHT - Pfingsten Road. TURN RIGHT (north). Note the gentle undulating swell and swale topography for the next couple of miles--it is partly masked by homes.
0.25	29.65	Enter Northbrook. The crest of the Park Ridge Moraine is higher than 685 feet mean sea level (msl) about 0.5 miles to the west.
0.5	29.4	CAUTION: STOP LIGHT - Techny Road. CONTINUE AHEAD (north).
0.35+	30.5+	CAUTION: STOP LIGHT - Koepke Road. CONTINUE AHEAD.


Radio Towers (WEEF)
Pit
Woodridge
Gaging Station
Claypit
Somme Woods
FOREST PRESERVE
Sacred Heart Cem
Water Tank
Green Acres Country Club
N O R T H F I E L D
Crestwood Sch
Shopping Center
Green Briar Sch
Water Tank
NORTHBROOK
Meadowbrook Sch
St Norberts Sch
Jr High Sch
Northbrook Park
St Marys Cem
Water Tank
St Anns Infirmary
St Marys Mission House
Wescott Sch
Glenbrook North High Sch
Maple Sch
Convent of the Holy Spirit
West Fork North Br
Chicago River
NORTH WESTERN
MILWAUKEE
TOLL ROAD
d
c
b
lp
g
lbg
pr
7
0 ½ 1 mi
0 ½ 1 1½ km

Miles to next point	Miles from start	
0.4-	30.9	CAUTION: STOP LIGHT - Walters Avenue. CONTINUE AHEAD (north).
0.25-	31.15-	CAUTION: STOP LIGHT - Cherry Lane. CONTINUE AHEAD (north).
0.5+	31.65	CAUTION: STOP LIGHT - Dundee Road. CONTINUE AHEAD (north) across Park Ridge Groundmoraine.
0.5	32.15	CAUTION: STOP LIGHT - Maria Avenue. To the right the Underwriter's Laboratory, Inc. is situated on the site of an old abandoned clay pit; another example of sequential land use.
0.25+	32.4+	Tollroad feeder overpass.
0.2+	32.65	CAUTION: STOP LIGHT - Lake/Cook Road. TURN RIGHT (east) and cross West Fork North Branch Chicago River.
0.05+	32.7+	To the left, the restaurant-office building complex is located on another abandoned clay pit site.
0.1-	32.8	CAUTION: STOP LIGHT. CONTINUE AHEAD (east).
0.15+	32.95+	CAUTION: SOO Railroad crossing - 2 tracks.
0.15-	33.1+	CAUTION: STOP LIGHT entrance to Lake Cook Shopping Plaza. We are ascending the Deerfield Moraine.
0.15+	33.3	CAUTION: STOP LIGHT - Waukegan Road. CONTINUE AHEAD (east).
0.1	33.4	Crest of the Deerfield Moraine, 680^{+} feet msl.
0.4+	33.8+	Enter Northbrook and descend backslope of Deerfield Moraine.
0.2	34.0+	CAUTION: STOP LIGHT. CONTINUE AHEAD.
0.15	34.15+	Cross North Branch Chicago River. Note gauging station on east side about 100 feet south of our route.
0.05+	34.25-	CAUTION: STOP LIGHT. CONTINUE AHEAD (east) and ascend the Blodgett Moraine.

Miles to next point	Miles from start	
0.15+	34.4	Crest of the Blodgett Moraine, 660^+ feet msl.
0.1	34.5	CAUTION: STOP LIGHT. CONTINUE AHEAD (east).
0.15	34.65	CAUTION: STOP LIGHT - Ridge Road/Lee Road. CONTINUE AHEAD.
0.1+	34.75+	CAUTION: STOP LIGHT. CONTINUE AHEAD.
0.1+	34.9	CAUTION: C & NW Railroad; 2-tracks guarded. CONTINUE AHEAD.
0.1+	35.0+	CAUTION: STOP LIGHT - Skokie Boulevard. CONTINUE AHEAD (east).
0.1-	35.1+	CAUTION: STOP LIGHT - entrance to Edens Expressway (U.S. 41).
0.05+	35.15+	Edens Expressway overpass. Area underlain by Glenwood lake plain sediments.
0.6	35.3+	CAUTION: STOP LIGHT - exit from Edens Expressway CONTINUE AHEAD (east) and cross muck and peat area.
0.1+	35.4+	Cross Skokie River.
0.05-	35.45+	Chicago Botanic Gardens to the right.
0.1	35.55+	Cross area underlain by Glennwood lake plain sediments.
0.3	35.85+	Cross Blodgett Groundmoraine.
0.2	36.05+	Ascend sharp frontal slope of Highland Park Moraine.
0.2	36.25+	CAUTION: STOP LIGHT - Green Bay Road. CONTINUE AHEAD.
0.05+	36.3+	Crest of Highland Park Moraine, 685^+ feet msl.
0.2+	36.5+	CAUTION: C & NW Railroad; 2-tracks guarded. CONTINUE AHEAD (east).
0.2+	36.75+	CAUTION: STOP LIGHT - Sheridan Road. TURN HARD LEFT and enter Lake County. Route to north crosses a number of stone bridges over narrow, deep ravines.



Exmoor Country Club
DEERFIELD
hp
lbg
High Sch
Hospital
Indian Trail Sch
AQUEDUCT
Waterworks
AVENUE
Green Bay Road Sch
Sunset Woods Park
Water Tank
HIGHLAND PARK
DEERFIELD RD
Sunset Valley Golf Club
Immaculate Conception Sch
City Hall
SHERIDAN
LINDEN
FOREST
Lincoln Sch
Briergate
Bob O'Link Golf Club
lbg
lp
b
END
9
8
Edgewood Sch
Northmoor Country Club
Skokie
Ravinia Sch
ROGER WILLIAMS AVE
Ravinia
hp
Sherwood Sch
West Ridge Sch
CLAVEY ROAD
Ravinia Park
Sewage Disposal
lp
g
lp
EDENS
Woodridge
Braeside Sch
HIGHLAND PARK CORP
Gaging Station
b
NORTH WESTERN
lbg
Braeside
Turnbull Woods
Lake Shore Country Club
hp
Glencoe Golf Club
lp
g
b
lp
EXPRESSWAY
Sacred Heart Cem
Water Tank
Green Acres Country Club
FOREST
Chicago
North Sch
0 ½ 1 mi
0 ½ 1 1½ km

Miles to next point	Miles from start	
0.7+	37.45+	STOP: 4-way. TURN RIGHT (north) on Sheridan Road.
0.4-	37.85+	TURN RIGHT (east) on Roger Williams Drive. This is just beyond the sign pointing to the Ravinia Business District.
0.1-	37.95+	Crossing a very deep ravine. CONTINUE AHEAD.
0.1	38.05+	TURN LEFT (north) into the Rosewood Park and Beach Parking area. Park your car and walk west to the bridge over the ravine.
		STOP 8. Discussion of drainage problems in this area.
0.0	38.05+	Leave Stop 8 and retrace route west to Sheridan Road.
0.2	38.25	STOP: 2-way; Sheridan Road. TURN RIGHT (north).
0.1+	38.35+	Descend hill and prepare to turn right.
0.1+	38.45+	TURN RIGHT downhill toward Rosewood Beach.
0.15-	38.6	Lower Rosewood Beach parking area.
		STOP 9. Discussion of the bluff geology and its attendant problems for North Shore communities.

END OF FIELD TRIP

FIELD TRIP STOPS

NOTE: The numbers in parentheses following the topographic map name, (42087A7), is the code assigned to that map as part of the National Mapping Program. The state is divided into 1^0 blocks of latitutde and longitude. The first pair of numbers refers to the latitude of the southeast corner of the block and the next three numbers designates the longitude. The blocks are divided into 64 7.5-minute quadrangles; the letter refers to the east-west row from the bottom and the last digit refers to the north-south row from the right.

STOP 1. Discussion of valley trains deposits along the Des Plaines River at Belleau Lake, Cook County Forest Preserve. [Parking area: N 1/2 NE 1/4 SE 1/4 Sec. 21, T. 41 N., R. 12 E., 3rd P.M., Cook County; Park Ridge 7.5-minute Quadrangle (42087A7)].

We are located about 0.4 miles east of the Des Plaines River, a relatively small stream that originates in Wisconsin and flows southward roughly paralleling the Lake Michigan shoreline. Forty miles south at the State Line, it lies along the west side of the Park Ridge Moraine. In its joruney southward for the next 20 miles, it cuts back and forth across low sags in the Park Ridge and Deerfield Moraines, finally emerging along the west side of the Park Ridge Moraine to flow across the Tinley Groundmoraine about 13 miles north of this location. Except in its lower course, where it occupies a channel through the Tinley Moraine and Valparaiso Morainic System, the Des Plaines River hardly has a valley. That is, it is not flowing in a well-defined, entrenched valley. Its gradient, bed slope, is less than two feet per mile from the State Line to this locality. The straight-line distance from here to the south-southwest, where it joins the Kankakee River to form the Illinois River, is about 50 miles.

