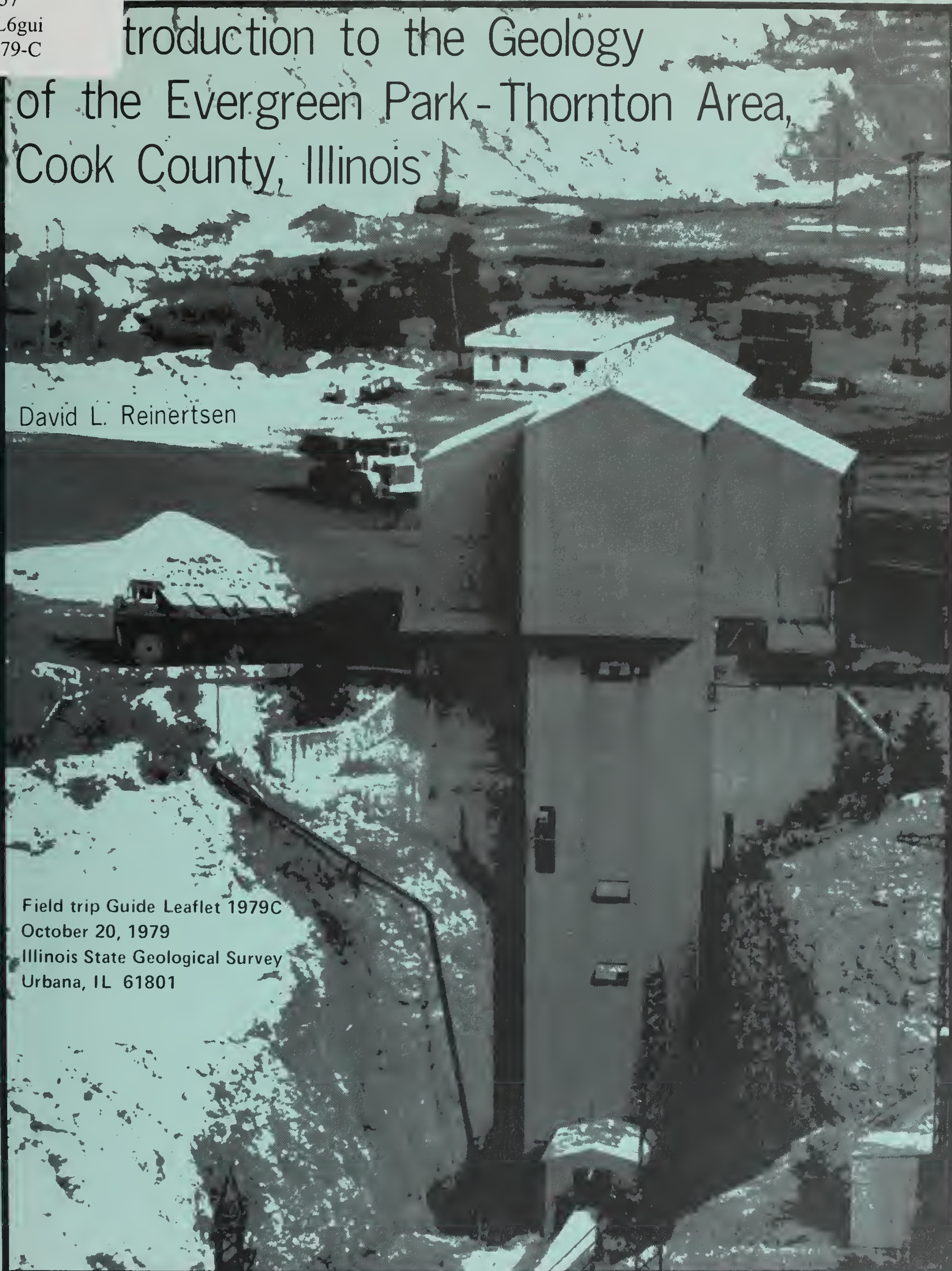
troduction to the Geology of the Evergreen Park-Thornton Area, Cook County, Illinois

David L. Reinertsen



Field trip Guide Leaflet 1979C
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Illinois State Geological Survey
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An Introduction to the Geology of the Evergreen Park-Thornton Area, Cook County, Illinois

David L. Reinertsen

GEOLOGICAL SCIENCE FIELD TRIPS are free tours conducted by the Educational Extension Section 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. High school science classes should be supervised by at least one adult for each ten students. A list of previous field trip guide leaflets is available for planning class tours and private outings.

November 3, 1979. CARLINVILLE, Macoupin County.

April 26, 1980. EQUALITY, Gallatin and Saline Counties.

May 17, 1980. HILLSDALE, Rock Island and Whiteside Counties.

an overview of the field trip

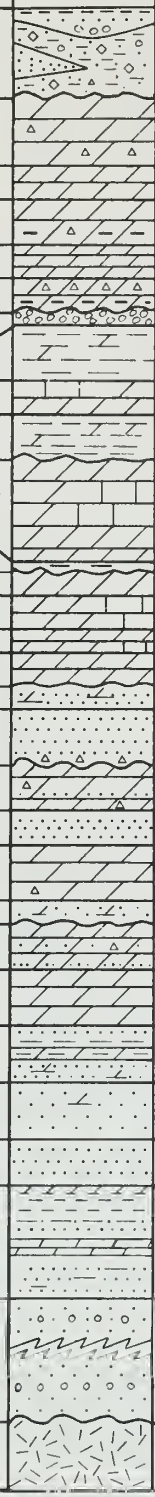
The Evergreen Park-Thornton Geological Science Field Trip is designed to acquaint you with some aspects of the general geology, surface topography, and mineral resources of a part of the southern Chicago Metropolitan Area, home to more than 7,000,000 people. The information that you read in this guide leaflet, in addition to your personal observations along the itinerary, will show you how geology relates to regional land-use planning and urban environmental improvement, to construction problems (structure foundations, highways, tunnels, etc.), and to locating, developing, and conserving our mineral and water resources.

The geographic location and geologic setting of the Chicago 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 to work and live.

Geologically, the Evergreen Park-Thornton area in northeastern Illinois 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 4,000 to 5,000 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 375-million years old)(fig. 1). 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. 2). The Kankakee Arch separates two broad structural basins—the Illinois Basin to the southwest and the Michigan Basin to the northeast. The field trip area lies east of the crest of the Kankakee Arch. The bedrock strata here are depressed slightly toward the



Time Stratig.			Rock Stratigraphy				
SYSTEM	SERIES	STAGE	MEGA-GROUP	GROUP	FORMATION	Thickness (ft)	KINDS OF ROCK
QUAT.	PLEIS.					0-200	Till, sand, gravel, silt, clay, peat, marl, loess
SILURIAN	NIAGARAN		Hunton		Racine	0-300	Dolomite, pure in reefs, mostly silty, argillaceous, cherty between reefs
					Waukesha	0-20	Dolomite, even bedded, slightly silty
					Joliet	40-70	Dolomite, shaly and red at base, white, silty, cherty above; pure at top
	ALEX.				Kankakee	20-50	Dolomite; thin beds; green shale partings
					Edgewood	0-100	Dolomite, cherty, shaly at base where thick
ORDOVICIAN	CIN.	RICH.		Maquoketa	Neda	0-15	Oolite and shale, red
					Brainard	0-100	Shale, dolomitic, greenish gray
					Ft. Atkinson	5-50	Dolomite; green shale; coarse limestone
		MAY. / ED.			Scales	90-120	Shale, dolomitic, gray, brown, black
	CHAMPLAINIAN	TRENT.	Ottawa	Galena	Wise Lake	170-210	Dolomite, buff, pure
					Dunleith		Dolomite, pure to slightly shaly; locally limestone
					Guttenberg	0-15	Dolomite; red specks and shale partings
		BLACKRIVERAN		Platteville	Nachusa	0-50	Dolomite and limestone, pure, massive
					Grand Detour	20-40	Dolomite and limestone; medium beds
					Mifflin	20-50	Dolomite and limestone, shaly, thin beds
					Pecatonica	20-50	Dolomite, pure, thick beds
				Ancell	Glenwood	0-50	Sandstone and dolomite, silty; green shale
					St. Peter	100-400	Sandstone, medium and fine grained; well rounded grains; chert rubble at base
	CANADIAN		Knox	Prairie du Chien	Shakopee	0-20	Dolomite, sandy; oolitic chert; algal mounds
					New Richmond	0-10	Sandstone, fine to coarse
					Oneota	150-200	Dolomite, pure, coarse grained; oolitic chert
					Gunter	0-15	Sandstone, dolomitic
CAMBRIAN	CROIXAN	TREMP.			Eminence	50-100	Dolomite, sandy
					Potosi	90-150	Dolomite; drusy quartz in vugs
		FRAN.			Franconia	50-140	Sandstone, glauconitic; dolomite; shale
					Ironton	100-150	Sandstone, partly dolomitic, medium grained
		DRESBACHIAN			Galesville	10-100	Sandstone, fine grained
					Eau Claire	370-450	Siltstone, dolomite, sandstone and shale, glauconitic
			Potsdam		Mt Simon	1700-2400	Sandstone, fine to coarse; quartz pebbles in some beds
PRECAMBRIAN SYSTEM							Granite

Figure 1. Columnar section of the rock strata in the Chicago area. Abbreviations: Alex.—Alexandrian; Cin.—Cincinnatian; Ed.—Edenian; Fran.—Franconian; May.—Maysvillian; Pleis.—Pleistocene; Quat.—Quaternary; Rich.—Richmondian; Tremp.—Trempealeauan; Trent.—Trentonian. (Modified from Willman, 1971.)

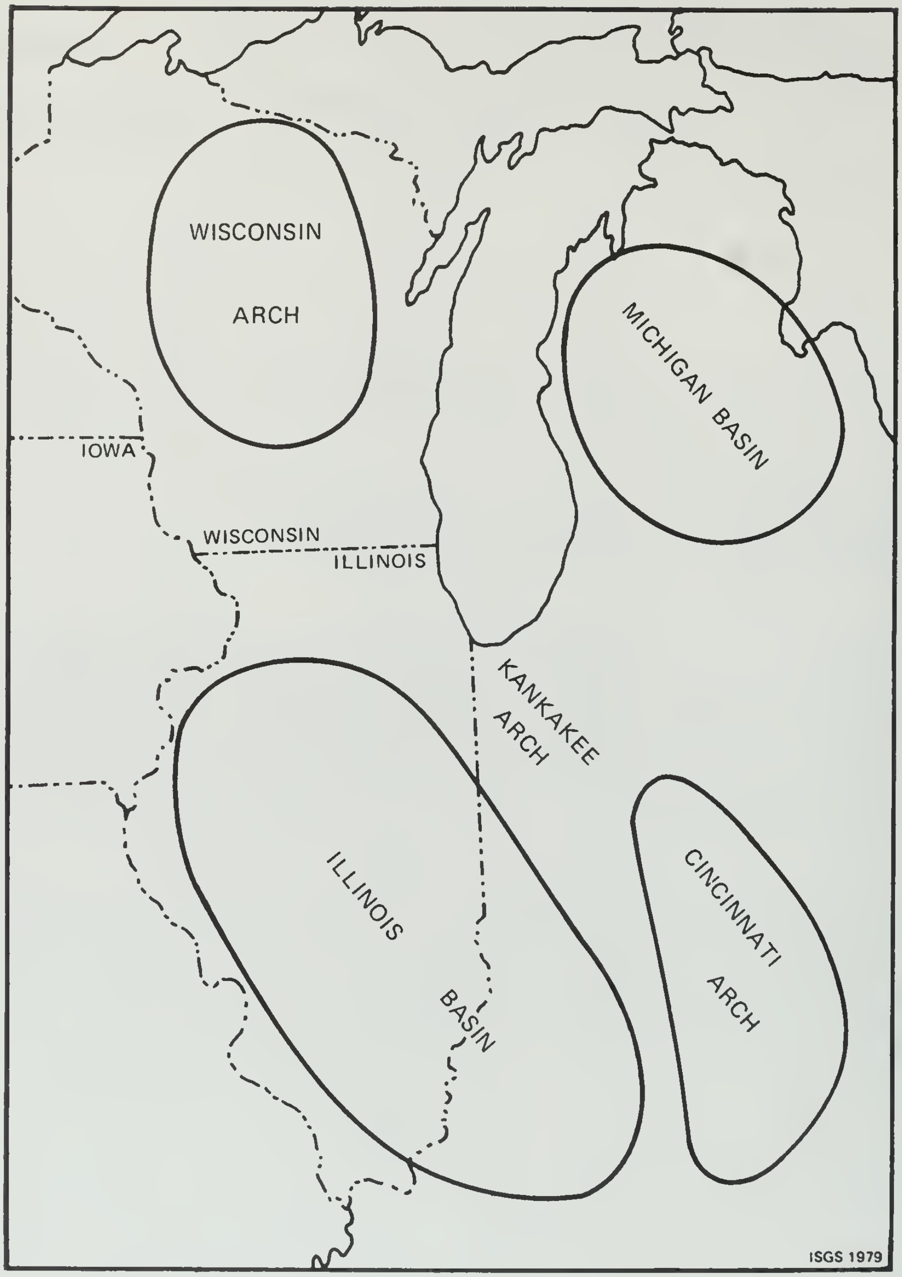


Figure 2. Location of the Kankakee Arch and adjacent structures, Wisconsin Arch, Cincinnati Arch, Illinois Basin, and Michigan Basin, in the north-central Midcontinent Region.

northeast about 10 to 15 feet per mile, less than a 1° dip and not perceivable by the eye. Locally there are exceptions to these gentle dips, especially noted in the steeply dipping, flanking beds of the Silurian reefs in this region.

Tilting of the bedrock strata took place several times during the geologic past. Gentle regional tilting of some Cambrian and early Ordovician rocks occurred before later Ordovician rocks were deposited on them. All of these rocks then were tilted slightly before the deposition of the younger Silurian and Devonian rocks across the area. Therefore, the bedrock strata are not parallel to each other. In addition, local warping has occurred to produce east- to west-trending low anticlines (upwarps) and shallow synclines (downwarps). In some cases the strata have been broken by faults having small displacements.

Erosion has cut across the gently upwarped strata of the Kankakee Arch to expose the older sedimentary strata that are seen in this area. Many of these rocks were only thinly mantled by glacial drift and subsequently were exposed by erosion and excavations for quarries and canals. Only the upper several hundred feet of the bedrock succession is exposed in the field trip and adjacent areas.

