GUIDE TO THE GEOLOGY OF THE DECATUR AREA, MACON AND CHRISTIAN COUNTIES

David L. Reinertsen

Field Trip Guide Leaflet 1991C, September 14, 1991
Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

Cover photo by D. L. Reinertsen

Wisconsinan glacial deposits exposed along the north side of the Sangamon River at Stop 7.

GEOLOGICAL SCIENCE FIELD TRIPS The Educational Extension Unit of the Illinois State Geological Survey conducts four free tours each year to acquaint the public with the rocks, mineral resources, and landscapes of Illinois. Each field trip is an all-day excursion through one or more Illinois counties. Frequent stops are made to explore interesting phenomena, explain the processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers preparing earth science units. Grade school students are welcome, but each must be accompanied by a parent or other responsible adult. High school classes should be supervised by at least one adult for each ten students.

A list of earlier field trip guide leaflets for planning class tours and private outings may be obtained by contacting the Educational Extension Unit, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820. Phone: (217) 244-2407 or 333-7372.

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Printed by authority of the State of Illinois/1991/500

GUIDE TO THE GEOLOGY OF THE DECATUR AREA, MACON AND CHRISTIAN COUNTIES

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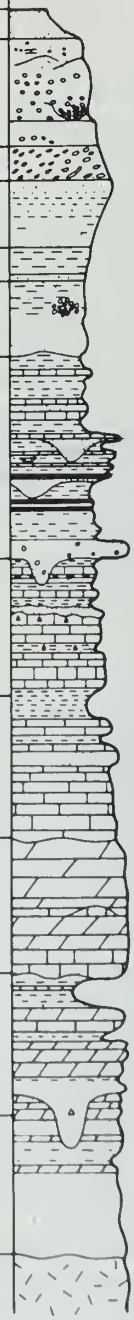
CONTENTS

FIGURES

Era		Period or System and Thickness	Epoch	Age (years ago)	General Types of Rocks
CENOZOIC "Recent Life"	Age of Mammals	Quaternary 0-500'	Holocene	10,000	Recent—alluvium in river valleys
			Pleistocene Glacial Age	1.6 m.	Glacial till, glacial outwash, gravel, sand, silt, lake deposits of clay and silt, loess and sand dunes; covers nearly all of state except northwest corner and southern tip
		Tertiary 0-500'	Pliocene	5.3 m.	Chert gravel, present in northern, southern, and western Illinois
			Eocene	36.6 m.	Mostly micaceous sand with some silt and clay; present only in southern Illinois
			Paleocene	57.8 m.	Mostly clay, little sand; present only in southern Illinois
MESOZOIC "Middle Life"	Age of Reptiles	Cretaceous 0-300'		66.4 m.	Mostly sand, some thin beds of clay and, locally, gravel; present only in southern Illinois
				144 m. – 286 m.	
PALEOZOIC "Ancient Life"	Age of Amphibians and Early Plants	Pennsylvanian 0-3,000' ("Coal Measures")			Largely shale and sandstone with beds of coal, limestone, and clay
				320 m.	
		Mississippian 0-3,500'			Black and gray shale at base; middle zone of thick limestone that grades to siltstone, chert, and shale; upper zone of interbedded sandstone, shale, and limestone
				360 m.	
	Age of Fishes	Devonian 0-1,500'			Thick limestone, minor sandstones and shales, largely chert and cherty limestone in southern Illinois; black shale at top
				408 m.	
	Age of Invertebrates	Silurian 0-1,000'			Principally dolomite and limestone
				438 m.	
		Ordovician 500-2,000'			Largely dolomite and limestone but contains sandstone, shale, and siltstone formations
				505 m.	
		Cambrian 1,500-3,000'			Chiefly sandstones with some dolomite and shale, exposed only in small areas in north-central Illinois
				570 m	
ARCHEOZOIC and PROTEROZOIC					Igneous and metamorphic rocks, known in Illinois only from deep wells



Rock succession chart

GEOLOGIC FRAMEWORK OF THE DECATUR AREA

The geology, landscape, and mineral resources in parts of Macon and Christian Counties in central Illinois are the focus of the Decatur geological field trip. Decatur is 38 miles east of Springfield, about 180 miles south-southwest of Chicago, and slightly more than 115 miles northeast of St. Louis.

Characterized by gently rolling uplands that developed from deposits left by two periods of continental glaciation during the past 300,000 years, the area's surface continuity is broken where the two sheets of glacial deposits meet and where they both are eroded by the Sangamon River and its tributaries. Sand and gravel resources are abundant in the glacial deposits. Other mineral resources produced from the bedrock underlying these counties include coal, petroleum, and stone.