Sometime after the Deerfield Moraine formed, large volumes of meltwater laden with vast amounts of outwash material (gravel, sand, and silt) from the waning glacier coursed southward through this area. As the volume of meltwater diminished, the stream was no longer able to transport this heavy load, and left it behind along its course as valley train deposits (see PLEISTOCENE GLACIATIONS IN ILLINOIS in back). The deposits are mostly gravel in the north, becoming finer-grained southward. Where mined, they have been well sorted and well laminated. The valley train deposits are 1/3 to as much as 1.5 miles wide and are 25 to 30 feet thick. The valley train deposits end about 7.5 miles downstream from here near Franklin Park, where the early Des Plaines River debouched into Lake Chicago. This is the only stream in the field trip area that contains valley train deposits and they have been the basis for a viable construction aggregate industry. Belleau Lake was formed when the valley train deposits here were removed for construction purposes.

STOP 2. View of surface of Lake Border Morainic System across from Mary Hill Cemetery. [West edge NW 1/4 NW 1/4 NW 1/4 SW 1/4 Sec. 24, T. 41 N., R. 12 E., 3rd P.M., Cook County; Park Ridge 7.5-minute Quadrangle (42087A7)].

We are standing on the farthest west, the outer, Lake Border Morainic System member, the Park Ridge Moraine. This system occurs east of the Des Plaines

River essentially in the northern part of the Metropolitan area. Five moraines are recognized in this system: from west to east (oldest to youngest) they are the Park Ridge, Deerfield, Blodgett, Highland Park, and Zion City. Except for the detached segment of the Park Ridge Moraine that forms Blue Island in the south suburban area, these moraines die out at the lake plain, which we will see shortly. Continuations of these moraines, however, are found in Indiana and Michigan so that the system forms a loop around the margin of Lake Michigan. Sags between the moraines are distinct in the field trip area, but to the north a short distance the separate moraines are not as easily separated and recognized. Total maximum width of the Lake Border Moraines in Illinois is about 7.5 miles.

The Park Ridge Moraine is the oldest and widest of the Lake Border Moraines, being nearly two miles wide at a maximum. It extends the farthest south into the lake plain, nearly 9.5 miles south from here, terminating in Elmwood Park. For the most part, this moraine has a more subdued surface relief and more gentle slopes than other moraines in the Chicago region. Kames, eskers, and small lakes are not common across its surface. The gently undulating surface is perhaps less disturbed and more open to view across Mary Hill Cemetery than elsewhere nearby. Later at other localities on the field trip, you will have the opportunity to see small areas of the moraine that are relatively undisturbed. The large amount of construction in the region will obscure and obliterate these small areas before long.

The moraine is made of a gray, clayey till that has a relatively low content of pebbles, cobbles, and boulders. This is the material into which the foundations and basements are being dug in this area. This till belongs to the Wadsworth Member of the Wedron Formation.

STOP 3. Discussion of Lake Chicago and some of its physical features. [SW cor SE 1/4 SE 1/4 SW 1/4 SW 1/4 Sec. 19, T. 41 N., R. 13 E., 3rd P.M., Cook County; Park Ridge 7.5-minute Quadrangle (42087A7)].

Lake Michigan, as we know it, developed about 2500 years BP (before present). Prior to that time, the Lake Michigan basin was occupied by a series of lakes of different sizes and levels formed during and after late Wisconsinan deglaciation from about 15,000 to 11,000 years BP. The record of these lakes is found in the deposits and elevations of abandoned shoreline features (wave-cut cliffs, beaches, spits, deltas) and abandoned outlets. We will see some of these features on this field trip. Adjustments in the Earth's crust have influenced the various lakes and associated features. We know that the crust was depressed by the great weight of the overlying massive continental glaciers; it is still slowly rebounding in some areas of the world from Pleistocene events. The southern Lake Michigan basin, however, appears to have been affected least by this crustal depression. The chronology of events in the Lake Michigan basin is shown in figure 7.

Hansel and others (1985) noted that glacial and postglacial lake levels changed because of several mechanisms: (1) advance and retreat of ice margins that blocked or uncovered outlets, (2) downcutting of outlets, (3) major increases and decreases in the volume of water entering the lakes, and (4) differential isostatic changes in the altitudes of parts of the basin or outlets. Generally, these mechanisms worked in combination to control events.

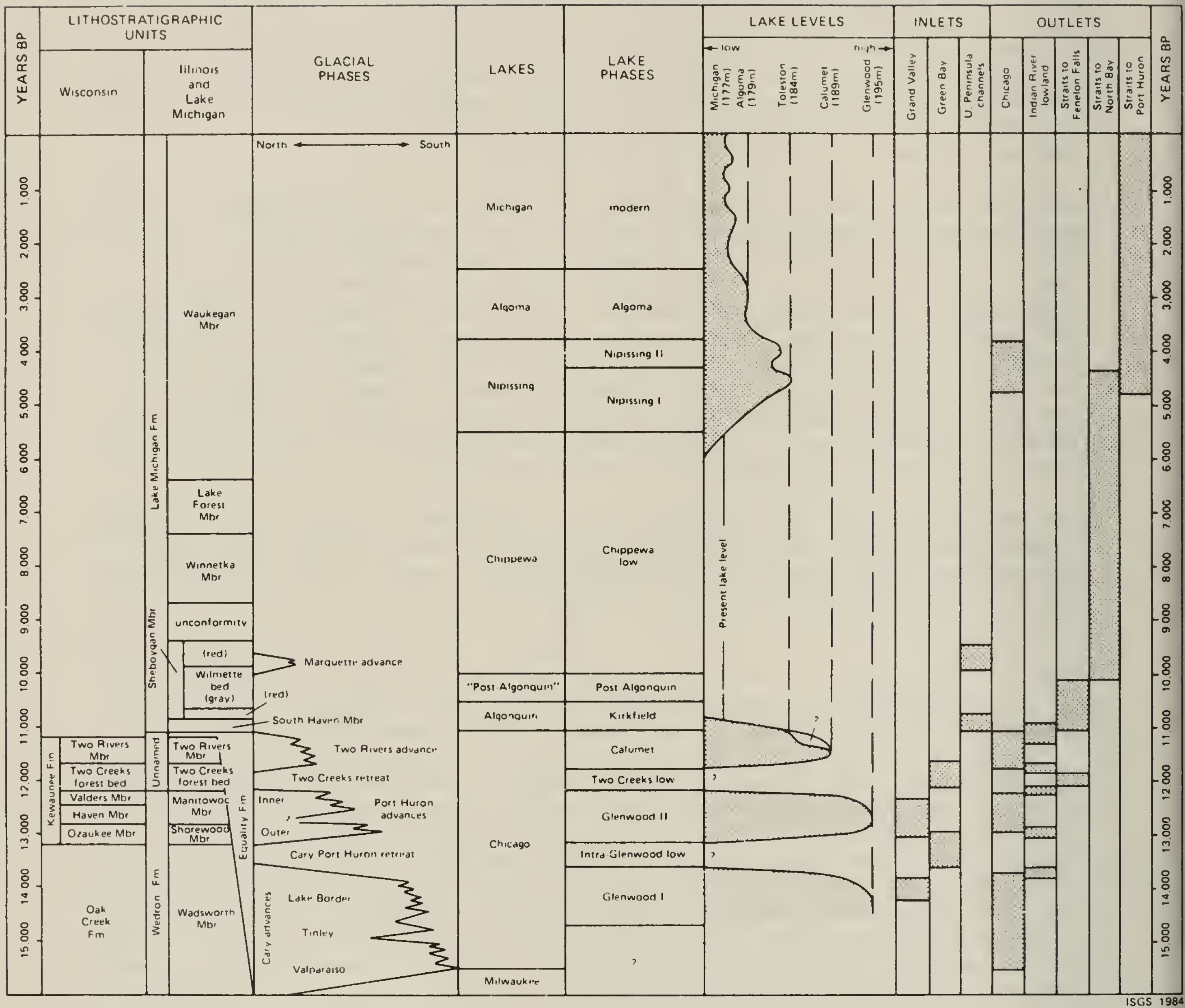


Figure 7. Chronology in the Lake Michigan basin. Shaded area indicates times inlets and outlets were used. Radiocarbon ages are estimates (from Hansel et al., 1985).