The bedrock surface in the Chicago Region has been considerably modified by the Pleistocene glaciers that repeatedly covered the area during the last 700,000 years. Some of the irregularities of the bedrock surface that were produced by pre-Pleistocene erosion were accentuated by meltwater from the early glaciers; however, some of the valleys were later filled so completely with glacial drift 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 well-developed scratches, called striations, which prove that the higher parts of the bedrock surface were scraped, rounded, and ground down by the overriding glacial ice. Its entrained rock debris 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.

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 being older than Wisconsinan in age are known from the field trip area. Available evidence indicates that Kansan glaciations were the earliest in northeastern Illinois. Kansan deposits near La Salle and Ottawa may have been left by a glacier that advanced southward and excavated the Lake Michigan Basin, although no Kansan deposits have been found in the basin nor close to it. Later 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 14,500 to nearly 14,000 years ago underlie this area; here the till of the Wedron Formation averages a little more than 50 feet thick with a maximum thickness of just over 100 feet. As the front of the Woodfordian glaciers melted back to the north, a series of lakes formed in 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 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 work of wind and running water to produce the land forms seen today.

Mineral production

The common building materials, such as stone, sand, gravel, and clay, are plentiful in the Chicago area and are the basis for a large mineral producing industry. Peat, which is used as a soil conditioner, is also produced here. Coke, lime, and clay products are manufactured from resources mined here and elsewhere, largely in Illinois. In addition, several mineral materials that originate largely outside the state are processed here, in order of value: pig iron, expanded perlite, sulfur, secondary slab zinc, and bismuth.

During 1977, the last year for which complete mineral production records are available, of the 102 counties in Illinois, 100 reported mineral production. The total value of all minerals extracted in Illinois was $1.5 billion. The total value of minerals extracted, processed, and manufactured in the state amounted to nearly $3.1 billion.

Cook County ranked sixth among the counties having a value of $86,408,000. Five quarries produced more than 15.7 million tons of stone having a value greater than $32.6 million. Two sand and gravel operations produced between 0.5 and 1.0 million tons. About 81,400 tons of clay valued at $186,400 were produced.

The close proximity of the quarries and pits to the large market area greatly reduces the shipping costs on these large bulk materials. Costs would quickly rise if these materials had to be shipped in from areas 50 miles away or farther. To conserve needed construction materials, long-range planning is necessary so that future quarry and pit sites having thin overburden do not become covered and lost by housing developments and shopping centers.

Abundant ground-water and surface-water supplies are readily available in the Chicago area. It would be extremely difficult, if not impossible, to place values on them.

a guide to the route

Assemble in the headquarters parking lot in Dan Ryan Woods, northeast corner of West 87th Street and Western Avenue. Dan Ryan Woods is part of the Forest Preserve of Cook County.

STOP 1

Discussion of ancient Lake Chicago. (Assemble about 50 feet north of the parking lot; N ½ SW ¼ SW ¼ SW ¼ Sec. 31, T. 38 N., R. 14 E., 3rd P.M., Blue Island 7.5-minute Quadrangle.)

Dan Ryan Woods is located at the north end of the Blue Island ridge. The northeastern part of the ridge is a southern segment of the Woodfordian Park Ridge Moraine. The southwestern part of the ridge is composed of Tinley ground moraine. The ridge extends about 5.5 miles from north to south and averages about 1 mile wide. The elevation of this vantage point is about 660 feet above mean sea level (msl), but the lower, open area to the northeast is about 50 feet lower and is part of the floor of an ancient lake that once covered this region. About 0.5 mile farther south, the crest of Blue Island ridge is slightly more than 670 feet msl and maintains this elevation intermittently for another 1.75 miles to the south.

When the Tinley glacier melted, about 14,000 years ago, a large lake formed between the ice front and the Tinley Moraine, about 9 miles to the west. The water rose to an elevation of about 640 feet and was called the Glenwood stage of Lake Chicago (fig. 3). The shoreline of the Glenwood stage, which was the highest level of Lake Chicago, would have been very close to the building near the base of this slope. The Blue Island ridge was the only island in the lake at this stage and its higher portions stood 25 to 30 feet above the lake. Large storm waves from the east and northeast eroded a cliff in the glacial till on the eastern side of the island, where the cliff is about 25 feet high. The western side of the island did not have a cliff cut into it by waves because the lake shore was only 7 to 8 miles away and that part of the lake was too shallow for large waves to develop. Currents carried sand and fine gravel southward from the moraine shore bluffs and built spits and beaches in the lake. A large sand spit hooks to the west from the north end of Blue Island ridge. The more gentle western slope of the ridge also contains tracts of Parkland Sand that have been blown up into dunes. These sandy areas are now the sites of country clubs and cemeteries.

Lake Chicago drained westward through the Chicago Outlet composed of two segments that were eroded through low sags in the Tinley Moraine. The northern segment drained into the Des Plaines Valley that had been formed by meltwater flowing down from the Tinley glacier across its moraine. About 4 miles south of the northern breach, the Sag was formed by drainage cutting through another

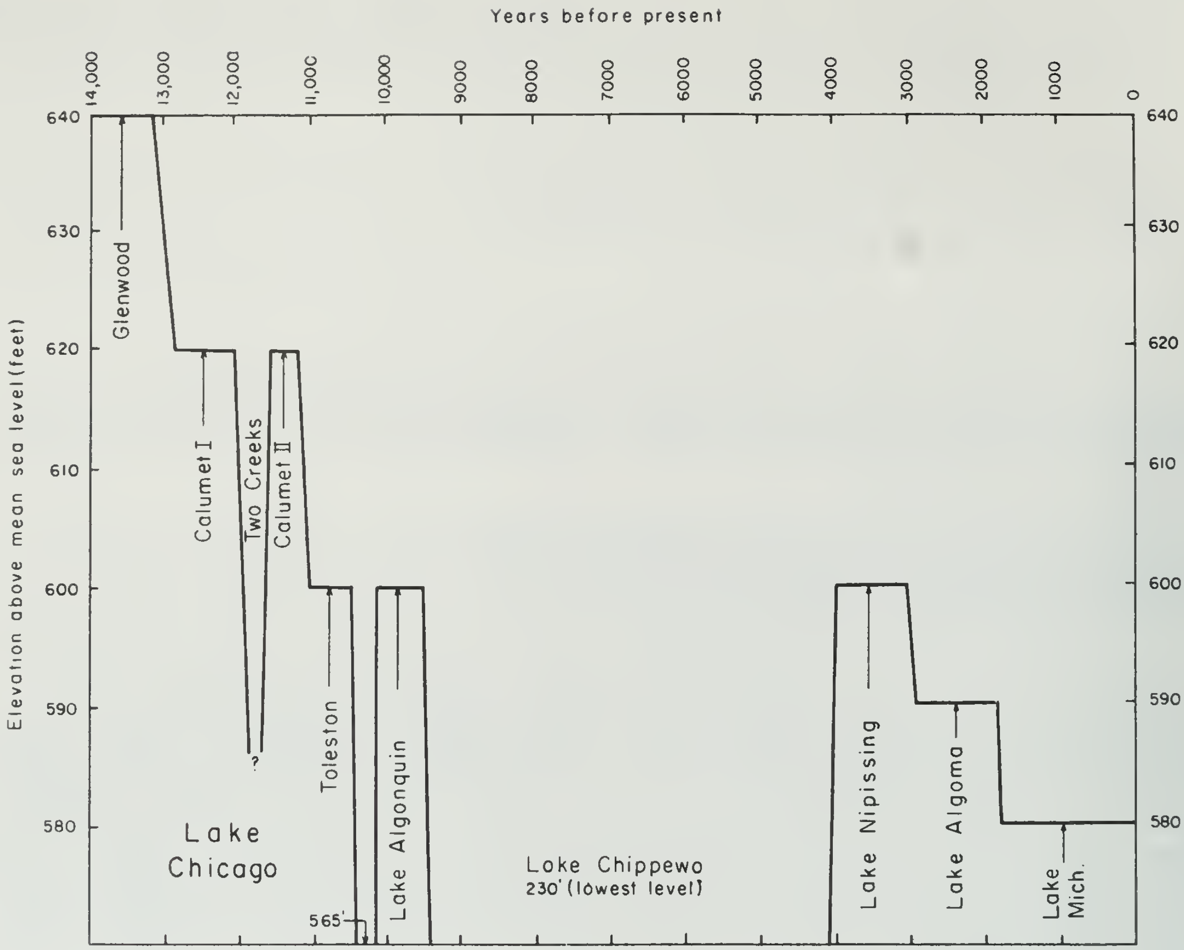


Figure 3. Elevation and ages of the glacial lakes in the southern part of the Lake Michigan Basin. (From Willman, 1971.)

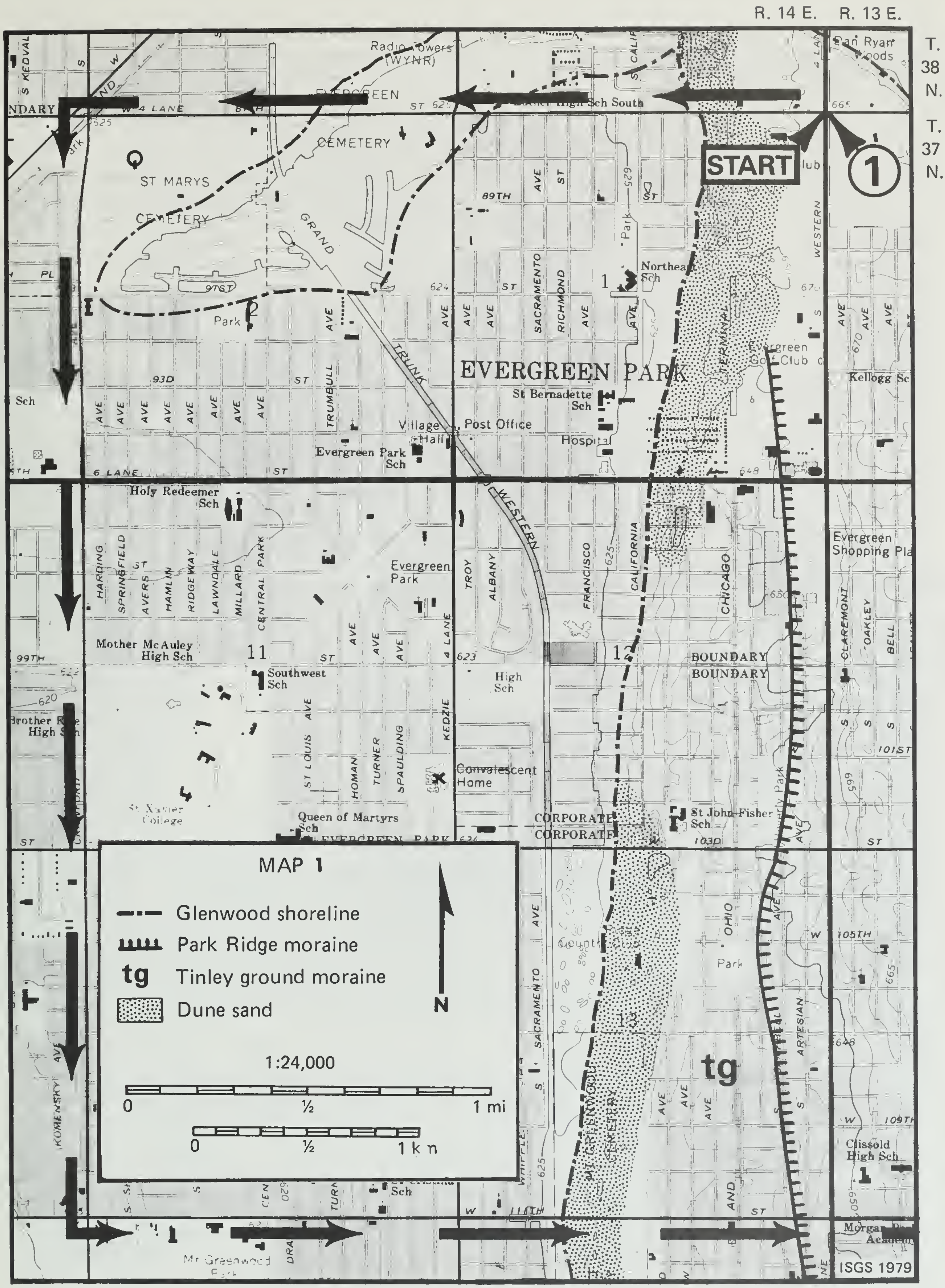
low segment of the moraine. These two outlets joined about 6 miles farther west and flowed southwestward.

Lake levels fluctuated in the Great Lakes region over the last 14,000 years or so. As the ice front melted back to the north, other lower outlets were uncovered and meltwater drainage was directed through other areas. Furthermore, to the north the Earth's crust was depressed more than in this area because of the much greater thickness and weight of the overlying ice. When the ice front melted back, the crust did not immediately rebound to its earlier position and much lower outlets to the northeast were established across the southern portions of Ontario, Canada. But as the crust slowly rose to its former level, some of these outlets were tilted too high for lake drainage and were abandoned. In North America, lake levels were largely determined by the position of the ice front and the elevation of the Earth's crust.

Rainfall patterns cause fluctuations of several feet in the levels of the present Great Lakes; these fluctuations cause many problems on the lakes. When the water is high, beaches and bluffs are eroded and many properties sustain major damage. When lake levels are low, fishing and boating piers may be left in water too shallow to permit use of the structures.

Mileage to next point	Mileage from starting point	
0.0	0.0	Leave Stop 1. NOTE: You are on your own to get to Stop 2. Obey <u>all</u> traffic lights and directions. Not all stoplights will be noted in the itinerary. Mileage begins at the 87th Street entrance/exit to this parking lot. TURN RIGHT (west) on 87th Street.
0.05	0.05	CAUTION. STOPLIGHT, Western Avenue. CONTINUE AHEAD (west) for 2 miles to Crawford-Pulaski Avenue.
0.05	0.1	You have just crossed the crest of Blue Island ridge. Beverly Country Club to left is located in an area of dunes of Parkland Sand on the gentle backslope of the ridge.
0.3	0.4	Cross Glenwood shoreline on west side of Blue Island ridge.
0.65	1.05	CAUTION. STOPLIGHT, Kedzie Avenue. CONTINUE AHEAD (west).
0.05	1.1	Crossing sand spit that arcs west and southwest from north tip of Blue Island ridge. Note cemeteries on both sides of 87th Street—good drainage and easy digging.
0.35	1.45	West edge of sand spit.
0.5	1.95	CAUTION. Prepare to turn left.
0.1	2.05	CAUTION. STOPLIGHT and Norfolk & Western Railroad crossing. TURN LEFT (south) on Crawford-Pulaski Avenue.
0.45	2.5	St. Mary's Cemetery to left is located on west end of previously mentioned sand spit. Spit ends about 300 feet to the east. CONTINUE AHEAD (south) 2.55 miles to 111th Street. Crossing lake plain of Lake Chicago.