Bedrock

Rock units (beds), commonly solid and strongly cemented materials, underlie the relatively loose (unconsolidated) glacial deposits at and near the surface of the earth. The geology of the Macon-Christian counties area, like the rest of Illinois, has undergone many changes throughout the several billion years of geologic time (see rock succession column, facing page). The oldest rocks beneath the area of the field trip belong to the ancient Precambrian basement complex. We know relatively little about these rocks from direct observations because they are not exposed at Earth's surface anywhere in Illinois. Only about 30 drill holes have reached deep enough in Illinois for geologists to collect samples from Precambrian rocks. From the samples, however, we know that these ancient rocks consist of mostly granitic igneous and possibly metamorphic, crystalline rocks about 1.5 to 1.0 billion years old. These ancient rocks, which underwent deep weathering and erosion when they were part of Earth's surface up to nearly 0.6 billion years ago, formed a landscape that must have been similar to the present-day Missouri Ozarks.

You will note that the long interval for which we have no rock record in Illinois—from the time Precambrian rocks were formed until Cambrian sediments accumulated—is almost as long as recorded geologic time from the Cambrian to the present. Although geologists seldom see Precambrian rocks, except as cuttings from drill holes, they can determine some basement complex char-characteristics by using various techniques. For example, evidence from surface mapping, gravity and magnetic field measurements, and seismic exploration for oil in southernmost Illinois near the Kentucky-Illinois Fluorspar Mining District indicates that rift valleys similar to those in east Africa formed during Early and Middle Cambrian time (570 to 523 million years ago). At this time plate tectonic movements (slow global deformation) were beginning to rip apart an ancient Precambrian supercontinent. These buried rift valleys in the midcontinent region are called the Rough Creek Graben and the Reelfoot Rift (fig. 1).

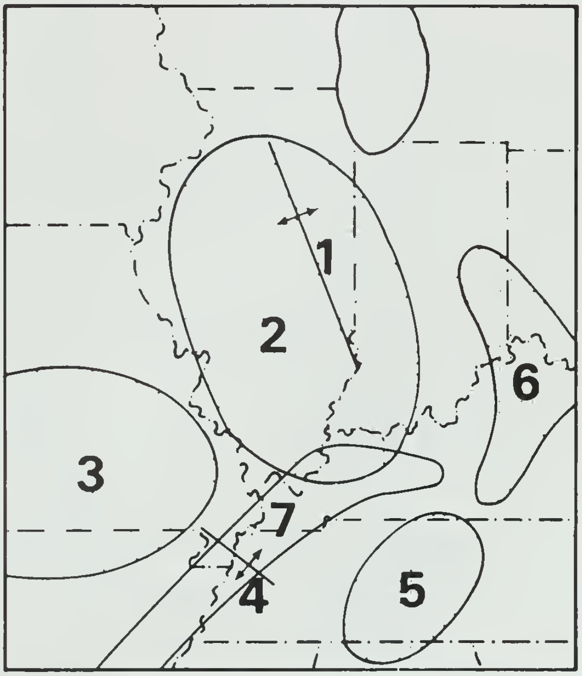


Figure 1 Location of some major structures in the Illinois region: (1) La Salle Anticlinal Belt, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, and (7) Reelfoot Rift, southwest to northeast, and Rough Creek Graben, west to east.

SYSTEM	SERIES	GROUP OR FORMATION	THICKNESS (ft)	DESCRIPTION	RESOURCES
QUATER-NARY	PLEISTOCENE		0-300	Alluvium, loess, and glacial drift	Sand, gravel, and clay; major ground-water supplies from thicker sand and gravel aquifers in bed-rock valleys and Sangamon River bottom.
PENNSYLVANIAN		McLeansboro Kewanee McCormick	375-1100	Shale, sandstone, limestone, clay, and coal	Clay; large coal reserves; small ground-water supplies from fractured shale, creviced lime-stone, and permeable sandstone.
MISSISSIPPIAN	CHESTERIAN		0-275	Shale, limestone, and sandstone	Petroleum
	VALMEYERAN	Aux Vases	0-50	Limestone, partly dolomitic; shale; and sandstone	
		Ste. Genevieve	0-100		
		St. Louis	70-225		
		Warsaw	100-350		
		Keokuk-Burlington	20-275		
		Fern Glen	0-100		
	KINDERHOOKIAN		25-100	Shale and thin limestone	
DEVONIAN			0-175	Limestone and shale	
SILURIAN	NIAGARAN		125-400	Dolomite, some limestone	
	ALEXANDRIAN		25-50		
ORDOVICIAN	CINCINNATIAN	Maquoketa	170-225	Principally shale	
	CHAMPLAINIAN	Galena	125-175	Limestone and dolomitic limestone	
		Platteville	175-325		
		Joachim	25-75	Dolomite	
		St. Peter	75-225	Sandstone	

Figure 2 Unconsolidated deposits and bedrock in the Springfield-Decatur region (Bergstrom et al. 1976).