Minor readvances of the glacier occurred between about 15,500 and 13,500 years BP to form the Valparaiso, Tinley, and Lake Border Moraines. Following the formation of at least the Valparaiso and the attendant ice-front melt-back, some earlier workers felt that there may have been earlier, higher lake levels in the southern part of the Lake Michigan basin. If this were the case, however, much of the evidence for these events appears to have been obscured or destroyed by the Tinley readvance.

During the formation of the Lake Border Moraines and as the ice margin melted northward, 14,000 to 13,600 years BP, Lake Chicago formed behind the Tinley and older moraines. Drainage for Lake Chicago was to the southwest, through a pair of spillway channels, the Des Plaines and Sag Channels (fig. 8). The early high levels of this lake occurred during the Glenwood I phase between 14,000 and 13,600 years BP when the lake stood at about 640 feet msl (fig. 9). Following this initial high stand of Lake Chicago, the ice margin melted northward to about the position of the Straits of Mackinac and drainage of the lake shifted to the east. The lake was lowered considerably below present Lake Michigan (580 feet, approximate msl) from 13,300 to 13,000 BP. With a southward readvance of the glacier, the outlet to the east was blocked and Lake Chicago rose to about 640 feet msl again, during the Glenwood II phase (12,900 to 12,700 years BP).

We are standing on the Glenwood shoreline that here was impinging on the backslope of the Park Ridge Moraine. To the east the surface slopes down to the flat Glenwood lake bottom. We will follow part of this shoreline to the north then turn east across the lake plain to another feature of the Glenwood lake level, the Wilmette Spit.

STOP 4. Examination of the Parkland Sand and discussion of the Wilmette Spit. [Parking area: NE 1/4 SE 1/4 NE 1/4 SE 1/4 Sec. 32, T. 42 N., R. 13 E., 3rd P.M., Cook County; Evanston 7.5-minute Quadrangle (42087A6)].

The area north-northeast from Morton Grove to Winnetka has the best developed Glenwood lake level features in the Chicago region. Bretz (1955) noted that the Glenwood shoreline shows nearly 30 miles each of sea cliffs and beaches in this area, nineteen miles of which are spits that formed offshore. Wave erosion at this time appears to have been more intense than any time since. The Glenwood sea cliff intersects the Lake Michigan wave-cut cliff along the east side of the Highland Park Moraine about three miles to the north. The Glenwood sea cliff extends south through Winnetka for about 1.5 miles, its southern tip located at the Indian Hills Golf Club, about 1.5 miles to the north-northeast. During the Glenwood phases, the Highland Park Moraine extended considerably farther east than now (fig. 10). Waves cut into the moraine to form a cliff and currents swept the debris southward along the cliff to build a large rounded sand and gravel deposit for about six miles off the moraine's southern tip. The east side of the spit is a smooth arc sweeping to the southwest, but the western side is digitate with nine westerly extending "fingers" which are successively from north to south on the Glenwood lake bottom.

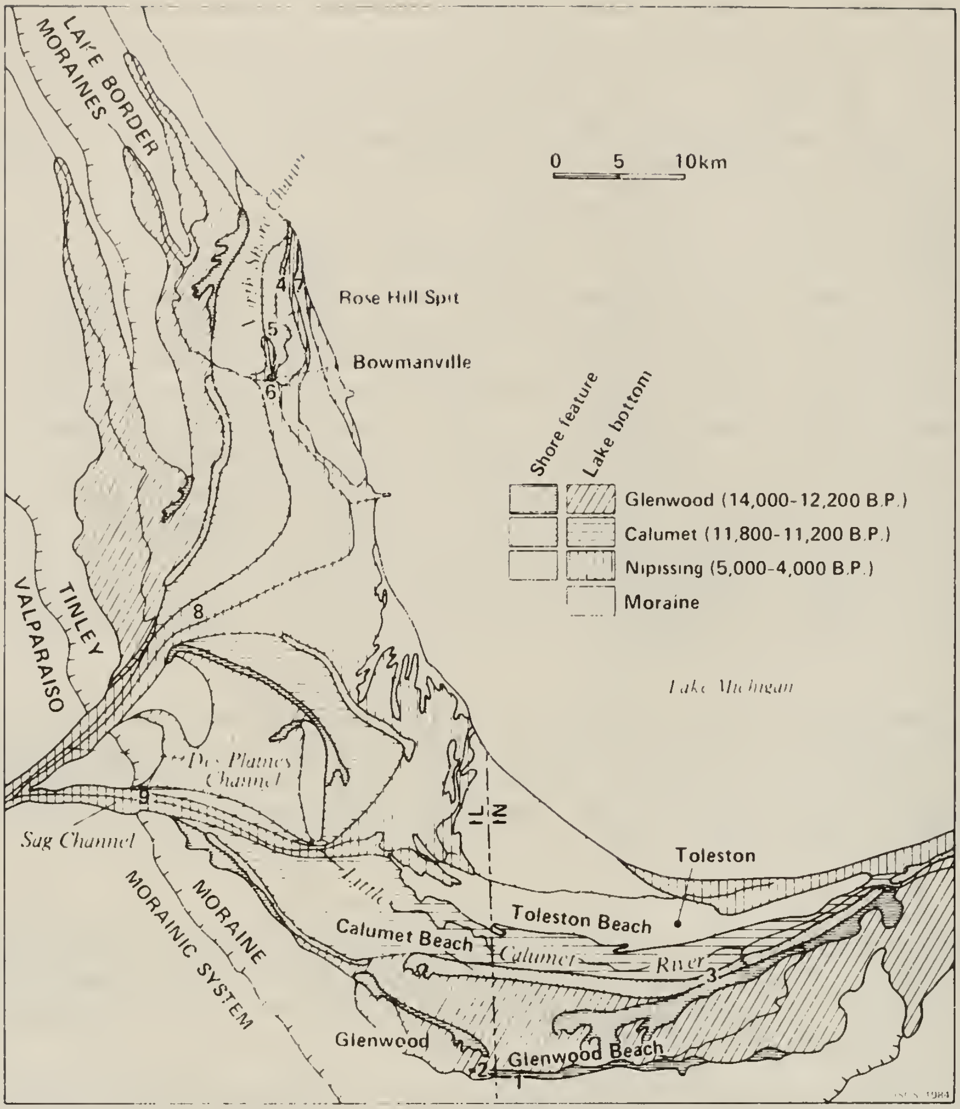


Figure 8. Map of reference area (type area) for Lake Chicago and Glenwood, Calumet, and Toleston beaches. Modified from Alden (1902), Schneider and Keller (1970), and Willman (1971). Numbers refer to locations of radiocarbon dates listed in Table 1. (from Hansel et al., 1985)

For the last 3.5 miles you have been travelling across the western slopes or the crest of the Wilmette Spit or across small segments of lake bottom during Glenwood time. Wind-blown sand mantles this hilltop, but it is well stabilized by the sod cover. The sand was derived from nearby beach deposits. The sand is exposed in garden plots along the north side of the swimming pool. You will note that it is well sorted, that is, the sand grains are all fairly unifomly medium-grained in size. The sand appears to contain a considerable amount of organic material here, which gives it a gray color. This is known as the Parkland Sand, a wind-blown deposit, that is Wisconsinan to Holocene in age.