Mileage to next point	Mileage from starting point	
2.0	4.5	Area to right slopes west into that portion of the southern part of the Chicago Outlet that drained Lake Chicago. This glacial sluiceway is now occupied by Stony Creek.
0.45	4.95	CAUTION. Prepare to turn left. (NOTE: East side of glacial sluiceway is 0.15 miles to right on 111th Street.)
0.1	5.05	CAUTION. STOPLIGHT, 111th Street. TURN LEFT (east) on 111th Street.
		CONTINUE AHEAD 2.4 miles to Hoyne Avenue.
1.3	6.35	Crossing Glenwood stage shoreline of Lake Chicago on west side of Blue Island ridge. Note cemeteries on both sides of 111th Street located in dune areas of Parkland Sand.
1.1	7.45	CAUTION. STOPLIGHT, Hoyne Avenue. CONTINUE AHEAD (east) on 111th Street and cross crest of Blue Island Ridge. SLOW DOWN as you descend hill to east; this is the wave-cut cliff above the Glenwood stage beach of Lake Chicago.
0.1	7.55	Longwood Drive at bottom of hill. This is the position of the level of Lake Chicago during the Glenwood stage.
0.05	7.6	CAUTION. RAILROAD CROSSING, Chicago, Rock Island and Pacific (CRI&P). CONTINUE AHEAD and BEAR RIGHT on Monterey Avenue.
0.35	7.95	CAUTION. STOPLIGHT, Vincennes Avenue. CONTINUE AHEAD (southeast) and cross Lake Chicago shoreline during Calumet stage.
0.15	8.1	CAUTION. STOPLIGHTS and RAILROAD CROSSING (CRI&P, 3 tracks), I-57 interchange. BEAR LEFT (east) on 112th Street and cross I-57. Prepare to turn left.
0.15	8.25	CAUTION. STOPLIGHT. TURN LEFT (north) on Hamlet Avenue.
0.2	8.45	CAUTION. STOPLIGHT. TURN RIGHT (east) on 111th Street.
0.5	8.95	Descend Calumet stage shoreline (620 feet msl) of Lake Chicago.


R. 14 E.
R. 13 E.
T. 38 N.
T. 37 N.
START
1
MAP 1
Glenwood shoreline
Park Ridge moraine
tg
Tinley ground moraine
Dune sand
N
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0
½
1 mi
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EVERGREEN PARK
ST MARYS CEMETERY
EVERGREEN CEMETERY
Radio Towers (WYNR)
Dan Ryan Woods
Evergreen Golf Club
Kellogg Sch
St Bernadette Sch
Village Hall
Post Office
Hospital
Evergreen Park Sch
Holy Redeemer Sch
Evergreen Park
Mother McAuley High Sch
Southwest Sch
Brother Rice High Sch
High Sch
Convalescent Home
Queen of Martyrs Sch
St John Fisher Sch
CORPORATE
BOUNDARY
Evergreen Shopping Pla
Clissold High Sch
MT GREENWOOD CEMETERY
Mt Greenwood Park
TRUNK
WESTERN
ISGS 1979

Mileage to next point	Mileage from starting point	
0.4	9.35	CAUTION. STOPLIGHT. TURN RIGHT (south) on Halsted Avenue. CONTINUE AHEAD 2.35 miles through 7 stoplights to Stop 2 on the Little Calumet bridge. You MUST park on the side streets to the right (west) of Halsted Avenue before you get to the bridge.
0.65	10.0	Ascend Calumet stage shoreline of Lake Chicago.
0.15	10.15	Descend Calumet stage beach deposits.
1.3	11.45	CAUTION. STOPLIGHT, Vermont Street (last stoplight before Stop 2).
0.25	11.7	TURN RIGHT (west) on 129th Street and park along street. Do NOT block driveways or park in store lot. WALK back to Halsted Street and then walk to center of bridge. Walk ONLY on the shoulder to the bridge on the west side of Halsted.

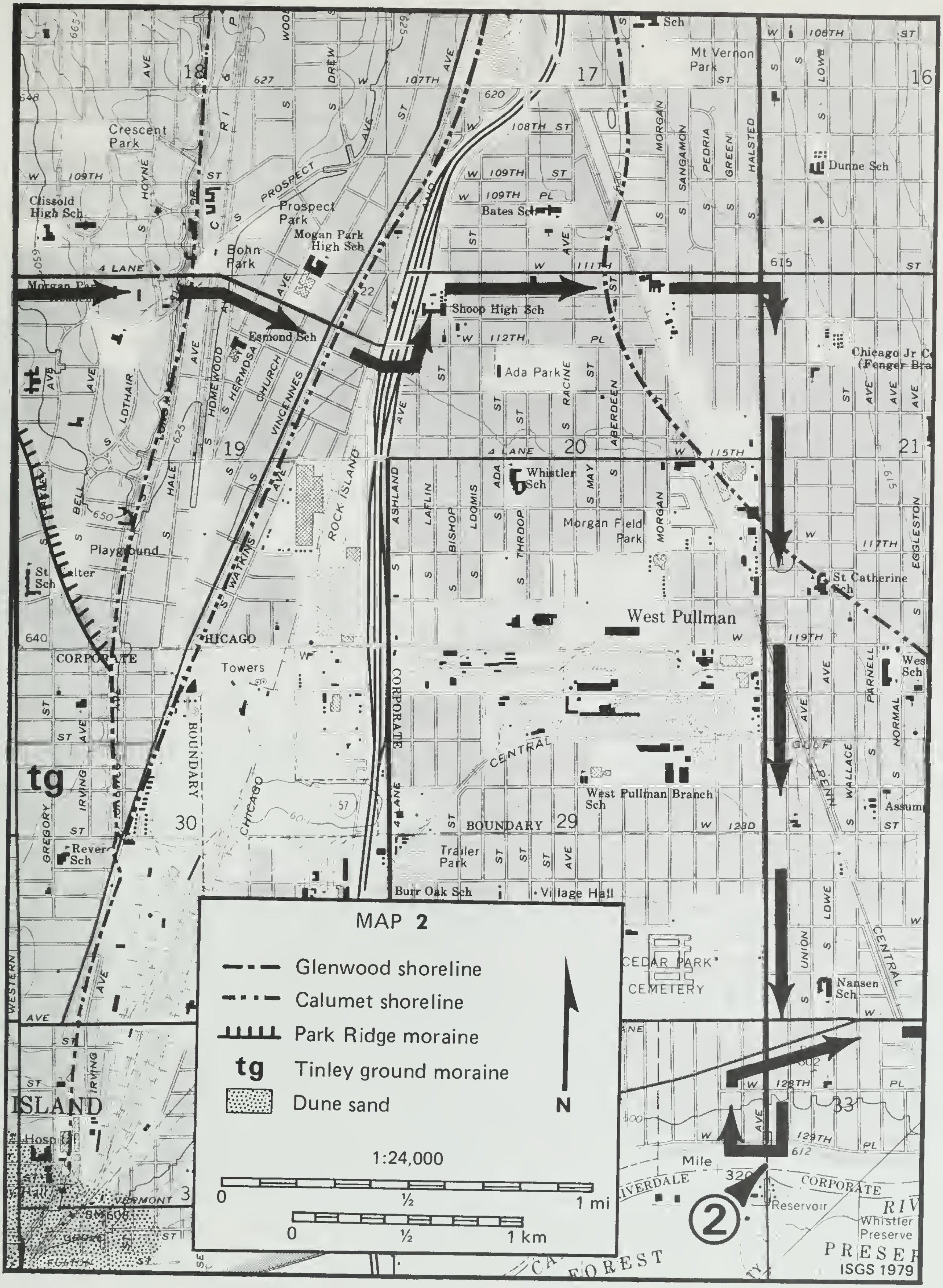
STOP 2

Discussion of Calumet-Sag Channel. (CAUTION: the vantage point for this stop is mid-span on the west side of the Halsted Avenue [State Route 1] bridge over the Little Calumet River. There is a walkway on the outside of the bridge girders. The walkway is not wide so it may be somewhat crowded. Do NOT get in the roadway—traffic is fast and visibility is not good. E line NE ¼ SE ¼ SE ¼ NE ¼ Sec. 32, T. 37 N., R. 14 E., 3rd P.M.; Blue Island 7.5-minute Quadrangle.)

Except for the high land of Blue Island to the northwest at 2 o'clock, all of the area adjacent to the bridge was inundated by the Glenwood stage of Lake Chicago about 14,000 years ago. The view to the west is down the course of the southernmost of the two discharge channels for this lake. Downcutting of this channel to the west and the Des Plaines River channel was slowed by the resistant Silurian dolomite that lies a few feet below the surface here. In addition, a concentration of lag boulders that were eroded from the till was too large to be readily moved by flowing water and thus helped to protect the dolomite bedrock floor.

The Lake Michigan elevation of 580 feet was too low to permit natural flow down these old channels. The Sanitary and Ship Canal was excavated into bedrock from Summit to just north of Lemont, a distance of about 29 miles, during the late 1800s. An 8-mile channel was dug from the North Branch of the Chicago River northward to connect with Lake Michigan at Wilmette from 1908 to 1910. When the 16-mile Calumet-Sag Channel was completed in 1922, surface waters in the Chicago region were successfully intercepted and diverted away from Lake Michigan. This action was taken to guard against heavy rains flooding the sewers and streams and flushing the raw sewage into the lake, as happened in

R. 14 E.


T. 37 N.
MAP 2
Glenwood shoreline
Calumet shoreline
Park Ridge moraine
tg Tinley ground moraine
Dune sand
N
1:24,000
0 ½ 1 mi
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ISGS 1979
West Pullman
Crescent Park
Prospect Park
Bohn Park
Mogan Park High Sch
Esmond Sch
Shoop High Sch
Ada Park
Whistler Sch
Morgan Field Park
St Catherine Sch
West Pullman Branch Sch
Burr Oak Sch
Village Hall
CEDAR PARK CEMETERY
Nansen Sch
Dunne Sch
Mt Vernon Park
Clissold High Sch
Playground
Trailer Park
Towers
Reservoir
Whistler Preserve
Mile 320
ISLAND
Hospital
CORPORATE
BOUNDARY
ROCK ISLAND
CHICAGO
tg
2

August 1885. In addition, the canals would permit barge traffic to pass from the lakes into the Illinois River.

Slightly over a half mile to the west is the juncture of the Calumet-Sag Channel and the Little Calumet River. The stone abutment to the right was the north wall of the old locks that controlled the flow and direction of the channel. Indentations in the lock wall are receptacles for the opened lock gates, used when locking barges through the system. The south wall was removed years ago. Water levels are now controlled by a Corp of Engineers lock about 6.5 miles downstream to the east just short of Lake Calumet.

For many years the Little Calumet River and the Sag Channel were not much more than open sewers. Efforts over the last 15 years or so have cleaned them to the point where they now support some fish. In addition, people are now using the waterway for recreational purposes and are building homes along its banks.

Just behind the old lock wall is the main shaft for the Calumet deep tunnel, part of the Crawford Avenue to Calumet Sewage Treatment Works. These tunnels are designed to intercept surface flood waters and store them until they can be properly handled through the sewage treatment plants in the Chicago Metropolitan Area. In the past, heavy rainfall has flooded the sewer systems and rendered the treatment plants inoperative so that raw sewage escaped into the surface streams.

Mileage to next point	Mileage from starting point	
0.0	11.7	LEAVE STOP 2. CONTINUE AHEAD (west) on 129th Street.
0.05	11.75	TURN RIGHT (north) on Green Street.
0.2	11.95	STOP; 2-way. TURN RIGHT (northeast) on Vermont Street and cross Halsted.
0.25	12.2	CAUTION. STOPLIGHT; BEAR RIGHT (east) on 127th Street.
0.45	12.65	Cross old Indian Treaty Boundary. The street to the left at 10:30 o'clock follows the boundary to the northeast for several blocks. The boundary line and a parallel one 20 miles to the north were established in 1816 by the Treaty of Black Partridge, negotiated in St. Louis. The strip of land extended southwestward to the mouth of the Kankakee River so that a military road could be constructed in order to protect and facilitate the construction of the proposed Illinois-Michigan Canal. According to John Volp (1935), these boundaries have been "the despair of surveyors ever after."

Mileage to next point	Mileage from starting point	
0.25	12.9	Little Calumet River to right. Sewer outfall can be seen along east side of bend about 1:00 o'clock at waterline stream level. This outfall is from the Calumet Sewage Treatment Works, which is located about 0.6 mile to the east. The present plant was opened in 1935 and was designed to process 150 to 160 million gallons of sewage per day (mgd). Expansion since the late 1950s has increased the capacity to 220 mgd. Plans are to spend about 300 million dollars over the next 10 years to expand and modernize these facilities. Only liquids are discharged into the Little Calumet River through this outfall. Solids from this plant have been shipped to test plots in the Shawnee Forest of extreme southern Illinois, some have gone to local landfills, and some treated waste has been sold for liquid fertilizer. This is the smallest of the three Metropolitan Sanitary District plants.
0.2	13.1	Descend Toleston stage shoreline (600 feet msl elevation) of Lake Chicago.
0.1	13.2	TURN RIGHT (south) on Indiana Avenue along the west side of the Illinois Central Gulf (ICG) Railroad embankment.
0.2	13.4	View to right of Interlake Steel Company across river. This plant uses metallurgical coke produced in the Chicago area from coal mined in southern Illinois.
0.1	13.5	CAUTION. TURN LEFT (east) on 130th Street under the ICG Railroad overpass. Prepare to turn right.
0.05	13.55	CAUTION. STOPLIGHT, Indiana Avenue. TURN RIGHT (south).
0.55	14.1	Cross Little Calumet River.
0.3	14.4	CAUTION. STOPLIGHT, 137th Street and Leyden Avenue. BEAR LEFT (southeast) on Leyden Avenue.
0.2	14.6	CAUTION. STOP (4-way), 138th Street. BEAR LEFT (east) on 138th Street. CONTINUE AHEAD 1.2 miles to Stop 3.

Mileage to next point	Mileage from starting point	
0.85	15.45	CAUTION. Cottage Grove Avenue. CONTINUE AHEAD on rough, unpaved portion of 138th Street. The area to the left was the site of one of the older clay pits that has been used for a sanitary landfill. To the right is an area that is currently being used as a landfill.
0.35	15.8	STOP 3.