ORDOVICIAN	CANADIAN	Prairie du Chien	675-775	Dolomite and sandstone	
CAMBRIAN	CROIXAN	Eminence	140-175	Dolomite	Fractured limestones and dolomites and porous, permeable sandstones are possible reservoirs for waste disposal and gas storage.
		Potosi	240-300		
		Franconia	225-300	Principally dolomite	
		Ironton-Galesville	50-150	Sandstone; thin dolomite at top	
		Eau Claire	425-550	Siltstone, limestone, dolomite, and shale	
		Mt. Simon	750-1800	Sandstone	
PRECAMBRIAN				Granite and other igneous rocks	

Figure 2 *continued*

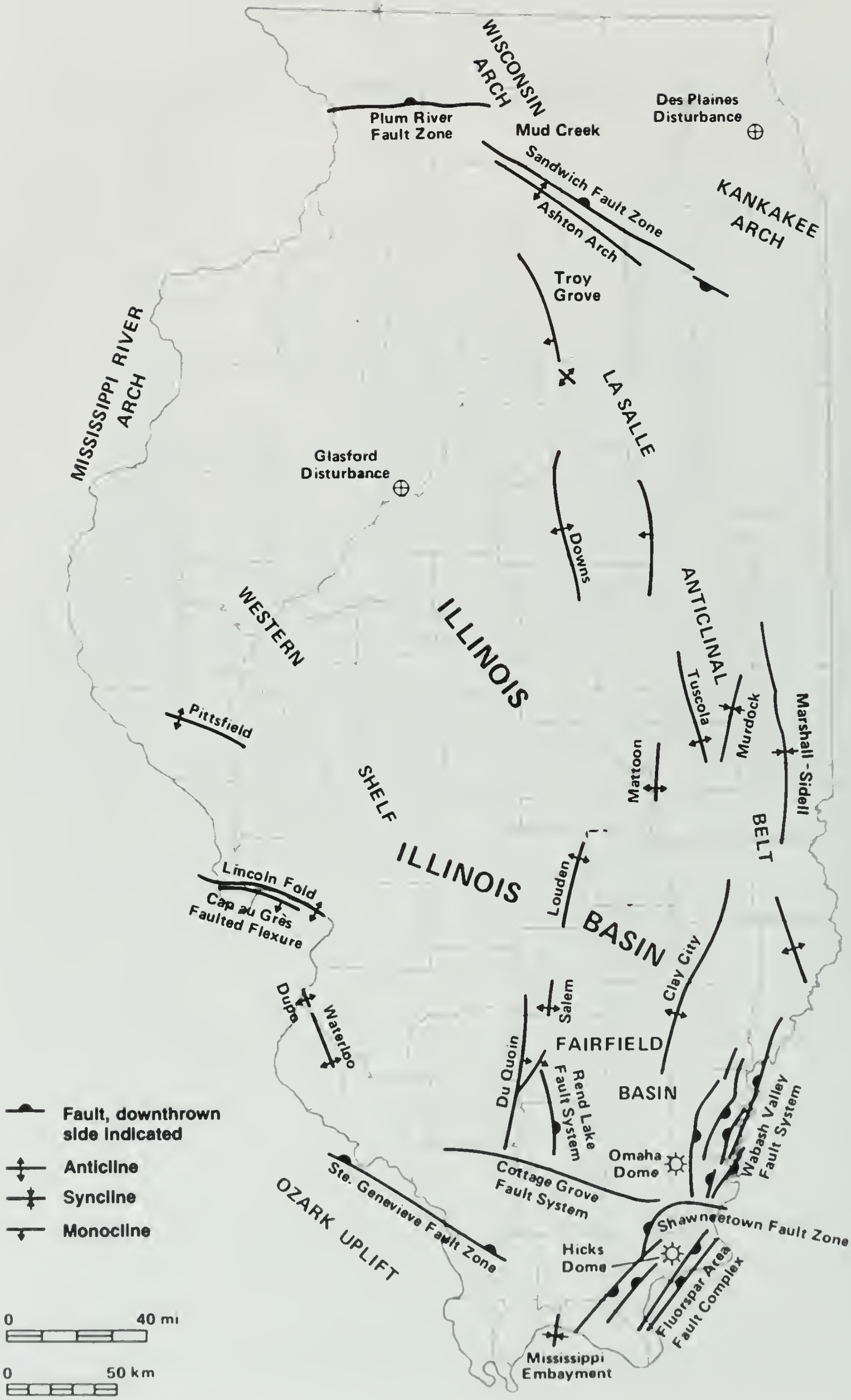


Figure 3 Structural features of Illinois (Treworgy 1981).