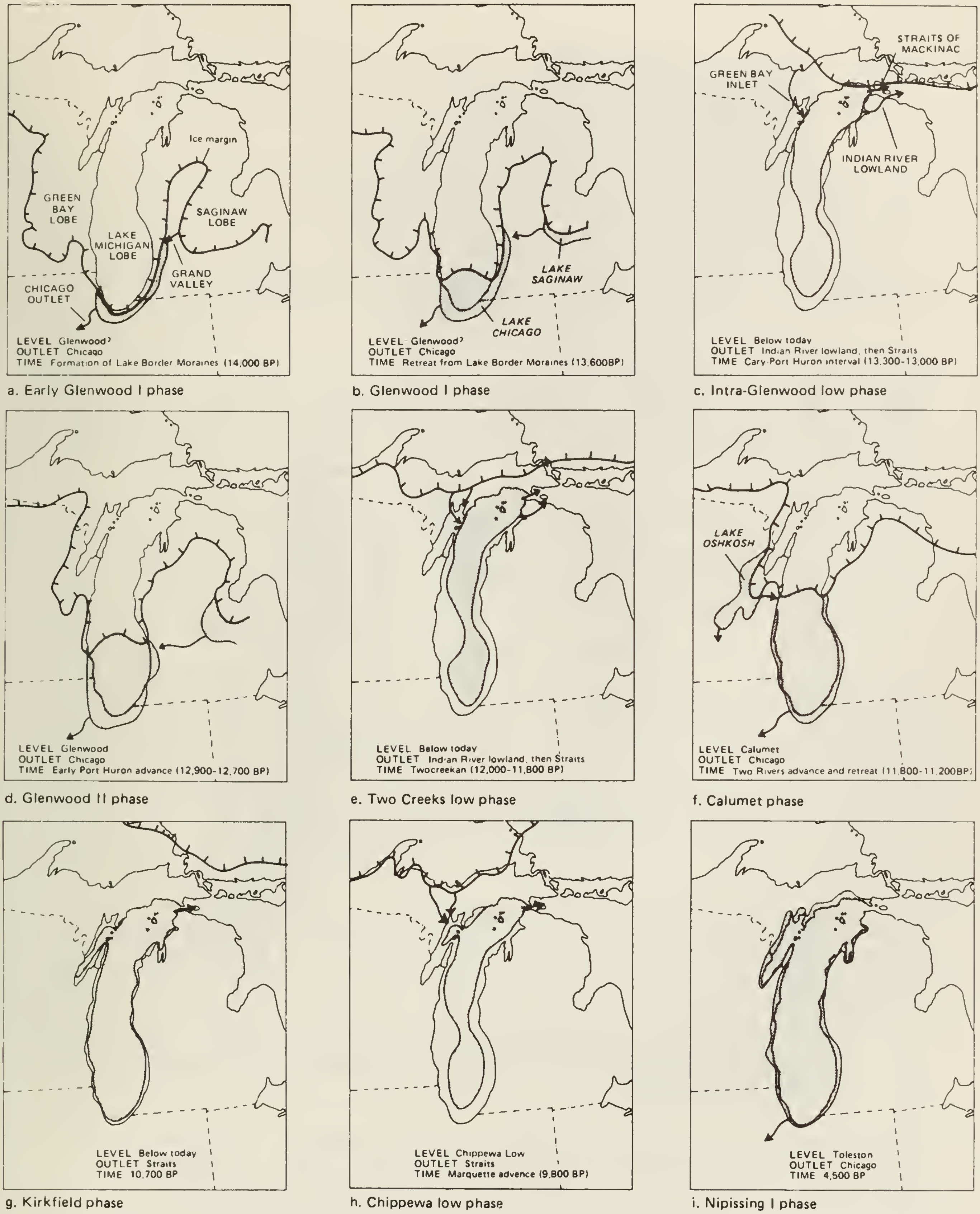


Figure 9. Late Wisconsinan and Holocene lake phases in the Lake Michigan basin. Radiocarbon ages are estimates. a) Early Glenwood I phase b) Glenwood I phase c) Intra-Glenwood low phase d) Glenwood II phase e) Two Creeks low phase f) Calumet phase g) Kirkfield phase h) Chippewa low phase i) Nipissing I phase (from Hansel et al., 1985)

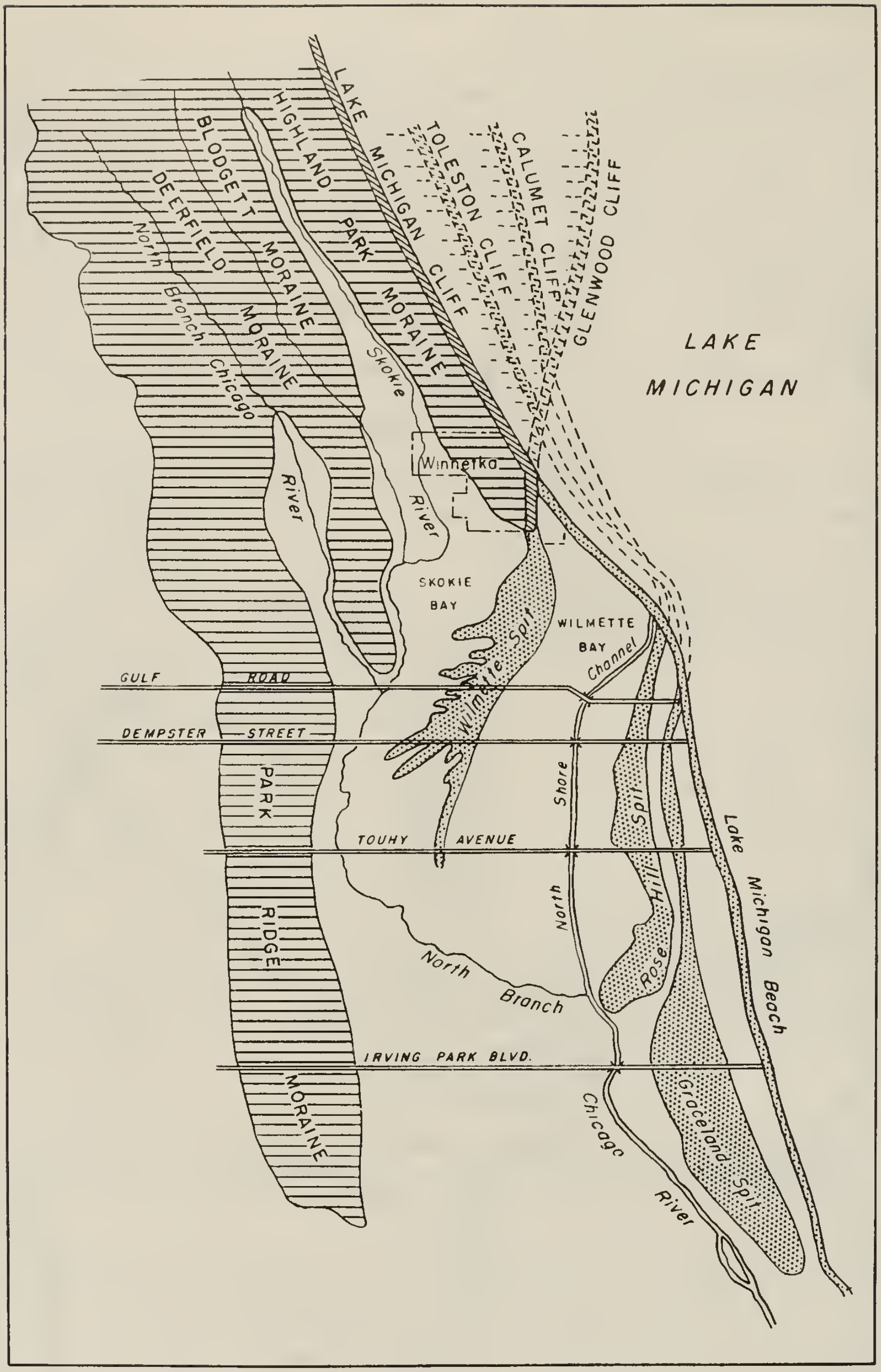


Figure 10. Reconstruction of the vanished sea cliffs and spit connections of the North Shore district (from Bretz, 1955).

STOP 5. Lunch and additional discussion of Lake Chicago and Lake Michigan features. [Parking area in Gillson Park: S 1/2 SE 1/4 SE 1/4 SW 1/4 Sec. 26, and NE 1/4 NW 1/4 Sec. 35, T. 42 N., R. 13 E., 3rd P.M., Cook County; Evanston 7.5-minute Quadrangle (42087A6)].

For about the last 3.3 miles you have traversed an area that was a lake bottom during the Glenwood phases (640 foot level) and then again later during the Calumet phases (620 foot level) (fig. 8). The very flat Chicago Lake Plain according to Willman (1971) is about 45 miles long and about 15 miles wide at a maximum. It covers approximately 450 square miles, 90 percent or more of which is covered by built-up areas of Chicago and its suburbs. The plain is nearly uneroded by modern streams which flow almost on its surface in very shallow channels.

Bretz (1955) and Hansel, et al (1985) note that the Calumet shoreline does not show obvious cut terraces in the type area, which suggests that the Calumet Phase at the close of Lake Chicago time was relatively short-lived (11,800 to 11,200 years BP). The surface elevation of Rose Hill Spit (615 to 620 feet msl) indicates that it was formed when Lake Chicago was at the Calumet level.

The lake-side of the Rose Hill Spit is fairly steep down to about 600 feet in elevation, the level of the Toleston shoreline. This latter feature earlier was thought to represent a stage of Lake Chicago. Radiocarbon dates determined during the past several years show that the Toleston shoreline is Holocene in age, formed when Lake Nipissing filled the Lake Michigan basin from about 5000 to 4000 years BP.

The Lake Michigan level was reached about 2500 years BP. Although the approximate average lake level is 580 feet msl, the level has fluctuated over the years. This has become reinforced the last few years when lake levels rose dramatically in response to climatic conditions affecting the upper Great Lakes watershed. There is some evidence that indicates that perhaps throughout most of historical time, the lake has been at low levels, and is now rising to higher, more normal levels. The increase in lake levels has resulted in much damage to property along the shoreline as well as considerable concern to those who live close to it.