STOP ③

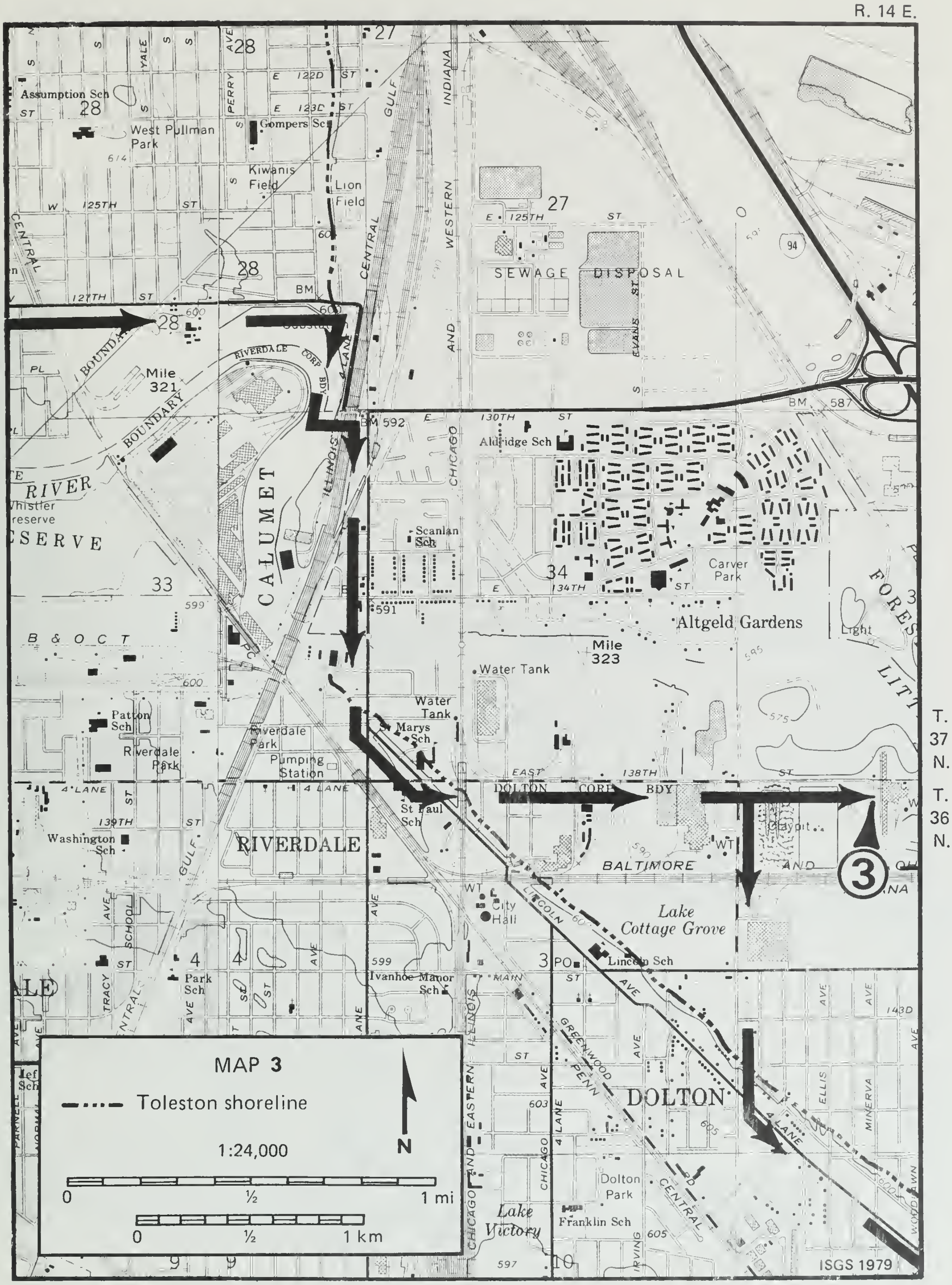
Visit to the American Brick Company clay pit and brick plant. (NOTE: this is a <u>hard-hat area</u> and you MUST have permission to enter the property. Office: $SW_{cor.}$ SE ¼ SE ¼ SW ¼ Sec. 35, T. 37 N., R. 14 E., 3rd P.M.; Lake Calumet 7.5-minute Quadrangle.)

The American Brick Company was formed by the merger, in 1967, of three large brick companies in the Chicago area—Chicago, National, and Cary Brick Companies. This facility is the last clay mine-brick yard operating in the Chicago area. At one time there were about 40 such yards throughout the metropolitan area. Bricks were first made at this location about 1885 by the Chicago Brick Company. This plant is the third one to be located here, the first two wooden structures having been destroyed by tornadoes in 1924 and 1945. The new plant has a steel framework for durability during storms and for fire resistance. A fire in December 1976, destroyed everything east of the large metal shed housing the kilns. The heavy equipment was salvaged and the company switched from rail to truck haulage from the pit to the plant at that time. The plant now employs from 110 to 120 persons.

Usable clay from the pit located just west of the plant and south of 138th Street is about 35 feet thick and belongs to the Wadsworth Member of the Wisconsinan Wedron Formation. Below the clay are gravel and hard pan, a tough, nonplastic bouldery glacial till, neither of which are usable in the brick-making process. The gray clay yields a mottled buff common brick that was used mainly as backers and fillers in brick constructions; however, more and more of these rough commons are being used for face bricks.

The dragline removing the clay from the pit has a 2 1/2-cubic yard bucket which enables it to dig about 600 cubic yards per 8-hour day. All of the clay mined here is used in this plant. The clay reserves lie behind the dragline and south to the railroad and eastward to the plant. These reserves are estimated to last for another 4 to 6 years at which time the plant will either have to import clay or stop operations.

Semi-trailer trucks deliver the clay to the east end of the plant where the clay goes through a granulator to disaggregate it. Next a series of rollers ejects larger stones and another set crushes the smaller ones. Then coal is added to the clay that will be used for the outer layer of green bricks making up the kiln. This coal must be blended into the clay, otherwise the kiln will not burn properly. (When the kilns were coal-fired this process was called


R. 14 E.
T. 37 N.
T. 36 N.
MAP 3
Toleston shoreline
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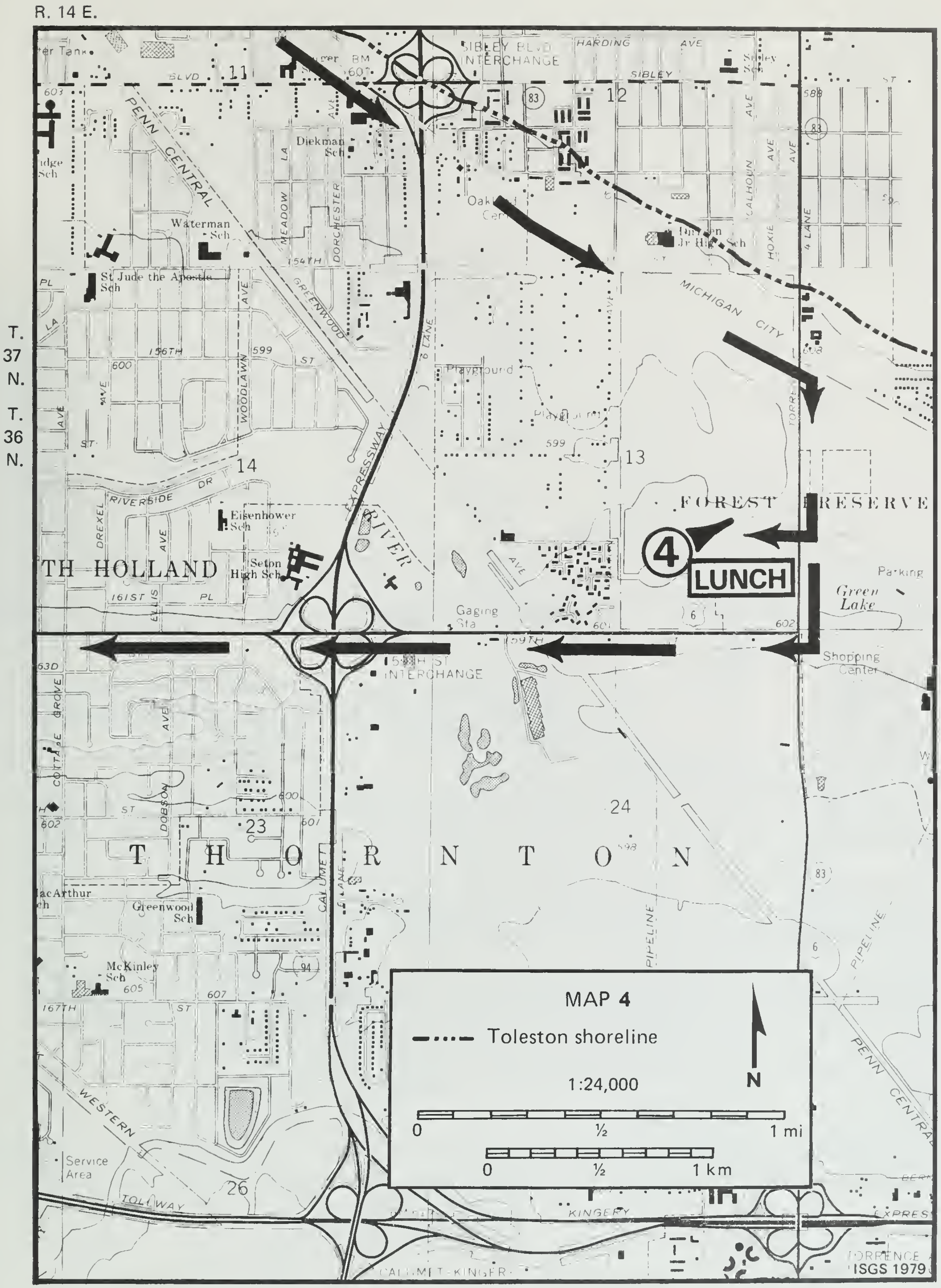
Assumption Sch
West Pullman Park
Gompers Sch
Kiwanis Field
Lion Field
SEWAGE DISPOSAL
Mile 321
RIVERDALE CORP BDY
CALUMET
RIVER
Whistler Preserve
BOUNDARY
Aldridge Sch
Scanlan Sch
Carver Park
Altgeld Gardens
Mile 323
Water Tank
Water Tank
St Marys Sch
Patton Sch
Riverdale Park
Riverdale Park
Pumping Station
St Paul Sch
Washington Sch
RIVERDALE
DOLTON CORP BDY
BALTIMORE AND OHIO
Lake Cottage Grove
City Hall
Lincoln Sch
Park Sch
Ivanhoe Manor Sch
DOLTON
Dolton Park
Franklin Sch
Lake Victory
Claypit
3
ISGS 1979

"double coal," and the term is still used even though the kilns are now gas-fired.) Next the clay goes to the pug mill where it is mixed thoroughly with the proper amount of water to go through the extruder. Two ribbons of clay are extruded onto a conveyor belt and the outer edge is coated with brick dust for ease in handling. Nothing more is added to the common brick. When the American Colonial Blend bricks are made, various additives are dusted onto the outer edge of the brick before it is surfaced and cut by a wired wheel.

Twenty persons then load steel cars with the green bricks. Each car holds 1,048 bricks and an average of 285,000 bricks are made each day. Loaded cars are transfered to the dryers which are arranged 18 to each side and parallel to the loading tracks. The cars roll through the dryers in about 2 days. Temperatures increase from about 150°F on the east end to between 480°F and 540°F on the west end of the dryers. Then the bricks are cooled before being stacked into piles to make a scove kiln.

In this type of procedure, a new kiln is constructed from the ground up; that is, the kiln is only used once and then it is torn apart. Green bricks are stacked up from the base by using an outer layer of double-coal bricks that are covered on the outside of the kiln by a layer of previously fired bricks. The whole kiln then is coated with a mud mix of broken green bricks and sand to seal the cracks between the bricks to hold in the heat. Portable, reusable walls are used for the upper 8 feet or so, and the top is covered with rolls of insulating material. Each kiln holds about 1.5 million bricks and is about 40 feet wide, 120 feet long, and 18 feet high. Arches constructed across the base of the kiln have gas burners in each end to fire the kiln. The kilns are fired on Thursday morning and are burned for about 60 hours at about 1700°F. The fire goes out on Sunday, and the upper, portable walls come off the following Wednesday. In the meantime, a new kiln has been built, and the cycle is repeated: 1 week to make and dry the brick, 1 week to set the kiln, and 1 week to burn and cool the kiln. Eight kilns can be constructed in this large shed which is almost .25 mile long. The bricks are loaded on pallets and are strapped as the kiln is dismantled. Some bricks are dumped directly into trucks or are loaded onto barges or into railcars. Last year the plant shipped about 200 railroad cars of bricks to markets in Michigan, Minnesota, Wisconsin, and Iowa, but rail shipments are decreasing in number and frequency.

Mileage to next point	Mileage from starting point	
0.0	15.8	LEAVE STOP 3. Retrace itinerary to Cottage Grove Avenue.
0.35	16.15	STOP, Cottage Grove Avenue. TURN LEFT (south).
0.1	16.25	View to left—abandoned part of clay pit, landfill, and brick plant in distance.
0.25	16.5	Lake Cottage Grove to right. Site of abandoned clay pit and brick plant that was located on the south side of the railroad tracks. Example of multiple land use. Area is now used for private recreational purposes. CONTINUE AHEAD (south).


R. 14 E.
T. 37 N.
T. 36 N.
MAP 4
Toleston shoreline
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0 ½ 1 km
LUNCH
4
FOREST PRESERVE
SIBLEY BLVD INTERCHANGE
159TH ST INTERCHANGE
MICHIGAN CITY
PENN CENTRAL
CALUMET EXPRESSWAY
RIVER
THORNTON
TH HOLLAND
Green Lake
Shopping Center
Parking
Gaging Sta
Playground
Diekman Sch
Waterman Sch
St Jude the Apostle Sch
Eisenhower Sch
Seton High Sch
Greenwood Sch
McKinley Sch
Service Area
TOLLWAY
KINGERY
WESTERN
PIPELINE
ISGS 1979

Mileage to next point	Mileage from starting point	
0.15	16.65	STOP (4-way), 142nd Street. CONTINUE AHEAD (south).
0.3	16.95	STOP (2-way), Lincoln Avenue. BEAR LEFT (southeast).
1.05	18.0	CAUTION. STOPLIGHT, Sibley Boulevard/State Route (SR) 83. CONTINUE AHEAD (southeast) on Lincoln Avenue/Michigan City Road and cross Calumet Expressway (SR-394). Itinerary is just below crest of sand spit formed in Lake Chicago. Sand has been reworked by wind into dunes that are now fairly stable. The Toleston stage shoreline lies to the left near the base of the slope.
1.4	19.4	CAUTION. STOPLIGHT, Torrence Avenue. BEAR RIGHT (south).
0.45	19.85	TURN RIGHT (west) at entrance to Shabonna Woods.