From Late Cambrian (523 million years ago) into Permian time (perhaps 286 million years ago), the irregular ancient landscape slowly began to sink as a broad embayment across much of Illinois, western Indiana, and western Kentucky. This embayment widened southward to join large embayments in Arkansas/Oklahoma, and Alabama. This subsidence permitted the invasion of a shallow sea from the south and southwest. During the several hundred million years of the Paleozoic Era, the embayment continued to receive clastic, continental sediments (washed in from surrounding landmasses) and marine sediments formed by precipitation of carbonates from the seas and by the accumulation of abundant skeletal remains of marine organisms. Because of the warping of Earth's crust, seas withdrew from the embayment periodically. Thus, the sediments were subjected to weathering and erosion from time to time. As a result, there are gaps in the sedimentary record in Illinois. The geologic column in figure 2 shows the succession of rock strata that a drill bit might encounter in this area *if* all the sediments deposited during that time were still present. At least 15,000 feet of sedimentary strata accumulated.

In the field trip area, bedrock strata range from about 523 million years old (Cambrian Period) to perhaps 295 million years old (Pennsylvanian Period). Sediments and organic debris deposited in shallow seas and swamps during the Pennsylvanian Period ultimately formed bedrock strata, consisting of sandstone, siltstone, shale, limestone, coal, and underclay. None of these rocks are exposed at the surface in the field trip area, but they do occur immediately beneath a cover of glacial till. The thickness of Pennsylvanian strata increases from slightly more than 700 feet in the northwestern part of the area to nearly 900 feet just southeast of Decatur.

Paleozoic sedimentary strata in southwestern Macon County ranges from about 6,500 feet thick in the north to more than 7,100 feet thick in the south. Cambrian, Ordovician, Silurian, Devonian, Mississippian, and Pennsylvanian-age strata (fig. 2) underlie all or parts of the two counties.

Structural and Depositional History

The strata underlying Illinois are divided into formations. A formation is a consistent body of rocks with easily recognizable top and bottom boundaries, readily traceable in the field and sufficiently widespread to be represented on a map. Many of the sedimentary formations have conformable contacts; that is, no significant interruptions in deposition took place between them (fig. 2). In some instances, even though the composition and appearance of the rocks change significantly at the contact between two formations, the fossils in the rocks and the relationships between the rocks at the contact indicate that deposition essentially was continuous. At other contacts, however, the lower formation was subjected to weathering, and partial erosion occurred before the overlying formation was deposited. The fossils and other evidence in the formations indicate a significant gap in the time between deposition of the lower unit and the overlying unit. This type of contact is called an unconformity. Where the beds above and below an unconformity are essentially parallel, the unconformity is called a disconformity; where the lower beds have been tilted and eroded before the overlying beds were deposited, the contact is called an angular unconformity. Figure 2 shows several major unconformities, each representing a long interval of time, during which a considerable amount of rock, present in nearby regions, was either eroded or never deposited in parts of this area. Several smaller unconformities are present, representing shorter time intervals, and thus smaller gaps in the depositional record.

Near the end of the Mississippian Period (320 million years ago), gentle arching of the bedrock in eastern Illinois initiated the broad upwarp of the La Salle Anticlinal Belt (figs. 1 and 3), a complex structure on which smaller structures such as domes, anticlines, and synclines are superimposed. This gradual arching continued through the Pennsylvanian Period. Because the