Gillson Park covers about 30 acres nearly half of which are man-made. Much of the area east of the driveway near the Wilmette Coast Guard Station is made land. Sheet piling and concrete at the shoreline have given some protection here. However, the high lake levels and storms have done considerable damage to the shore protection devices here. The concrete pier has been damaged too. Make good mental notes of the shoreline here and what has been done to protect it. Later on you will have the opportunity to examine a much different type of shoreline, a sea cliff several miles to the north.

STOP 6. Discussion of Skokie River and Skokie Lagoons, peat and muck deposits. [West side of Forest Way: SE 1/4 NW 1/4 SW 1/4 NE 1/4 Sec. 19, T. 42 N., R. 13 E., 3rd P.M., Cook County; Park Ridge 7.5-minute Quadrangle (42087A7)].

Skokie River occupies the sag between the Blodgett and Highland Park Moraines. This is the lowest sag between the Lake Border Moraines and, as a result, it contained the longest bay of Lake Chicago. The present-day stream traverses only four miles of groundmoraine with a gradient of about 4.5 feet per mile before it reaches and flows across the lake plain where the gradient is a little more than two feet per mile. Earlier maps of this area indicated a three mile long marsh into which the river flowed at the north end and from which it drained at the south end. Extensive alterations are apparent on new maps which show where lagoons and artificial hills have been constructed to produce a recreational area.

The material underlying and filling this marsh is the Grayslake Peat. Although it is dominantly peat, it includes organic silts (muck) and contains some interbedded silts and sands from local slopewash. It generally is less than 20 feet thick. Peat is produced in three Illinois counties: Cook, Lake, and Whiteside. It is used primarily as a soil conditioner to increase the organic content of the soil and increase its ability to retain moisture.

STOP 7. View of Lake Landfill and discussion of landfills. [Near center S edge: SE 1/4 NW 1/4 NW 1/4 Sec. 23, T. 42 N., R. 12 E., 3rd P.M., Cook County; Park Ridge 7.5-minute Quadrangle (42087A7)].

The large mound just ahead on the north side of Willow Road is the Lake Landfill which received its operating permit in January, 1970. This operation is located on former farm land on the lake plain along the west side of West Fork North Branch Chicago River which drains the narrow sag between the Park Ridge and Deerfield Moraines.

The first load of refuse arrived on April 1, 1970. This trench-method landfill rises about 80 feet above Willow Road at present with nearly 110 feet of refuse in the center of the structure. Refuse is compacted in trenches daily and covered with clayey glacial till before being compacted further.

There are 80 vertical wells on the mound and currently they are flaring the methane gas generated from the decomposition of the refuse materials. The operators plan to connect the wells through a network of 18,000 feet of pipe to a compressor/generator plant located along the north side of Willow Road. Two compressors will compress the collected gas so that it can be used as fuel for the two turbines that will generate electrical power.

The landfill has 187 acres permitted to date, but it appears unlikely that additional acreage will become available to them. The result is that this operation has a life expectancy of only 12 to 18 months. This poses some rather alarming questions. What will the nearby communities do for disposal of their refuse? Will they be able to extend the life of this operation by providing additional land? Will they have to find a new site nearby? Will they be able to find an adequate, environmentally safe site elsewhere? Will they be able to answer some of these questions before this operation has to close?

The Geological Survey has been committed for more than 25 years to mapping complex geologic and resource information data and presenting it in useful form so that planners at all levels can make wise land-use decisions. With detailed geologic information at hand, local officials, citizens, and industries can avoid improper land uses that could cost millions of dollars to correct or alleviate at a later time.

STOP 8. Discussion of drainage patterns and problems in this part of the North Shore area. [Parking area: NW 1/4 NW 1/4 NW 1/4 Sec. 31, T. 43 N., R. 13 E., 3rd P.M., Lake County; Highland Park 7.5-minute Quadrangle (42087B7)].

The frontal slope of the Highland Park Moraine in this area rises 25 to 40 feet above the sag separating it from the Blodgett Moraine to the west. In several places the crest of the Highland Park Moraine is 50 to 60 feet above the Skokie Valley to the west and more than 100 feet above Lake Michigan to the east.

As noted earlier, a sea cliff faces the lake north of Kenilworth. This cliff has been retreating westward by wave action ever since the early stages of Lake Chicago more than 16,000 years BP.

The longest and most numerous ravines in the Chicago area are in the North Shore area. However, because the area is so built up, fenced, and posted against trespass, it is difficult to see much of the topography here. All of the ravines occur on the east slope of the Highland Park Moraine, where the crest is parallel to the lake shore. The ravines are a consequence of the wave-cut lake bluff. Here are the steepest slopes in the Chicago area, therefore, the steepest stream gradients are also here for rapid run-off. The greatest changes by stream erosion will also occur in this area. Streams form a dendritic or tree-like pattern with their branching tributaries. The steep slopes, small valley floors, and moderate-sized undissected upland tracts suggest that the area is in a youthful stage of landscape development. As the ravines increase in number and lengthen headward, the eastern slope of the moraine will become much more dissected and remnants of original slopes will be reduced. On the Highland Park Quadrangle more than 18 ravines empty along the lake shore, a number of them have several tributaries. Only one of these ravines is more than a mile long. The crest of the moraine here is 650 to 680 feet msl. Gradients of 100 feet to the mile are common. Remember the low gradients of the streams west of the Highland Park Moraine? The small volume, temporary, wet-weather streams debouching on the lake shore have been able to incise steep-sided ravines 50 to 60 feet deep. This particular ravine is slightly more than a mile in length and its gradient is approximately 100 feet per mile.

STOP 9. Discussion of bluff geology and some of the attendant problems for North Shore communities. [Parking area: SE 1/4 SE 1/4 SE 1/4 Sec. 25, T. 43 N., R. 12 E., 3rd P.M., Lake County; Highland Park 7.5-minute Quadrangle (42087B7)].

The top 1.5 inches or so of the macadam along the south side of the parking area appears to have been ripped loose by torrential flood water coursing down the short, narrow ravines here as a result of the devastatingly heavy rainfall that swept the Chicago area during August, 1987.

The bluffs to the north and south of the parking area are developed in wave-cut, over-steepened glacial till. The only place where the till appears to be well exposed is a short distance south of the public bathhouse, but the exposure is on private property. The till is exposed just above the rip-rap armor that has been placed on the toe of the slope to protect it from direct wave action. Note that the coarsest material is placed at the base of the bluff and extends lakeward across the narrow beach developed here.

Factors encouraging erosion along the bluff here include: (1) narrow protective beach which only partially protects the bluff from wave action, (2) materials that will quickly slump when the slope is oversteepened, (3) the removal of protective vegetative cover from some areas by earlier erosion, and (4) the presence of groundwater seeps that keep the material wet and prone to slump.

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PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

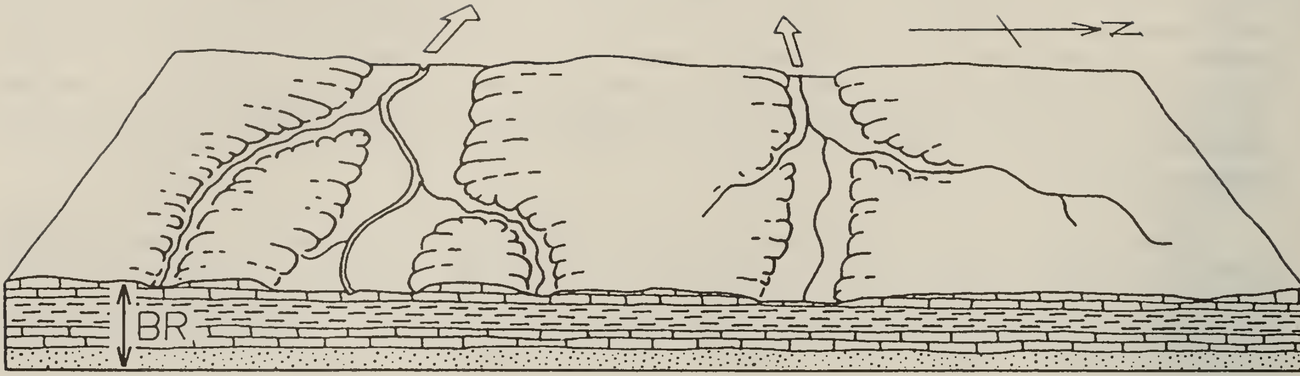
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as "key beds," or stratigraphic markers, and are evidence of the passage of a long interval of time.