Lunch at Shabonna Woods, Forest Preserve of Cook County. (S ½ NE ¼ SE ¼ Sec. 13, T. 36 N., R. 14 E., 3rd P.M.; Calumet City 7.5-minute Quadrangle.)

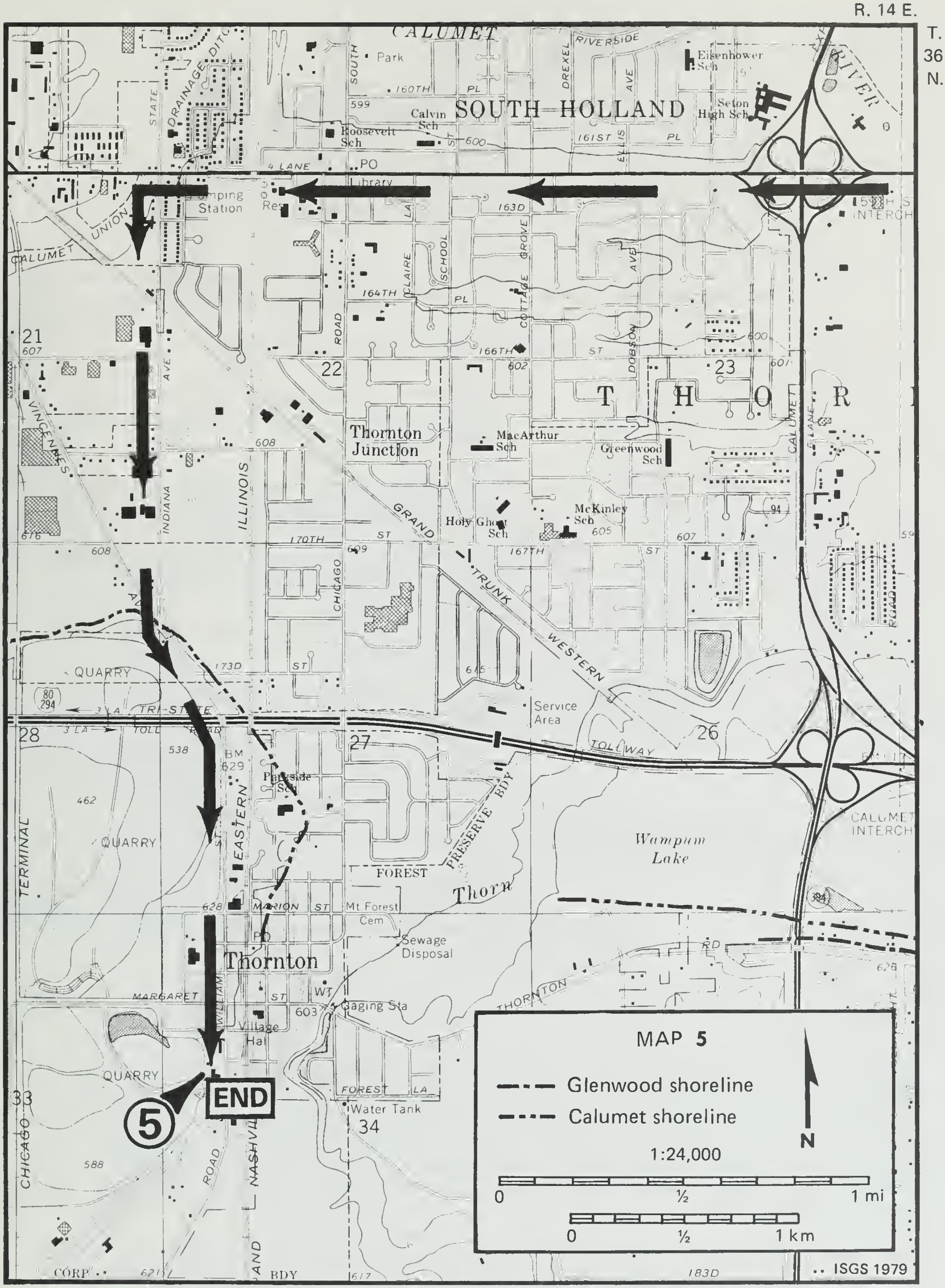
STOP 4

NOTE: Early lunch time. We must be ready to go down into Thornton Quarry at 1 p.m. It is about 7 miles to the quarry from here. We cannot take everyone's car down into the quarry, so plan to double and triple up for this last stop.

If you are finished eating early and feel you have time to visit the Sand Ridge Nature Center, do so. The Center is located about 600 feet west of the turnaround at the end of this drive. Many excellent dioramas are on display.

Green Lake, Forest Preserve of Cook County, is situated across Torrence Avenue about .25 mile. This is an example of multiple land use. The area may have been farmed before a clay pit was opened in it, the clay mine was abandoned, the area was secured by the Forest Preserve of Cook County and finally was converted into an excellent sandy beach swimming area.

Mileage to next point	Mileage from starting point	
0.0	19.85	Leave Stop 4 and return to entrance where mileage figures resume. TURN RIGHT (south) on Torrence Avenue.


R. 14 E.
T. 36 N.
CALUMET
RIVERSIDE
SOUTH HOLLAND
Park
Eisenhower Sch
Seton High Sch
Calvin Sch
Roosevelt Sch
PO
Library
Pumping Station
CALUMET UNION
DRAINAGE DITCH
STATE
SOUTH
160TH
161ST
163D
164TH
166TH
167TH
170TH
173D
PL
DREXEL
AVE
ELLIS
SCHOOL
COTTAGE GROVE
CLAIRE
LA
ROAD
DOBSON
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599
600
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33
34
T H O R
Thornton Junction
MacArthur Sch
Greenwood Sch
McKinley Sch
Holy Ghost Sch
GRAND TRUNK WESTERN
CHICAGO
ILLINOIS
INDIANA AVE
VINCENNES
CALUMET
94
80
294
QUARRY
TRI-STATE
TOLL ROAD
TOLLWAY
3 LA
Service Area
BM
Parkside Sch
EASTERN
PRESERVE BDY
FOREST
Thorn
Wampum Lake
CALUMET INTERCH
TERMINAL
MARION ST
Mt Forest Cem
Sewage Disposal
Thornton
MARGARET ST
WILLIAMS
WT
Gaging Sta
Village Hall
THORNTON
RD
FOREST LA
Water Tank
END
5
CHICAGO ROAD
NASHVILLE
CORP
BDY
183D
MAP 5
Glenwood shoreline
Calumet shoreline
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ISGS 1979

Mileage to next point	Mileage from starting point	
0.3	20.15	CAUTION. STOPLIGHT, 159th Street/US Route 6. TURN RIGHT (west for 3.0 miles to Indiana Avenue.)
0.95	21.1	Cross Little Calumet River. NOTE: Gauging station for stream to right, east side of stream.
2.05	23.15	CAUTION. STOPLIGHT, State Street/Indiana Avenue. TURN LEFT (south) on Indiana Avenue.
1.15	24.3	Ascend Calumet shoreline.
0.1	24.4	CAUTION. STOPLIGHT, Vincennes Avenue. CONTINUE AHEAD and BEAR LEFT (southeast) on Vincennes.
0.25	24.65	BEAR RIGHT (south) and cross Tri-State Tollway. Views of Thornton Quarry to right.
0.75	25.4	STOP, 4-way. Margaret Street. CONTINUE AHEAD (south) on William Street.
0.2	25.6	CAUTION. Heavy truck traffic near quarry crushing plant.
0.1	25.7	Thornton Quarry, Materials Service Corporation. Plant office and visitor registration to right. Field trip participants will park to left across William Street from office and carpool into quarry. No cars will be allowed with only one occupant!

Thornton Quarry and Reef. (Office—SE ¼ SW ¼ NW ¼ Sec. 34, T. 36 N., R. 14 E., 3rd P.M.; Calumet City 7.5-minute Quadrangle.) (Adapted from D. R. Kolata and L. L. Dean *in* DuMontelle, Dixon, and Cyrier, 1979.)

STOP 5

THORNTON QUARRY

Thornton Quarry began in 1837 as a city-lot-sized opening about 10 feet deep where the processing plant now stands. Toward the end of the century a man named Moulding bought the quarry and operated it for a number of years. He later took on a partner, and the site became known as the Moulding-Brownell Quarry. The Brownell Improvement Company followed, and Material Service Corporation purchased the quarry and plant in 1938. Prior to that, all operations were in the South Quarry.

The quarry now covers over 550 acres and is divided into four quarries that are separated by Interstate 80/294, the Baltimore and Ohio Railroad, and Ridge Road (fig. 4). All the quarries are connected by tunnels. The quarry

THORNTON QUARRY
Quarry outlines, spring 1976

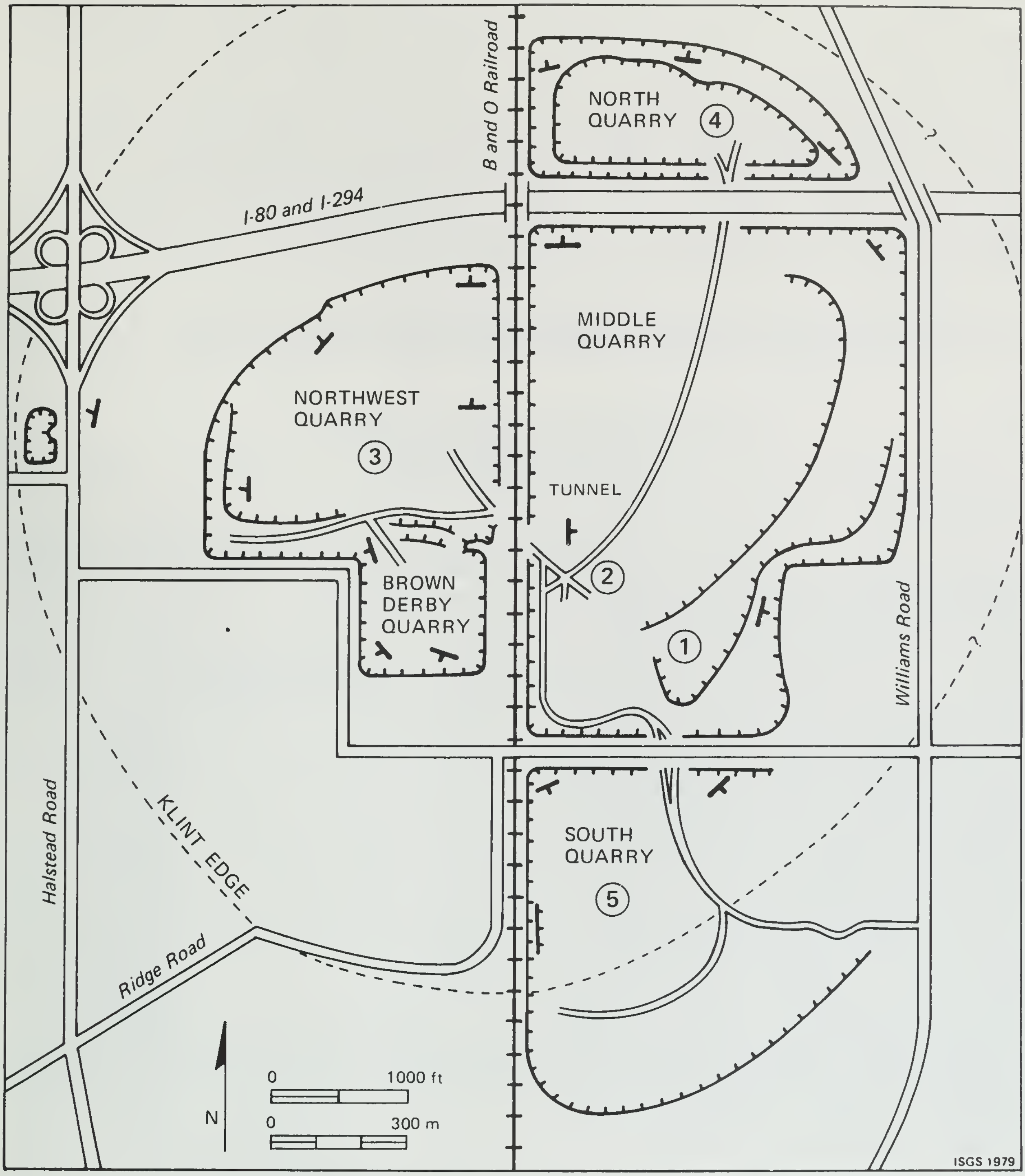

Figure 4. Field trip stops, approximate boundary of klint, and attitudes of reef flank beds in Thornton Quarry. (Modified from Wood, 1976.)

is 180 feet deep, and a new level 80 feet deeper is now being started on the west side of the Middle Quarry. Ultimate depth will be approximately 400 feet.

Thornton Quarry is the second largest producer of crushed stone in the world (the largest producer is the U.S. Steel Corporation quarry at Rogers City, Michigan.) Two hundred employees produce and ship 40,000 tons of rock per day for a total production of between 8 and 10 million tons per year. About 35 different products, which range in size from 8-ton riprap to siltsized particles (320 screen mesh), are produced. Construction aggregate used in ready-mix concrete, asphalt paving, and other building materials make up the bulk of the uses. Steel mill flux stone, railroad ballast, and various mineral filler items are also important uses for the material produced at Thornton Quarry.

We acknowledge and appreciate the continued support and cooperation of Mr. Ron Hartman, Area Manager, and Mr. Phil Peters, Quarry Foreman.

PLEASE OBSERVE ALL SAFETY PROCEDURES

WHILE IN THE QUARRY

THORNTON REEF

Thornton Reef is a dolomitized carbonate buildup within the Niagaran (Silurian) Racine Formation (fig. 5). It is roughly circular in outline and about a mile in diameter at ground level. The top has been eroded to a broad flat surface, and the present reef mass is shaped like an inverted bowl. The reef consists of highly pure dolomite that is more resistant to erosion than the surrounding shaly interreef dolomite. As a result of erosion and topographic adjustment to the differing lithologies, Thornton Reef stood as a mound or klint approximately 50 feet high during Pleistocene time. Subsequent deposition of lake sediments around the klint have reduced the relief to about 20 feet (Bretz, 1939). Thornton Quarry occupies the east half, most of the northwest quarter, and part of the southwest quarter of the klint.