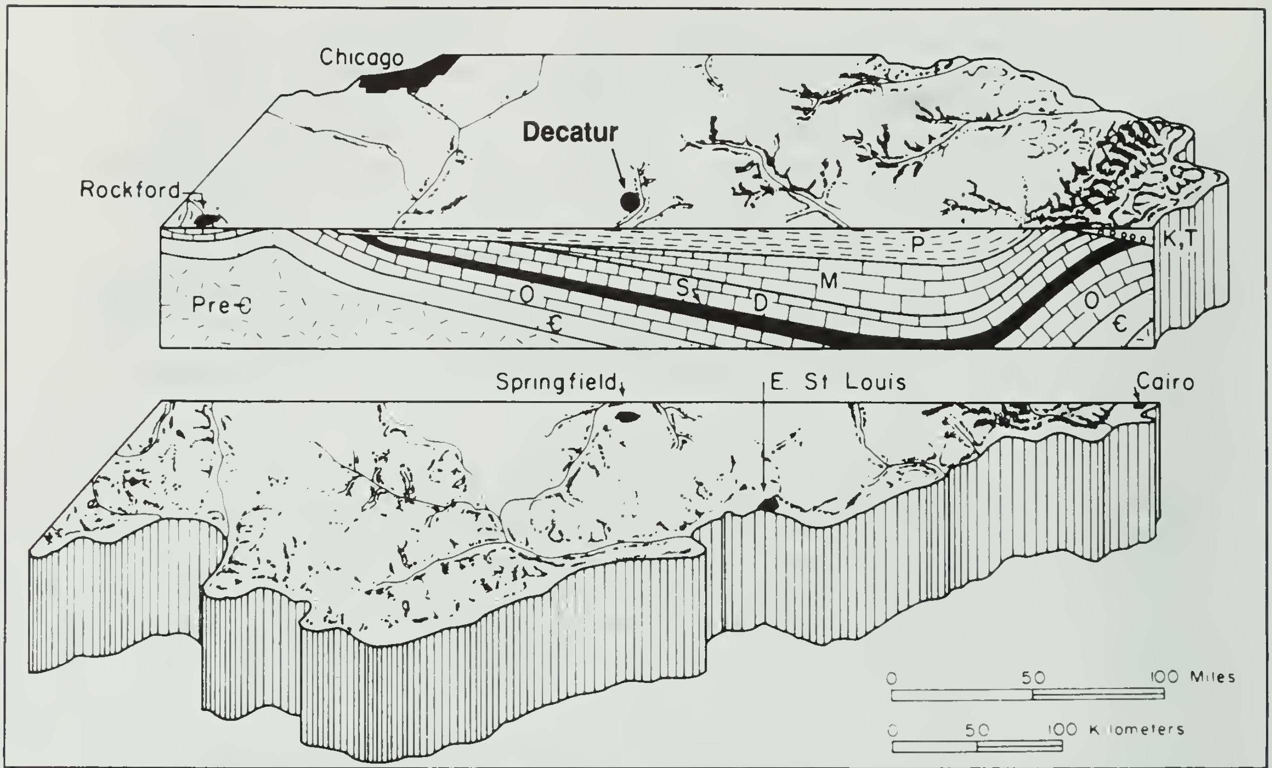


Figure 4 Stylized north-south cross section shows structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks have been greatly exaggerated and younger, unconsolidated surface deposits have been eliminated. The oldest rocks, Precambrian (Pre-C) granites, form a depression 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). Scale is approximate.

youngest Pennsylvanian strata were either eroded or never deposited in the area of the anticlinal belt, we have no evidence to indicate when movement along the belt ceased. Perhaps movement stopped by the end of the Pennsylvanian or a little later during the Permian Period, the youngest rock system of the Paleozoic Era. There are no known Permian rocks in Illinois.

During the Mesozoic Era, which follows the Paleozoic Era, the rise of the Pascola Arch (fig. 1) in southeastern Missouri and western Tennessee formed the Illinois Basin and separated it from other basins to the south. The Illinois Basin is a broad downwarp covering much of Illinois, southern Indiana, and western Kentucky (figs. 1 and 4). Development of the Pascola Arch, in conjunction with the earlier sinking of deeper parts of the area that would become the Illinois Basin, gave the basin its present asymmetrical, spoon shape. The geologic map (fig. 5) shows the distribution of the rock systems as they occur at the bedrock surface.

Evidence from outcrops and drill holes elsewhere in Illinois indicate that younger rocks of latest Pennsylvanian and perhaps Permian age may have covered extensive parts of Illinois. Even younger rocks of Mesozoic and Cenozoic ages may have been present in parts of the state. Geologists believe, from the degree of metamorphism (rank) of coal deposits and other indirect evidence, that perhaps as much as 1 mile of latest Pennsylvanian and younger rocks once covered northern Illinois. During the 243 million years or so between the close of the Paleozoic Era and the onslaught of glaciation 1 to 2 million years ago, ample time passed for several thousand feet of strata to erode. Furthermore, all traces have been erased of any post-Pennsylvanian bedrock that may have been present, except for scattered occurrences in western and extreme southern Illinois.