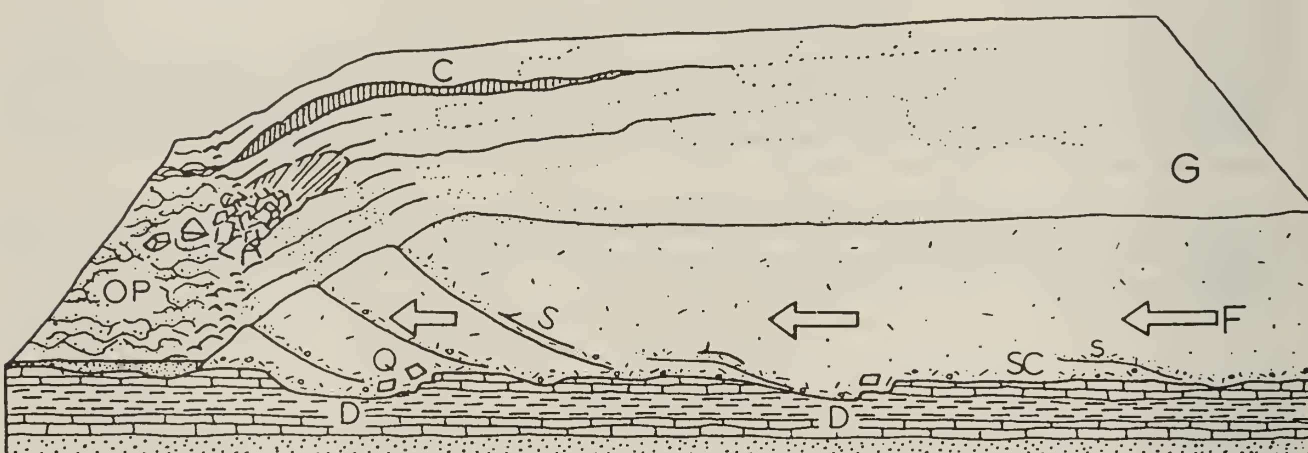
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

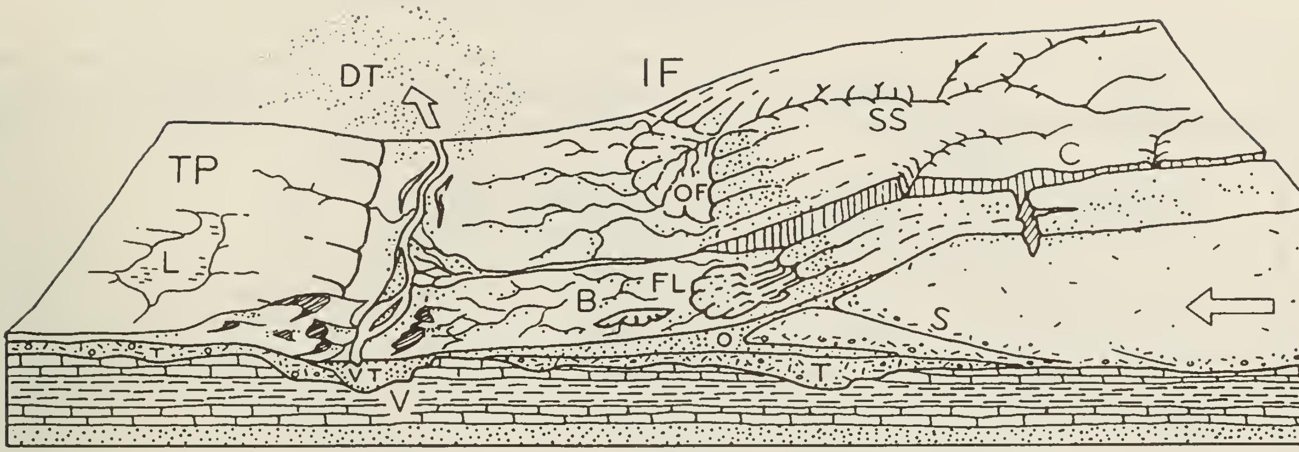
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



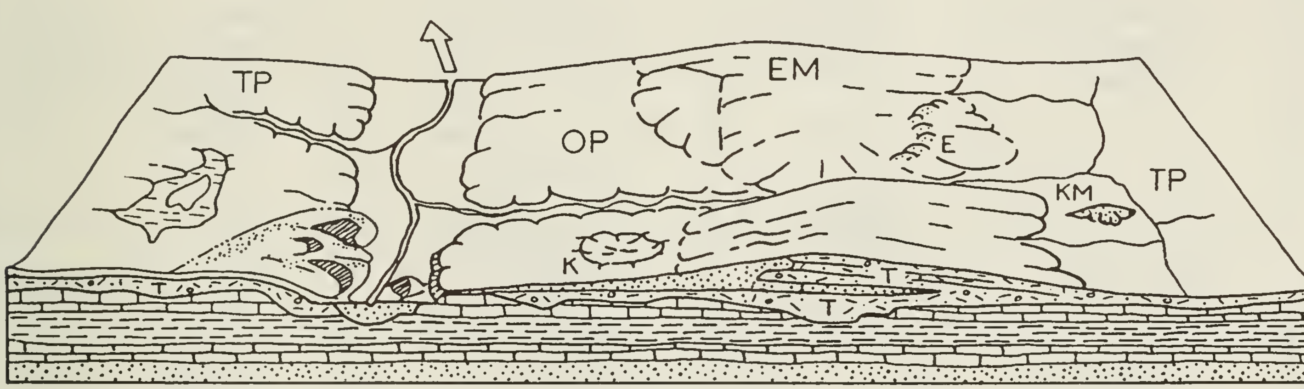
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.



3. **The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.