History of investigations

Over the past 40 years Thornton Reef has provided important paleontologic, paleoecologic, and sedimentologic information about the Silurian reefs of the Great Lakes Region. As the reef has become better exposed by expansion

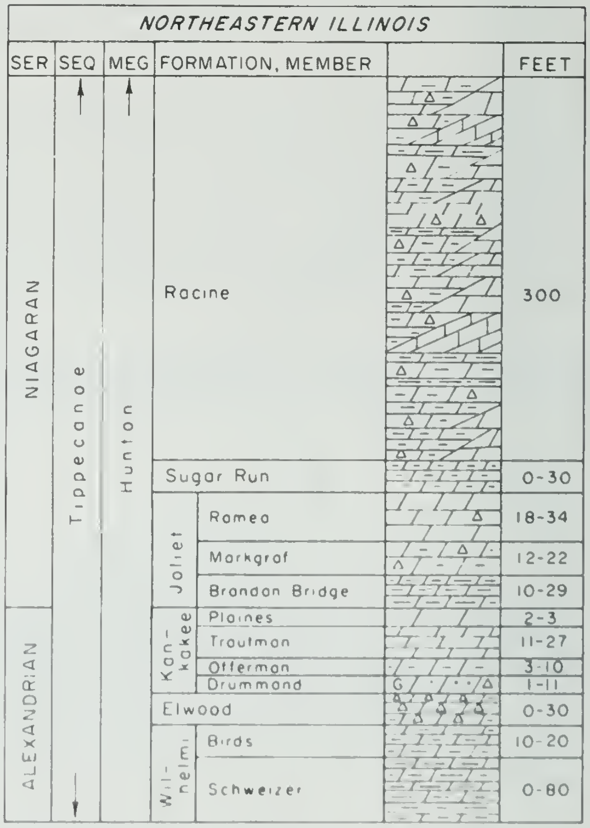

Figure 5. Columnar section of the Silurian System in northeastern Illinois. (From Willman et al., 1975, p. 91.)

of Thornton Quarry, the concepts and ideas concerning the reef structure have undergone considerable evolution.

Structure and composition of the reef

The structure of the reef is well displayed in approximately 9 miles of quarry walls and roadcuts. In addition, exploratory borings in and adjacent to Thornton Quarry provide information on the structure of the reef in subsurface. The maximum growth height of the reef is unknown because pre-early Devonian erosion truncated the top. Ingels (1963) estimated that as much as 300 feet of the upper reef mass was eroded away. Maximum preserved reef, as determined from outcrop and subsurface data, is about 300 feet (McGovney, 1978). Expansion of the quarry, particularly in the last 10 years, has revealed that the structure of the reef is that of a truncated cone. Reef flank strata, which make up about 99 percent of the preserved reef, dip radially away from the central cone. The dips range from 5° to 50° but more commonly are 25° to 40° (McGovney, 1978).

Thornton Reef formed on a broad shelf beneath a shallow sea in a normal marine environment. Evidence indicates that the water depth was at least 300 feet and could have been much greater. Subsurface data show that the reef began to grow when the Joliet Formation was being deposited, and that it continued to grow during deposition of the overlying Racine Formation. The reef grew upward and outward over successively younger interreef sediments. McGovney (1978) has shown that framebuilding corals and bryozoans are more common near the apex of the early reef and that there is a decrease in grain size and in-place corals from the apex down the flank. Beds of coarse pelmatozoan (crinoids and cystoids) debris are also common near the apex.

In general, the reef core and flank beds are characterized by an abundant and diverse fauna, in contrast to the limited fauna of the interreef beds. Although recrystallization and dolomitization have obliterated the fossils in parts of the reef, fossils have been well preserved as molds and casts in some places. The reef assemblages are mainly large, heavy-shelled, robust forms in contrast to the small, fragile forms in the interreef rocks. Among the most abundant fossils that occur in the reef are the corals *Favosites, Halysites, Lyellia,* and *Fletcheria*; the crinoids *Eucalyptocrinites* and *Crotalocrinites*; the cystoid *Caryocrinites*; the brachiopods *Monomorella, Conchidium, Eospirifer,* and *Wilsonella*; and the trilobites *Bumastus* and *Calymene.*

Thornton Reef was probably dolomitized in pre-middle Devonian time by mixing of marine and meteoric water. Petroleum was probably emplaced in the dolomitized reef in post-early Devonian time and is now seen as residual asphalt.

STOPS IN THORNTON QUARRY

1 MIDDLE QUARRY—OVERVIEW OF QUARRY AND STEEPLY DIPPING FLANK BEDS. The Middle Quarry exposes a large part of the east half of the Thornton Reef. We can see the quarry walls to the west and northwest of this point. The Middle Quarry is 4,000 feet from the south tunnel to the north tunnel (beneath I-80/I-294) and is approximately 2,640 feet wide. The tunnel in the west wall across from the main crusher is 110 feet high. It is estimated that the total thickness of usable rock is 430 feet.

The outward-dipping (30° to 40°) reef flank beds are well exposed in the west wall north of the tunnel. The beds are largely 2 to 10 inches thick, and most maintain a uniform thickness throughout their exposure. Some beds are very dense, but vesicular streaks and large vugs are common.

The purity of the dolomite is very high. Insoluble residues are negligible except for occasional well-rounded grains of quartz sand, the local presence of a mere trace of clay, and variable amounts of asphalt.

Note the iron-stained joint on the west wall south of the tunnel. This joint was widened by solution in pre-early Devonian time and later filled with gray to reddish-brown clay that contains shark teeth of Devonian and Mississippian age.

2 MIDDLE QUARRY—PRIMARY CRUSHER. Freshly blasted rock is loaded in 50- and 85-ton Euclid trucks by 12- and 15-cubic-yard shovels and endloaders and brought to the primary crusher on the west side of the Middle Quarry. The rock is dumped into either side of the 54-inch gyratory crusher and crushed into pieces no larger than 7 inches in diameter. The broken rock falls about 40 feet below the crusher, where it is fed to the primary conveyor and carried about 3,000 feet to the processing plant, where it is further crushed and separated according to size. As much as 3,000 tons of rock can be crushed in one hour.

3 NORTHWEST QUARRY—THORNTON REEF CORE. In 1967 a tunnel was cut on the west wall of the Main Quarry beneath the B & O Railroad and a new quarry was opened in the northwest quarter of Thornton Reef. As the quarry expanded, the core of the reef was uncovered on the southwest side of the tunnel just inside the Northwest Quarry. The conical shape of the reef is clearly shown at this location. Strata dip about 30° to 40° away from a narrow zone of dip reversal. South and southeast dips of the beds in the zone of dip reversal in the present high wall suggest that the exact center of the cone was about 100 feet northwest of the quarry wall and that it was removed by quarrying. The strata at the center of the cone are the oldest exposed beds in the quarry and the reef. Reef flank beds become younger with radial distance from the reef's center.

4 NORTH QUARRY—ASPHALT IN REEF FLANK BEDS; PROBABLE FAULT OR FISSURE. Many large blocks of the reef flank dolomite that are scattered about the North Quarry contain asphalt. The asphalt impregnates many porous areas throughout the reef, as well as the bordering interreef rocks to a depth of about 75 feet below the surface of the klint. It is extremely viscous, and on hot days it drips slowly from openings, especially from those in fresh exposures. The occurrence of asphalt in reefs is common in the Chicago region.

Note the narrow vertical zone of brecciated rock along the high wall immediately west of the tunnel under I-80/I-294 in the North Quarry. This appears to be a small northwest-southeast-trending fault that extends for at least .25 mile, along which the dolomite has been brecciated and recemented. The amount of offset is difficult to determine, but, judging from the similarity of lithologies on either side of the fault, the offset is probably not very great. Another possible explanation is a long fissure or filled joint which trends southeast-northwest as do other joints in the quarry.

5 SOUTH QUARRY—REEF TO INTERREEF TRANSITION; MEGABRECCIA. The South Quarry is the oldest part of Thornton Quarry. Within recent years the South Quarry has been used as a dump for tailings and other debris, and many of the significant outcrops in the reef and interreef transition are gradually being covered.

The west wall of the South Quarry exposes the transition from reef flank beds with dips of 20° or 30° at the north end of the outcrop, to nearly horizontal interreef beds along the major portion of the west wall to the south. The interreef rock consists of dense, very fine-grained, cherty, siliceous, argillaceous, thin-bedded dolomite. The most common fossils are sponges and crinoids, less commonly, bryozoans. Locally, a gastropod-trilobite-cephalopod assemblage is found. The most common crinoids, all small delicate species, are *Pisocrinus*, *Gisocrinus*, and *Lecanocrinus*. *Encrinurus* and *Calymene* are the most common trilobites. The overall taxonomic composition and life modes differ significantly between the reef and interreef faunas.

Interlayered with the interreef strata is a reef detritus or megabreccia bed from 4 to 10 feet thick that consists of blocks of a reef type of dolomite in a matrix of argillaceous dolomite. This is a continuous massive unit set off from adjacent units by prominent bedding planes. It extends from the reef flank beds across the entire exposed interreef. The top is marked by a graded bed approximately 1 foot thick. Associated with the megabreccia are several large masses of reef type of dolomite, some of which have been interpreted as "baby" or "satellite" reefs.

End of trip. Have a safe journey home and join us on future geological science field trips.

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PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, the period of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. Ice sheets formed in sub-arctic regions four different times and spread outward until they covered the northern parts of Europe and North America. In North America the four glaciations, in order of occurrence from the oldest to the youngest, are called the Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. 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 during periods 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 cooler periods 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 probably enough to lower sea level more than 300 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 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 unstratified (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.

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.

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. Cone-shaped mounds of coarse outwash, called kames, were formed where meltwater plunged through crevasses in the ice or into ponds along the edge of 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 quickly lost speed and almost immediately dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were moved across 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 trains may be both extensive and thick deposits. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess and Soils

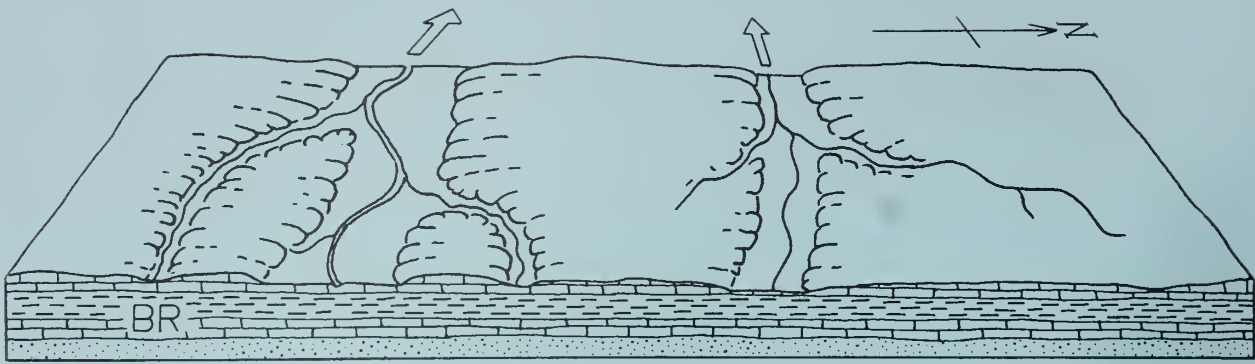
One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. Loess is the name given to such deposits of windblown silt and clay. The silt was blown from the valley trains on the floodplains. Most loess deposition occurred in the fall and winter seasons when 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 those that survive serve as keys to the identity of the beds and are evidence of the passage of a long interval of time.

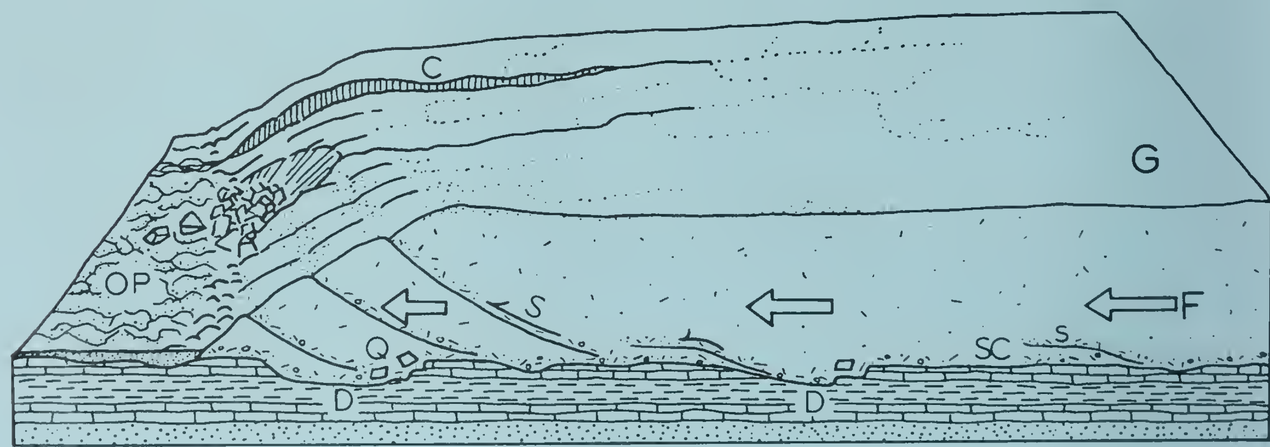
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked 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.

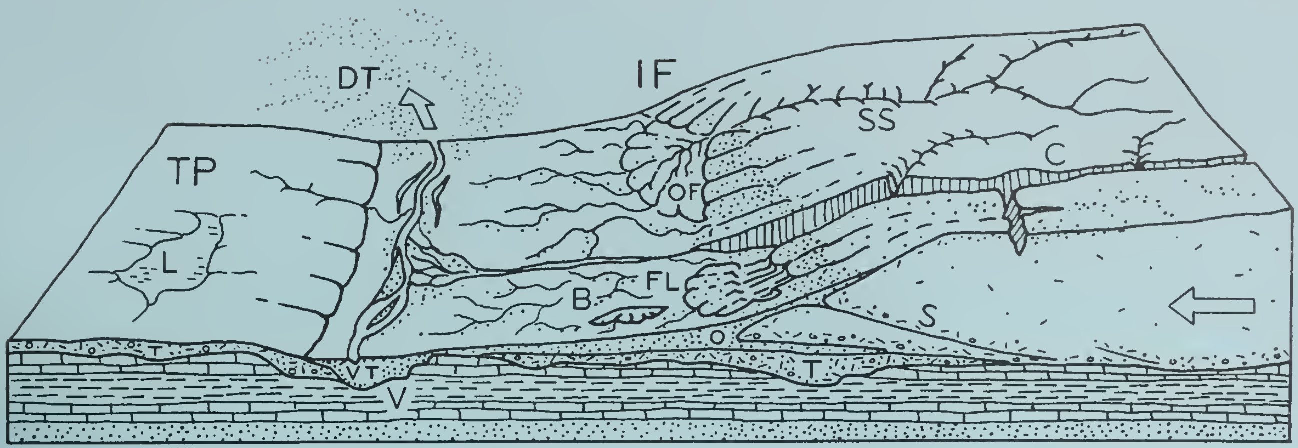
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated--layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



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.