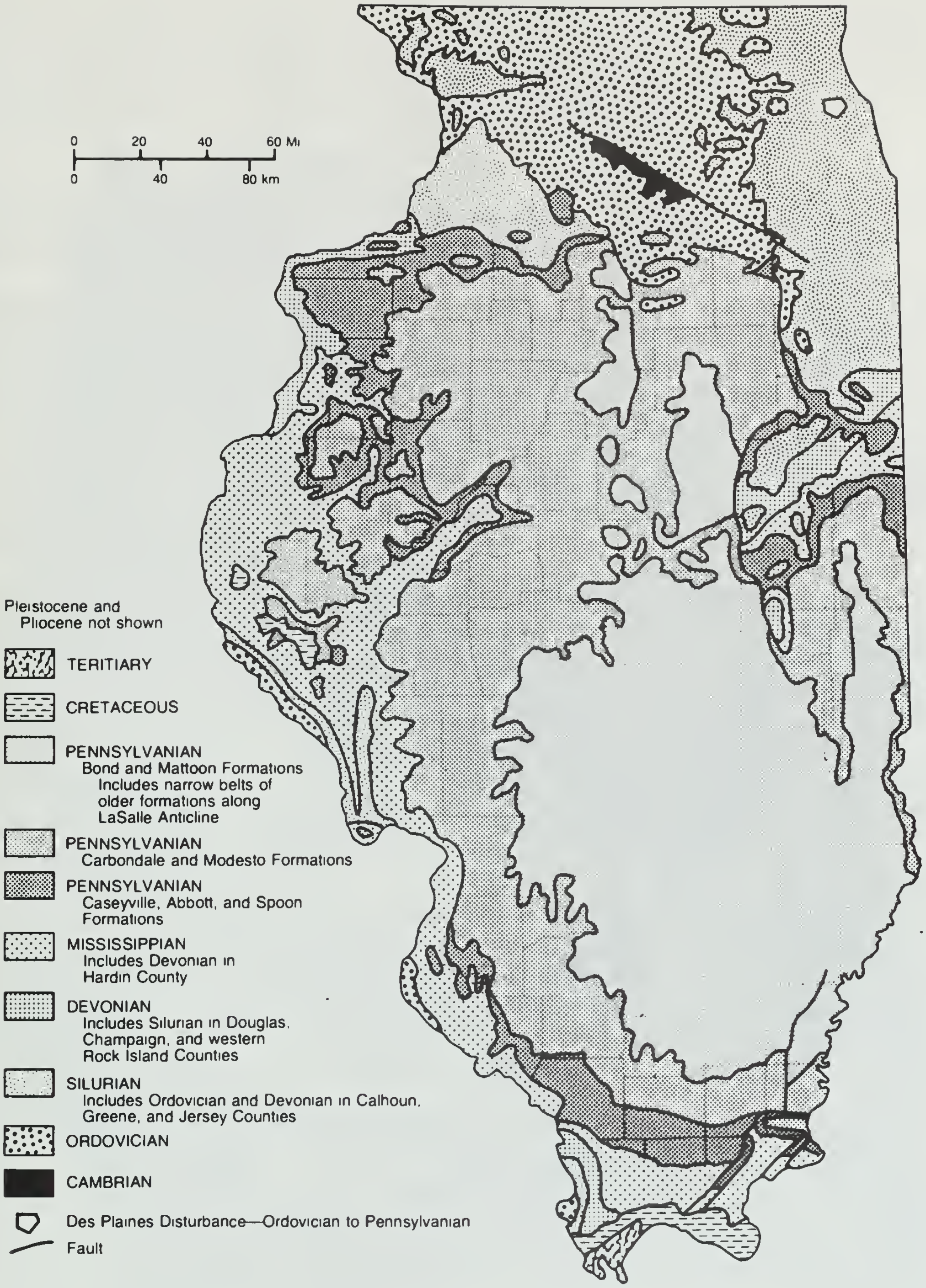


Figure 5 Bedrock geology beneath surficial deposits.

The Decatur field trip area is located in the north-central part of the Illinois Basin. Bedrock strata in the area are tilted slightly to the south and east toward the deeper part of the basin in Hamilton and White counties, about 125 miles away. Because tilting of the bedrock layers occurred several times during the Paleozoic Era, dips of successive strata are not always parallel to one another.