4. **The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

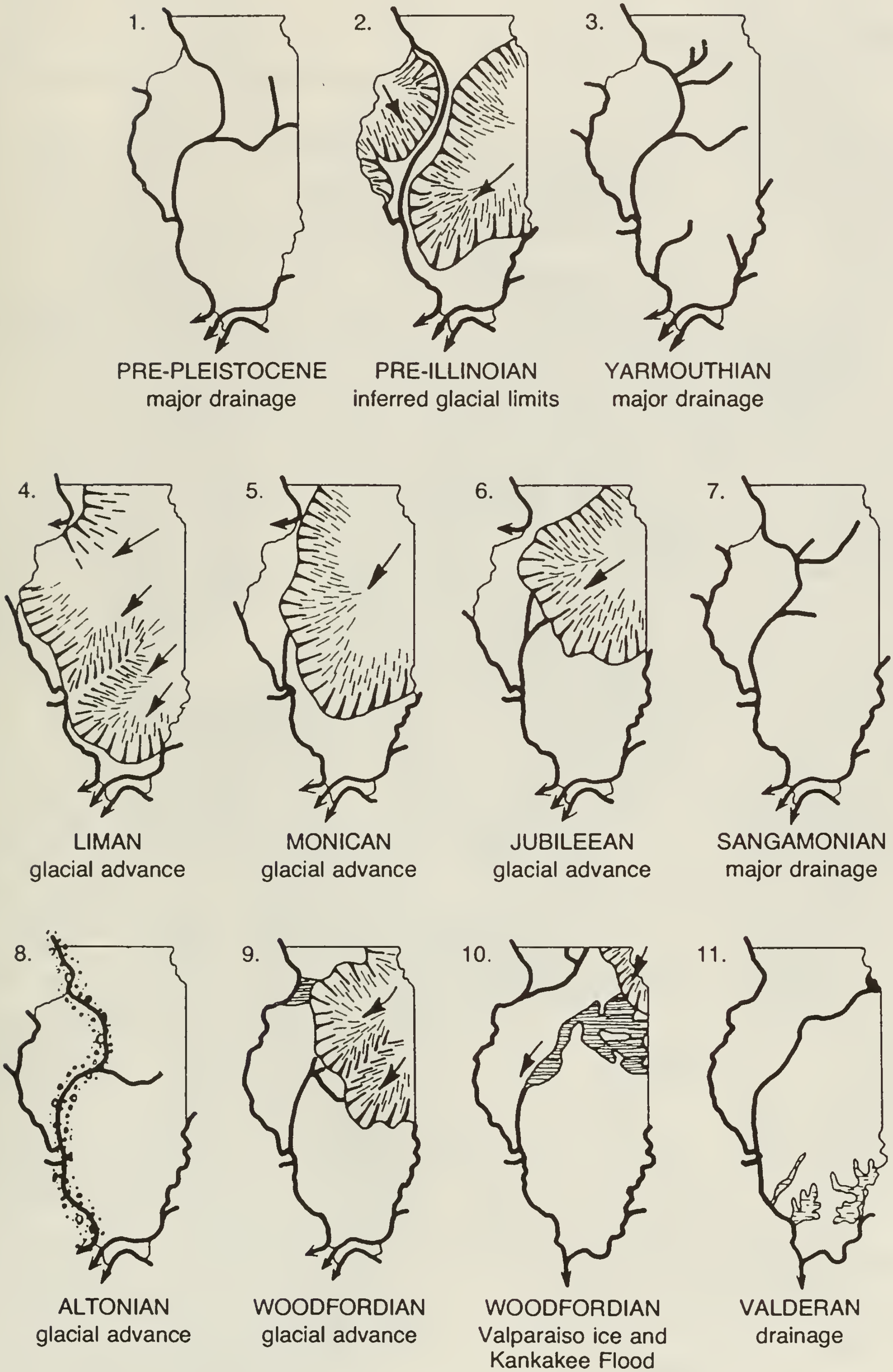
TIME TABLE OF PLEISTOCENE GLACIATION

			STAGE		SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
QUATERNARY			HOLOCENE (interglacial)		Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
					10,000		
	Pleistocene		WISCONSINAN (glacial)	late	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
					11,000		
					Twocreekan	Peat and alluvium	Ice withdrawal, erosion
					12,500		
					Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
					25,000		
				mid	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
					28,000		
				early	Altonian	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers
					75,000		
			SANGAMONIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
					125,000		
			ILLINOIAN (glacial)		Jubileean	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
					Monican	Drift, loess, outwash	
					Liman	Drift, loess, outwash	
					300,000?		
			YARMOUTHIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
					500,000?		
		Pre-Illinoian	KANSAN* (glacial)			Drift, loess	Glaciers from northeast and northwest covered much of state
					700,000?		
			AFTONIAN* (interglacial)			Soil, mature profile of weathering	(hypothetical)
					900,000?		
			NEBRASKAN* (glacial)			Drift (little known)	Glaciers from northwest invaded western Illinois
					1,600,000 or more		

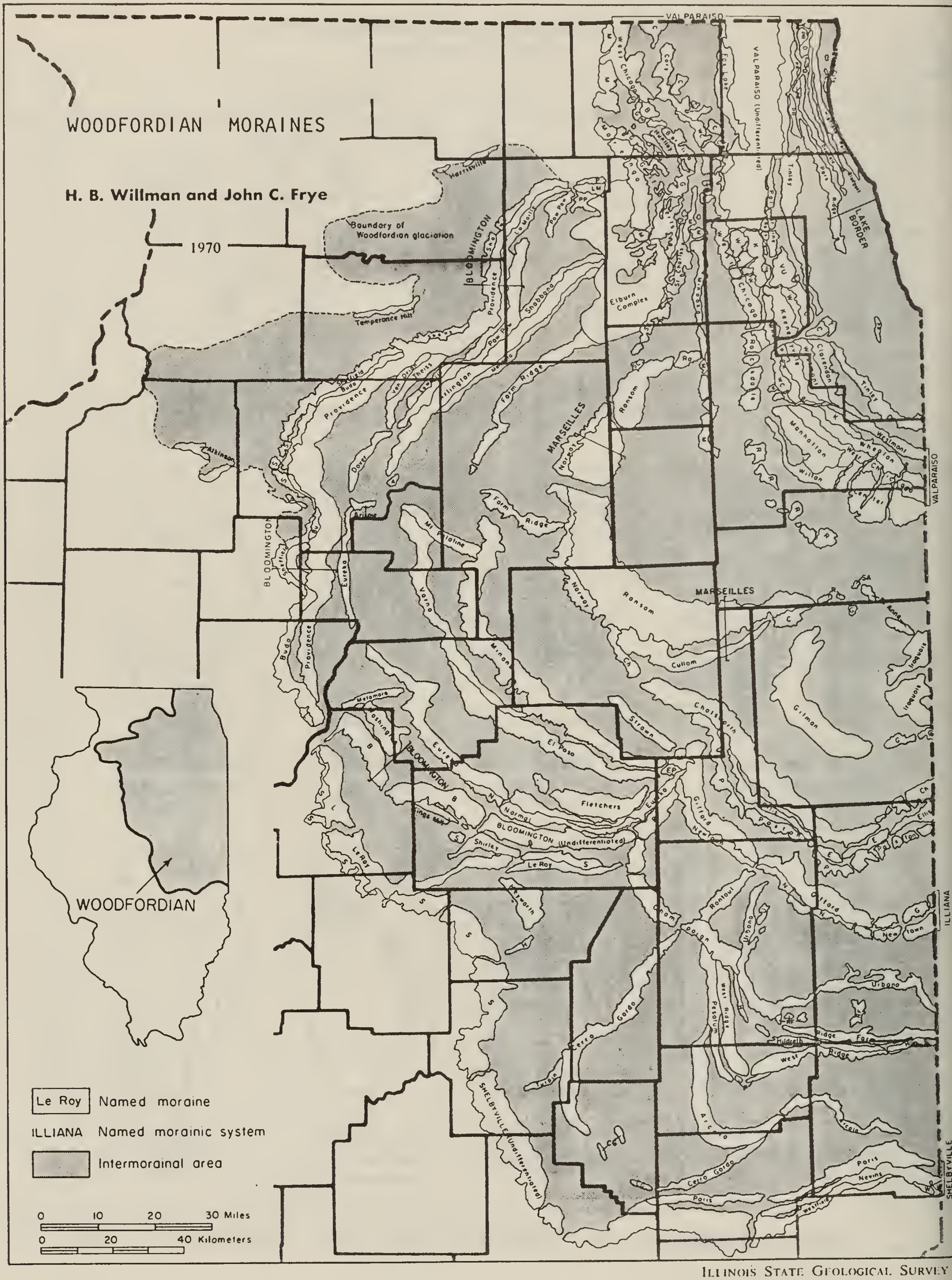
*Old oversimplified concepts, now known to represent a series of glacial cycles.

(Illinois State Geological Survey, 1973

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(Modified from Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)



WOODFORDIAN MORAINES
H. B. Willman and John C. Frye
1970
Boundary of Woodfordian glaciation
WOODFORDIAN
Le Roy Named moraine
ILLIANA Named morainic system
Intermorainal area
0 10 20 30 Miles
0 20 40 Kilometers
VALPARAISO
VALPARAISO (Undifferentiated)
LAKE BORDER
BLOOMINGTON
MARSEILLES
ILLIANA
SHELBYVILLE
SHELBYVILLE (Undifferentiated)
BLOOMINGTON (Undifferentiated)
Elburn Complex
Temperance Hill
Harrisville
Providence
Shabbona
Farm Ridge
Ransom
Norway
Mt Palatine
Varna
Eureka
Buda
Minonk
Cullom
Chatsworth
Strawn
El Paso
Fletchers
Normal
Shirley
Le Roy
Gilman
Iroquois
Gifford
Rantoul
Urbana
West Ridge
Pesotum
Cerro Gordo
Arcola
Paris
Nevins
Westfield
Manhattan
Wilton
Westmont
Wheaton
Tinley
Clarendon
Newtown
Atkinson
Dover
Metamora
Hildreth