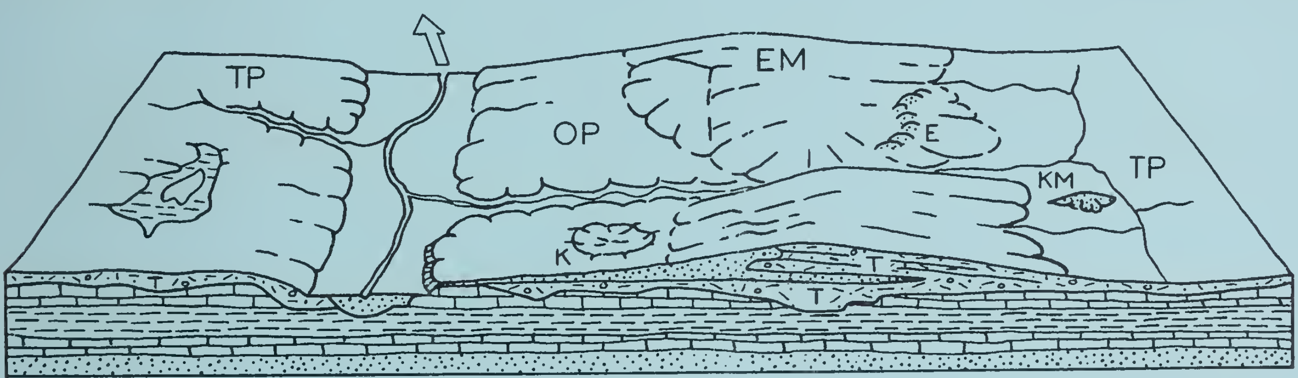
2. The Glacier Advances Southward - As the glacier (G) spreads out from its snowfield, it scours (SC) the soil and rock surface and quarries (Q)--pushes and plucks up--chunks of bedrock. These materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or 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 the 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 , except near its margin. Its ice front advances perhaps as much as a third of a mile per year.



3. <u>The Glacier Deposits an End Moraine</u> - After the glacier advanced across the area, the climate warmed and the ice began to melt as fast as it advanced. 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 was 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 superglacial 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) was left 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) remained a low spot in the terrain. As soon as its ice cover melted, meltwater drained down the valley, cutting it deeper. Later, outwash partly refilled 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.



4. <u>The Region after Glaciation</u> - The climate has warmed even more, the whole ice sheet has melted, and the glaciation has ended. 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.

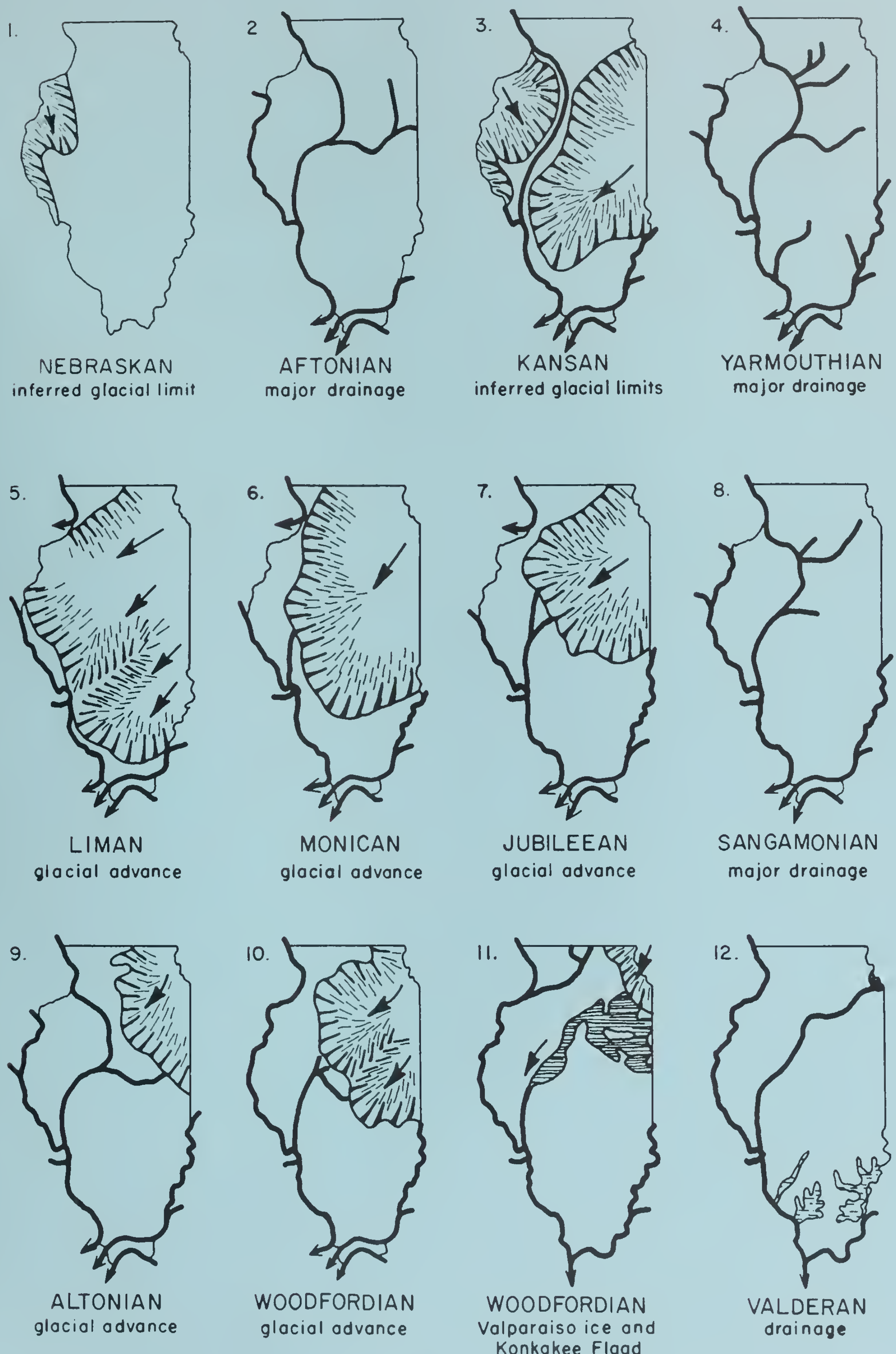
Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel 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

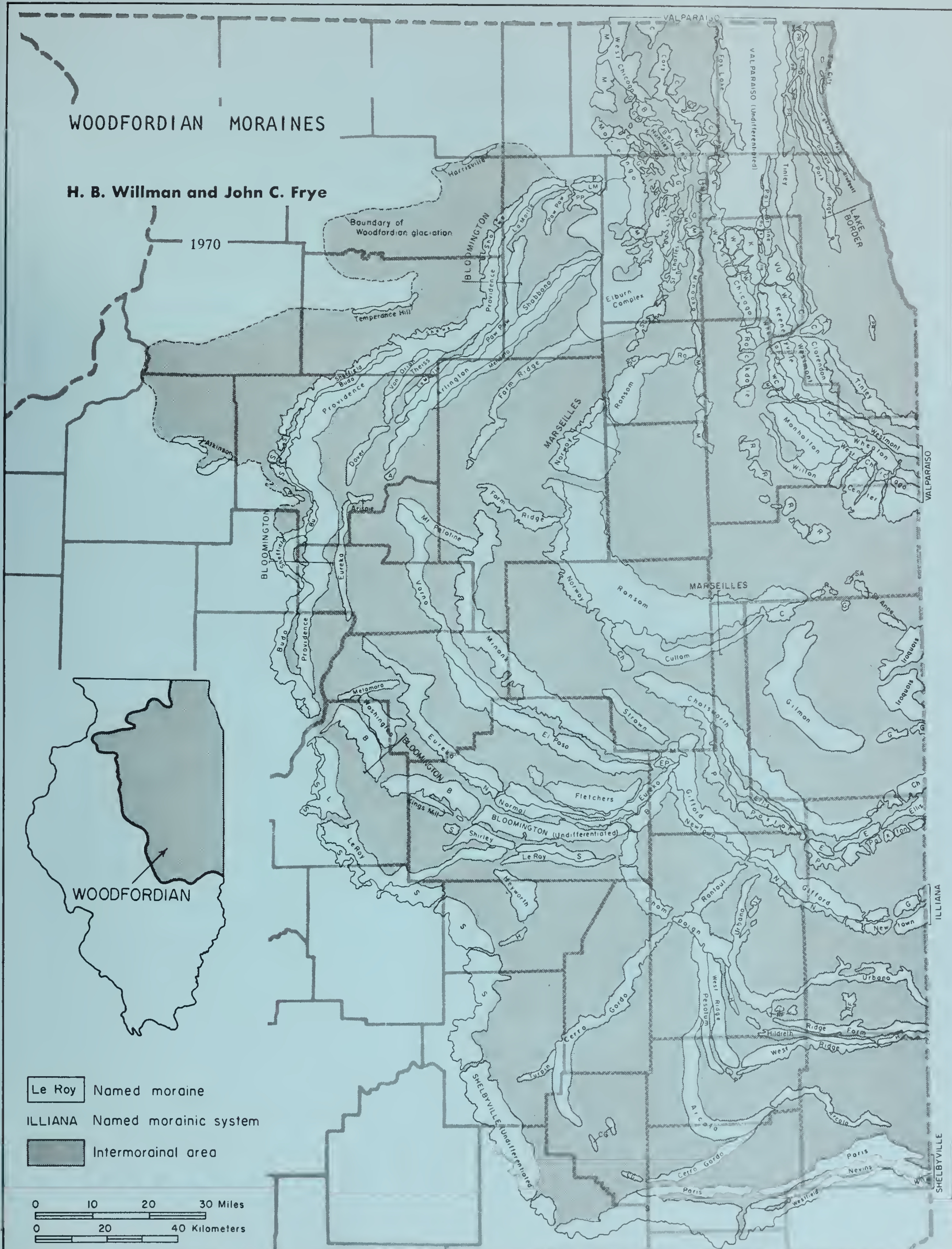
STAGE	SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
HOLOCENE	Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
	7,000		
WISCONSINAN (4th glacial)	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
	11,000		
	Twocreekan	Peat and alluvium	Ice 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
	22,000		
	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering and erosion
	28,000		
	Altonian	Drift, loess	Glaciation in northern Illinois, valley trains along major rivers
	75,000		
SANGAMONIAN (3rd interglacial)		Soil, mature profile of weathering	
	175,000		
ILLINOIAN (3rd glacial)	Jubileean	Drift, loess	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
	Monican	Drift, loess	
	Liman	Drift, loess	
	300,000		
YARMOUTHIAN (2nd interglacial)		Soil, mature profile of weathering	
	600,000		
KANSAN (2nd glacial)		Drift, loess	Glaciers from northeast and northwest covered much of state
	700,000		
AFTONIAN (1st interglacial)		Soil, mature profile of weathering	
	900,000		
NEBRASKAN (1st glacial)		Drift	Glaciers from northwest invaded western Illinois
	1,200,000 or more		

(Illinois State Geological Survey, 1973)

SEQUENCE OF GLACIATIONS AND INTERGLACIAL
DRAINAGE IN ILLINOIS



(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
VALPARAISO
VALPARAISO (Undifferentiated)
LAKE BORDER
BLOOMINGTON
MARSEILLES
ILLIANA
SHELBYVILLE
BLOOMINGTON (Undifferentiated)
SHELBYVILLE (Undifferentiated)
Elburn Complex
WOODFORDIAN
Le Roy
Named moraine
ILLIANA
Named morainic system
Intermorainal area
0 10 20 30 Miles
0 20 40 Kilometers

ILLINOIS STATE GEOLOGICAL SURVEY

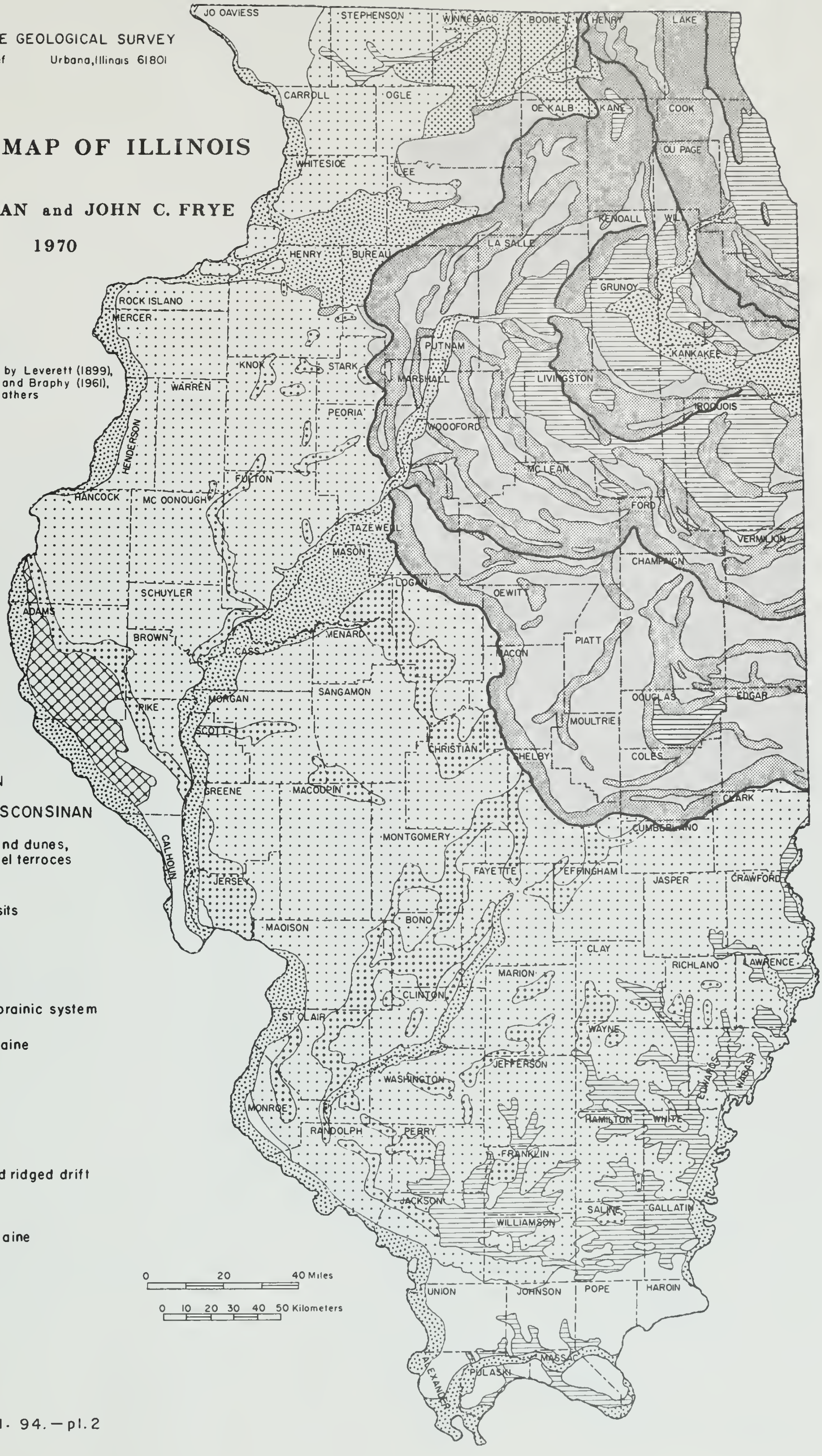
John C. Frye, Chief   Urbana, Illinois 61801