During the Mesozoic and part of the Cenozoic Eras, before the start of glaciation, the ancient Illinois land surface was exposed to long, intense weathering and erosion, which carved a

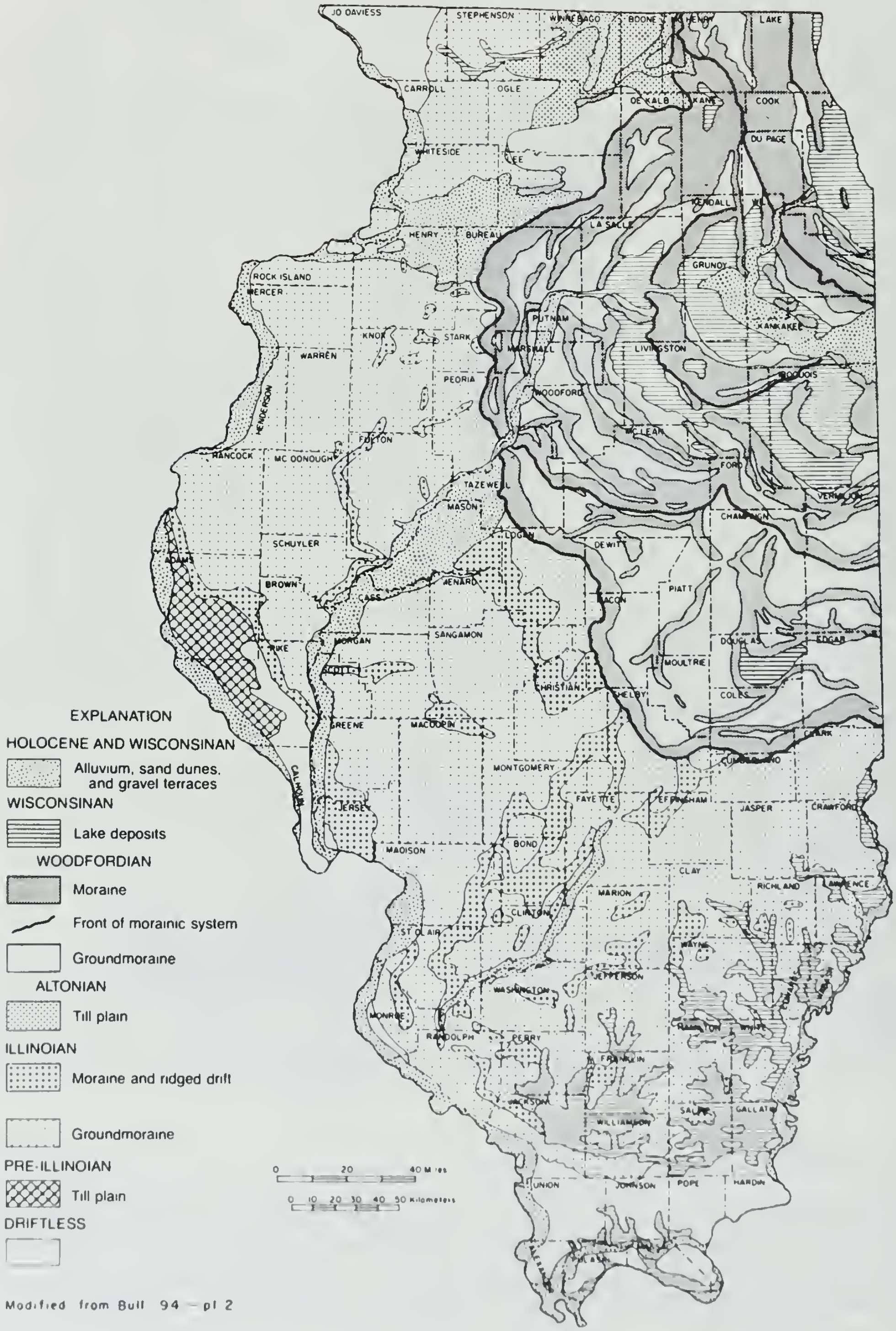


Figure 6 Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

series of deep valley systems into the gently tilted bedrock formations. Later, the topography was subdued considerably by the repeated advance and melting of the glaciers, which scoured and scraped the old erosion surface, affecting all bedrock except the Precambrian rocks. The glaciers finally melted away, leaving nonindurated deposits into which the Modern Soil developed.

Glacial History

A brief history of glaciation in North America and a description of the deposits commonly left by glaciers is found in *Pleistocene Glaciations in Illinois*, a section at the back of this guide.

Beginning about 1.6 million years ago during the Pleistocene Epoch, massive ice sheets called continental glaciers flowed slowly southward from centers of snow and ice accumulation in Canada. The last of these glaciers, which were several hundred feet thick, melted from northeastern Illinois about 13,500 years before the present (B.P.). Although ice sheets covered parts of Illinois several times during the Pleistocene Epoch, pre-Illinoian drift deposits are known only from the deeper parts of the largest bedrock valleys. During the Illinoian glaciation, around 270,000 years B.P., North American continental glaciers reached their southernmost extent, advancing as far south as the northern part of Johnson County, slightly more than 150 miles south of Decatur (fig. 6).