ILLINOIS STATE GEOLOGICAL SURVEY

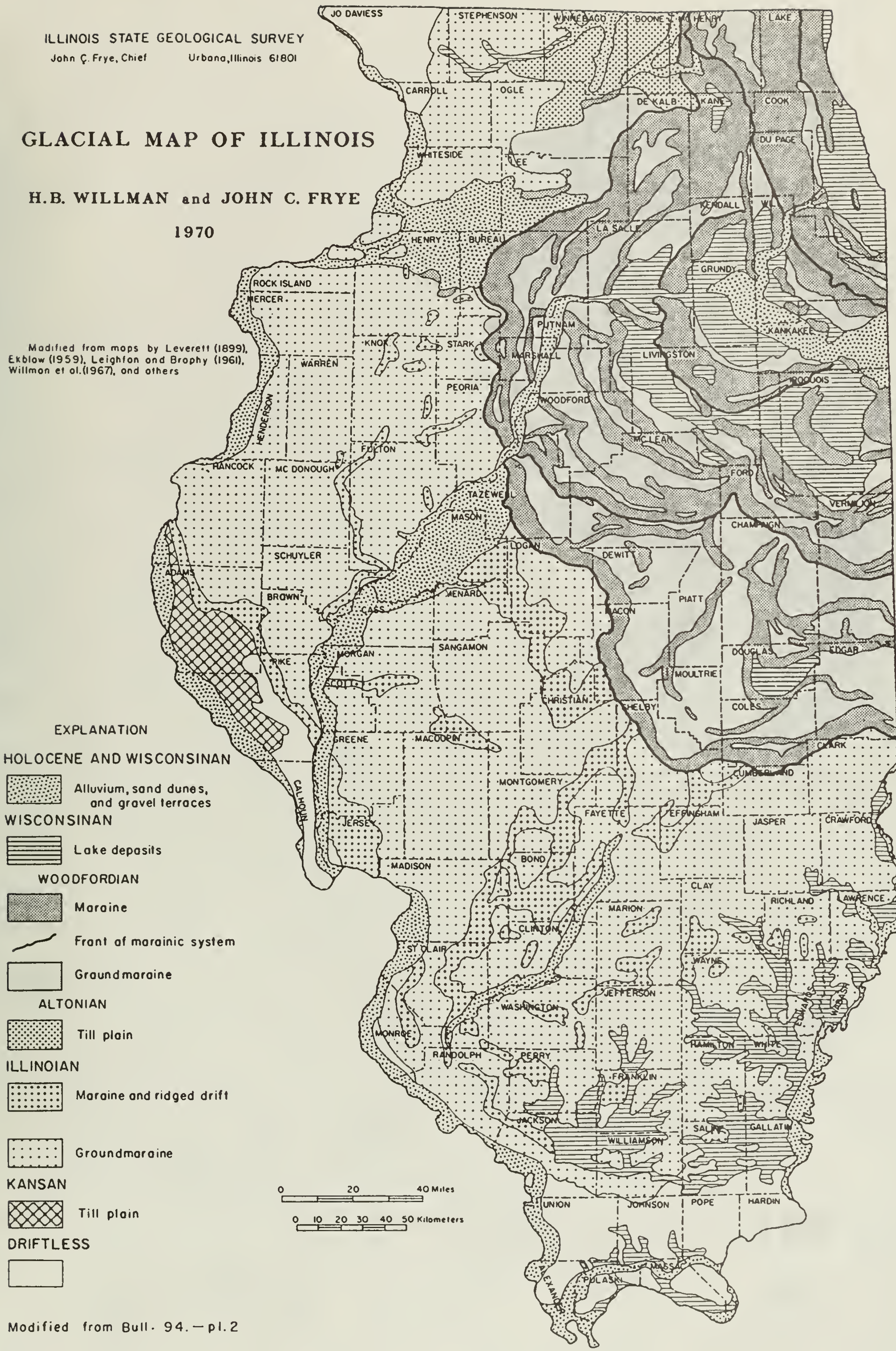
John C. Frye, Chief   Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblaw (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



Modified from Bull. 94.—pl. 2

QUATERNARY DEPOSITS OF ILLINOIS

Jerry A. Lineback

1981

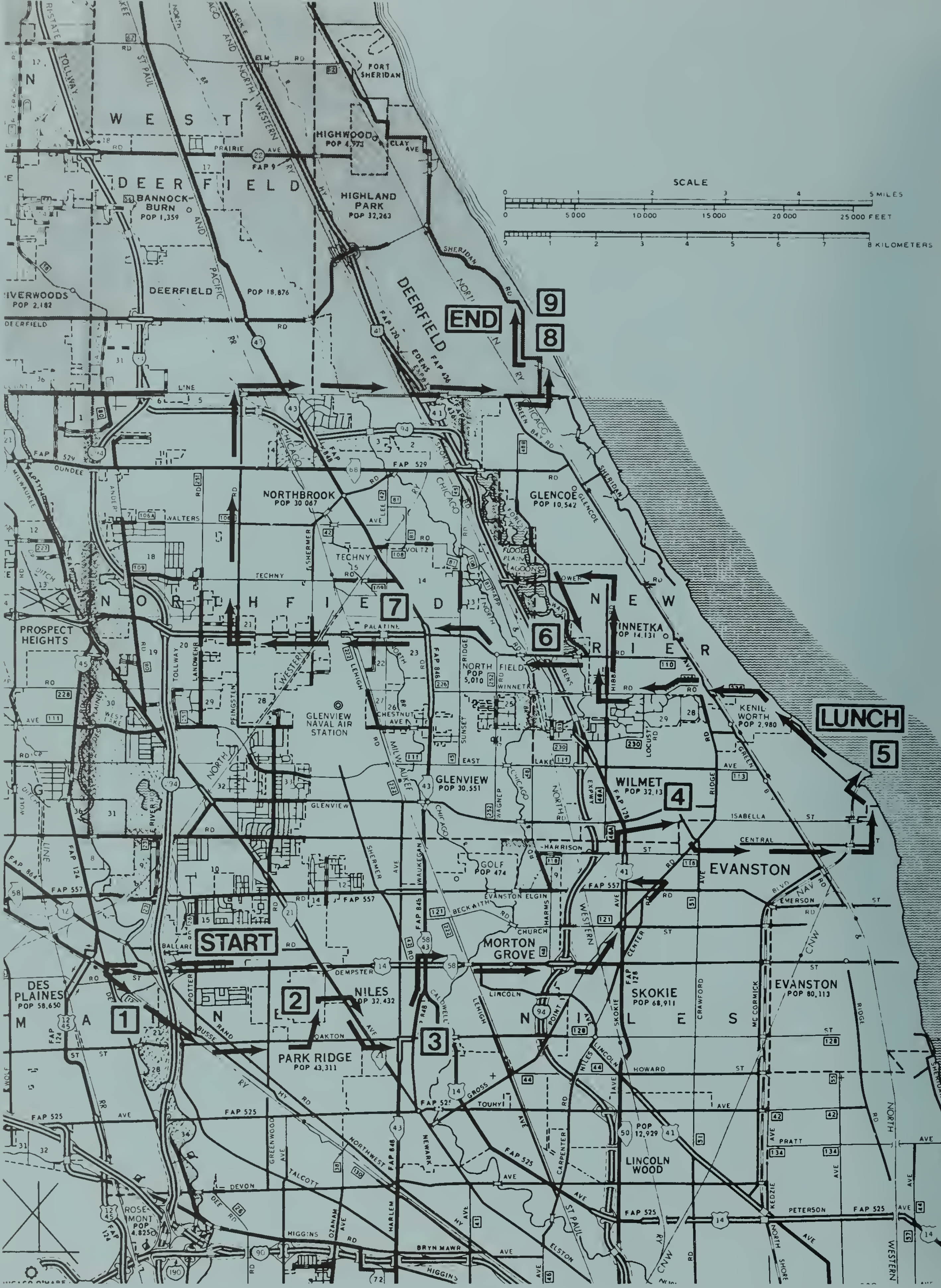
Modified from Quaternary Deposits of Illinois (1979) by Jerry A. Lineback

0 40 mi

0 50 km

AGE	UNIT
Holocene and Wisconsinan	Cahokia Alluvium, Parkland Sand, and Henry Formation combined; alluvium, windblown sand, and sand and gravel outwash.
Wisconsinan	Peoria Loess and Roxana Silt combined; windblown silt more than 6 meters (20 ft) thick.
	Equality Formation; silt, clay, and sand in glacial and slack-water lakes.
	Moraine / Ground moraine — Wedron and Trafalgar Formations combined; glacial till with some sand, gravel, and silt.
Wisconsinan and Illinoian	Winnebago and Glasford Formations combined; glacial till with some sand, gravel, and silt; age assignments of some units is uncertain.
Illinoian	Glasford Formation; glacial till with some sand, gravel, and silt.
	Teneriffe Silt, Pearl Formation, and Hagarstown Member of the Glasford Formation combined; lake silt and clay, outwash sand, gravel, and silt.
Pre-Illinoian	Wolf Creek Formation; glacial till with gravel, sand, and silt.
	Bedrock.

ISGS 1981


SCALE
5 MILES
25 000 FEET
8 KILOMETERS
START
1
2
3
4
LUNCH
5
6
7
8
9
END
PORT SHERIDAN
HIGHWOOD POP 4,973
HIGHLAND PARK POP 32,263
BANNOCKBURN POP 1,359
DEERFIELD POP 18,876
RIVERWOODS POP 2,182
NORTHBROOK POP 30,067
GLENCOE POP 10,542
WINNETKA POP 14,131
KENILWORTH POP 2,980
NORTHFIELD POP 5,010
GLENVIEW POP 30,551
GLENVIEW NAVAL AIR STATION
WILMETTE POP 32,134
PROSPECT HEIGHTS
GOLF POP 474
EVANSTON
MORTON GROVE
DES PLAINES POP 58,650
NILES POP 32,432
PARK RIDGE POP 43,311
SKOKIE POP 68,911
EVANSTON POP 80,113
LINCOLN WOOD POP 12,929
ROSEMONT POP 4,825
W E S T
D E E R F I E L D
N O R T H F I E L D
N E W T R I E R
M A I N E
N I L E S
TRI-STATE TOLLWAY
EDENS EXPWY
FLOOD PLAIN LAGOONS