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



EXPLANATION

HOLOCENE AND WISCONSINAN

Alluvium, sand dunes, and gravel terraces

WISCONSINAN

Lake deposits

WOODFORDIAN

Moraine

Front of morainic system

Groundmoraine

ALTONIAN

Till plain

ILLINOIAN

Moraine and ridged drift

Groundmoraine

KANSAN

Till plain

DRIFTLESS

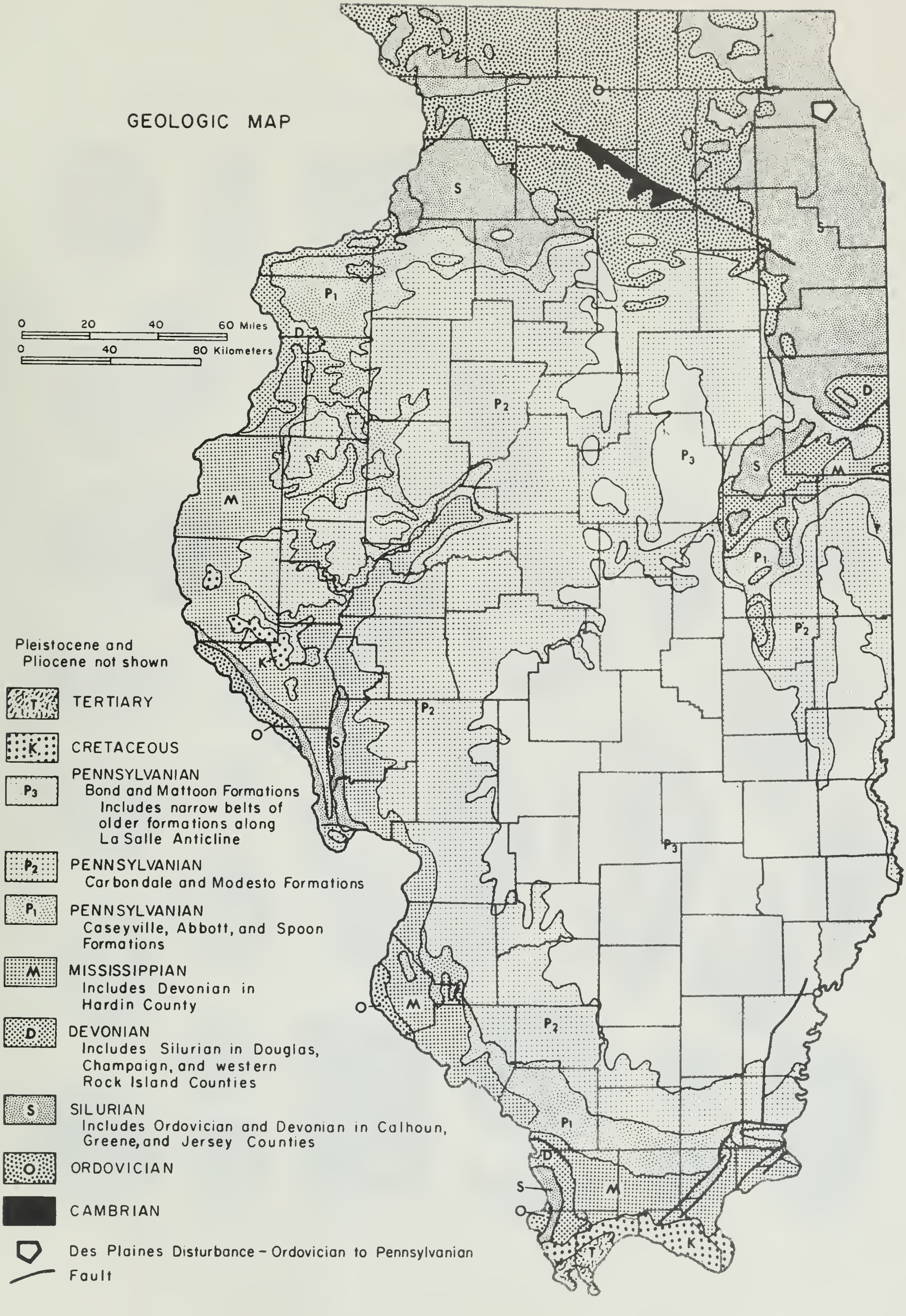
0 20 40 Miles

0 10 20 30 40 50 Kilometers

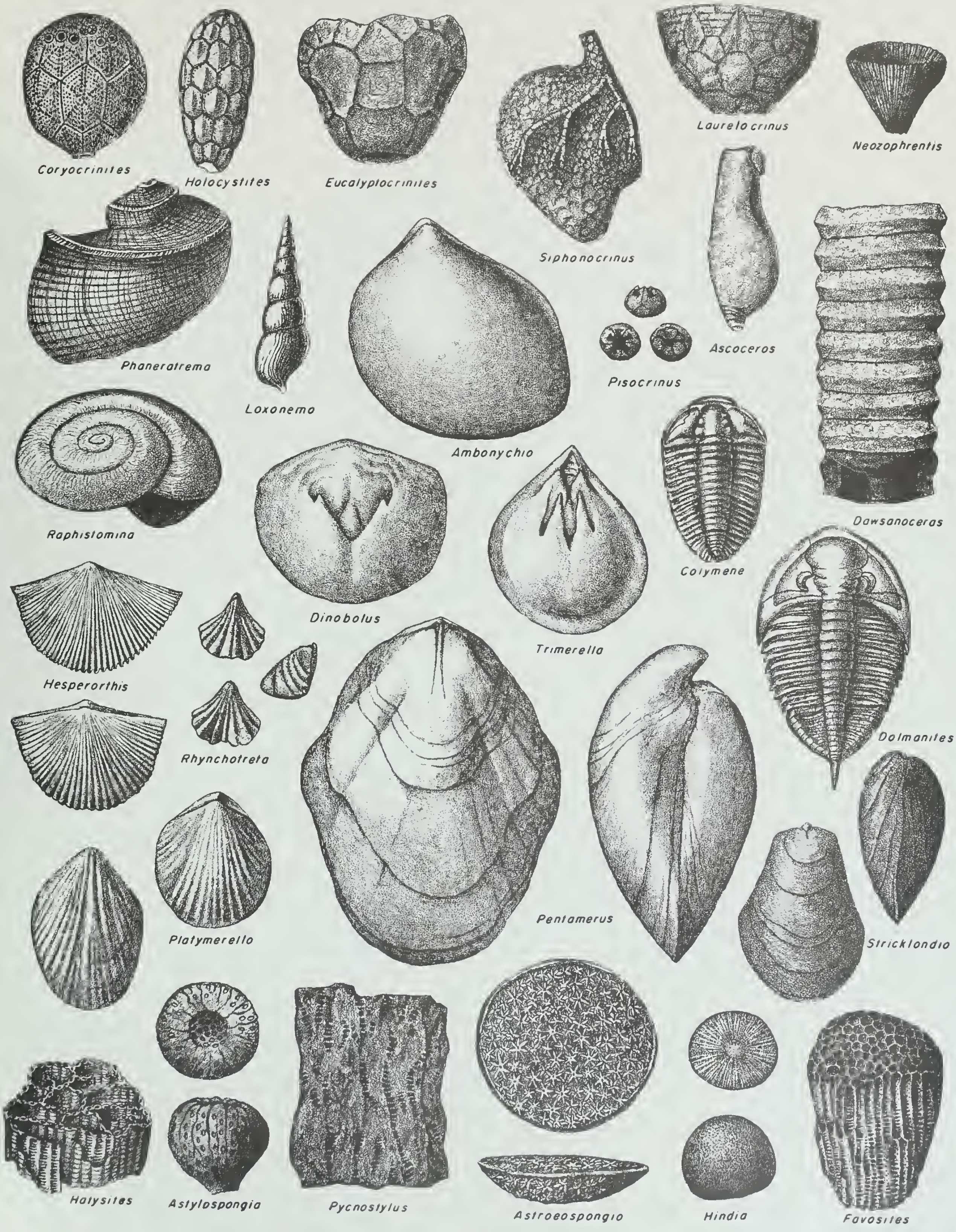
Modified from Bull. 94.—pl. 2

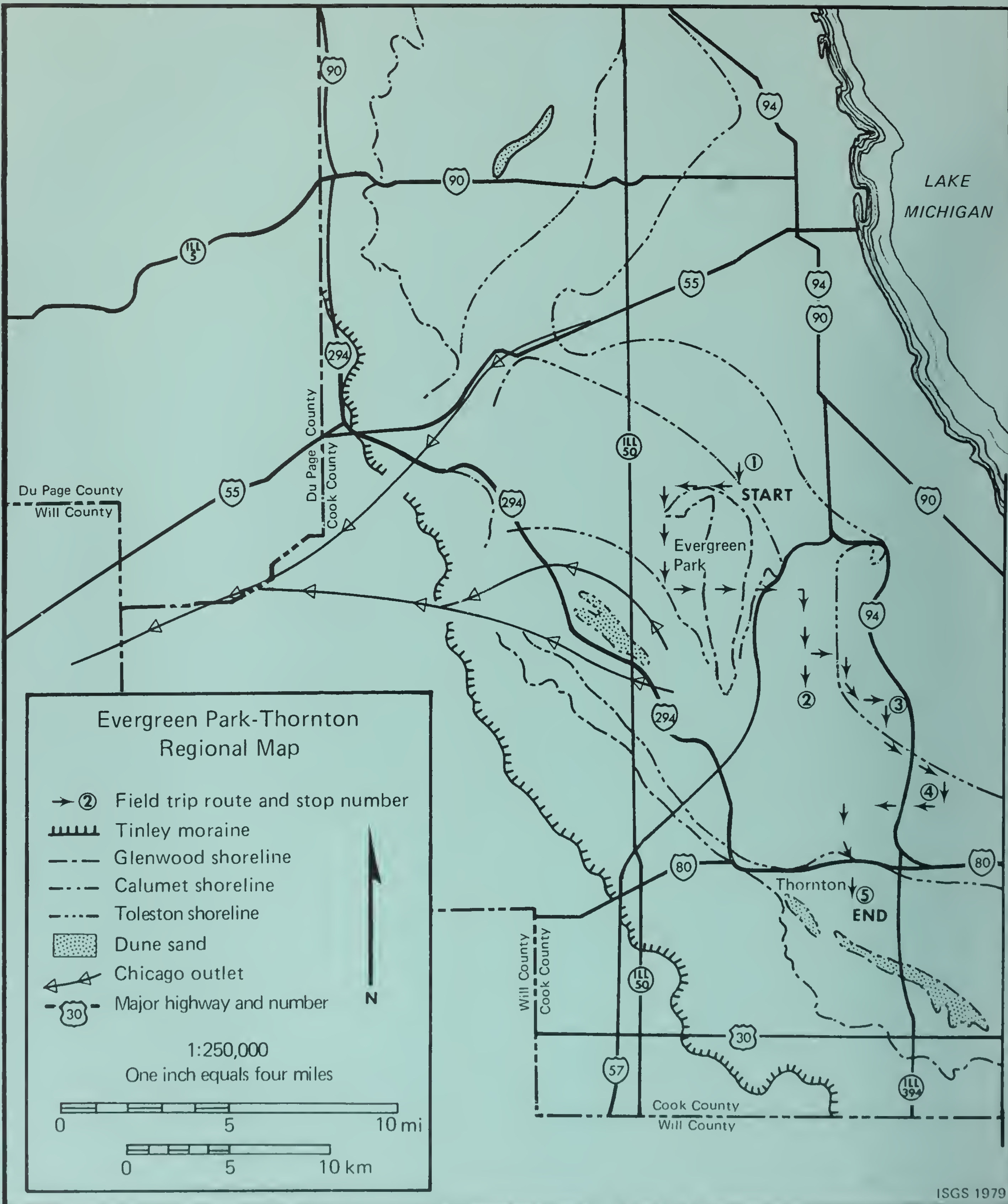
PHYSIOGRAPHIC DIVISIONS OF ILLINOIS

Reprinted 1978


GEOLOGIC MAP
0 20 40 60 Miles
0 40 80 Kilometers
Pleistocene and Pliocene not shown
T TERTIARY
K CRETACEOUS
P3 PENNSYLVANIAN
Bond and Mattoon Formations
Includes narrow belts of older formations along La Salle Anticline
P2 PENNSYLVANIAN
Carbondale and Modesto Formations
P1 PENNSYLVANIAN
Caseyville, Abbott, and Spoon Formations
M MISSISSIPPIAN
Includes Devonian in Hardin County
D DEVONIAN
Includes Silurian in Douglas, Champaign, and western Rock Island Counties
S SILURIAN
Includes Ordovician and Devonian in Calhoun, Greene, and Jersey Counties
O ORDOVICIAN
CAMBRIAN
Des Plaines Disturbance – Ordovician to Pennsylvanian
Fault
S
P1
D
P2
P3
S
M
M
P1
P2
K
S
O
P2
P3
M
O
P2
P1
D
S
M
O
T
K

REPRESENTATIVE SILURIAN FOSSILS FROM NORTHWESTERN ILLINOIS





Evergreen Park-Thornton
Regional Map
Field trip route and stop number
Tinley moraine
Glenwood shoreline
Calumet shoreline
Toleston shoreline
Dune sand
Chicago outlet
Major highway and number
1:250,000
One inch equals four miles
0 5 10 mi
0 5 10 km
N
LAKE MICHIGAN
START
Evergreen Park
Thornton
END
Du Page County
Will County
Cook County
ISGS 1979