Until recently, glaciologists had assumed that ice thicknesses of 1 mile or more were reasonable for these glaciers. However, the ice may have been only about 2,000 feet thick in the Lake Michigan Basin and perhaps about 700 feet thick across much of the land surface (Clark et al. 1988). These conclusions resulted from studying (1) the degree of consolidation and compaction of rock and soil materials that must have been under the ice; (2) comparisons between the inferred geometry and configuration of the ancient ice masses and those of present-day glaciers and ice caps; (3) comparisons between the mechanics of ice-flow in modern-day glaciers and ice caps and those inferred from detailed studies of the ancient glacial deposits; and (4) the amount of rebound of the Lake Michigan Basin, which had been depressed by the tremendous weight of the ice.

Although Illinoian glaciers probably formed morainic ridges similar to those of the later Wisconsinan glaciers, Illinoian moraines are not nearly so prominent nor apparently so numerous. In addition, they have been exposed to weathering and erosion for thousands of years longer than their younger Wisconsinan counterparts. The most prominent Illinoian end moraine in central Illinois is the Buffalo Hart, nearly 30 miles west of Decatur, where this irregular, discontinuous tract of ridges and knobs stands as much as 75 feet above the uplands.

As mentioned earlier, erosion had carved an extensive network of bedrock valleys deeply into the irregular bedrock surface by the time glaciation began about 1.6 million years ago. As glaciation began, streams changed from erosion to aggradation—that is, the streams began to build up and fill in their channels because the flow or volume of water was insufficient to carry increasing loads of sediments. During times of deglaciation, vast quantities of meltwater and sediments were released from the waning ice front. No evidence, however, indicates that any pre-Illinoian fills in the preglacial valleys were ever completely flushed out of their channels by succeeding deglaciation meltwater torrents.

The topography of the bedrock surface through much of Illinois is largely hidden from view by glacial deposits, except along the major streams and in areas mantled by thin drift near the glacial margins. As is true in many other parts of Illinois, however, studies of mine shafts, water-well logs, and other drill-hole information show that the Decatur field-trip area is in a region where glacial drift is thick enough to completely mask the underlying bedrock surface. Partly because of the irregular bedrock surface and erosion, glacial drift is distributed unevenly across Macon and eastern Christian counties. In the buried Middleton bedrock valley that

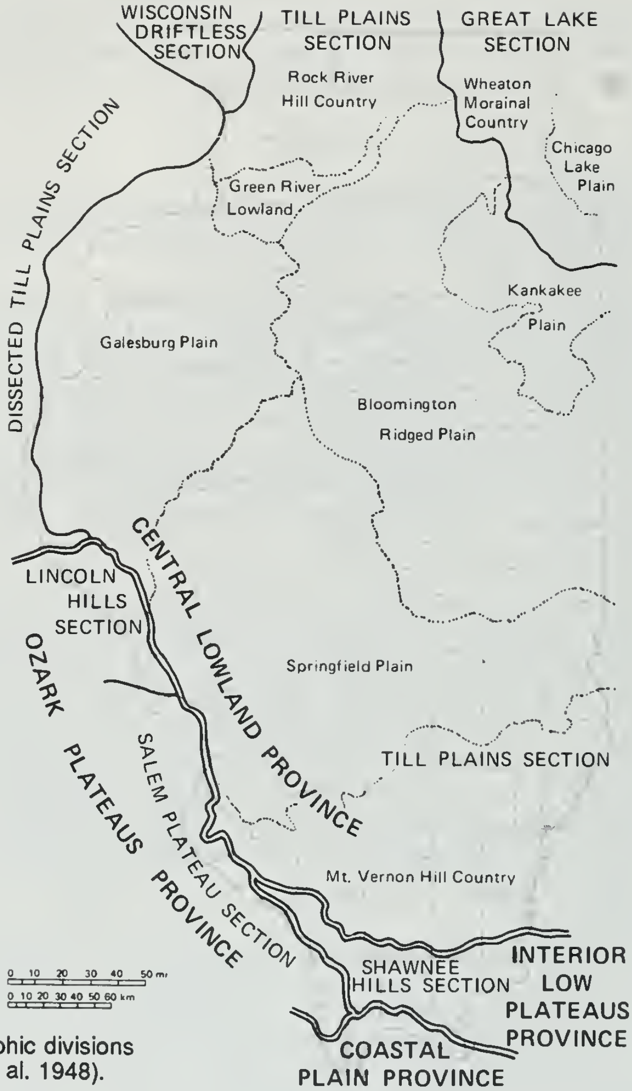


Figure 7 Physiographic divisions of Illinois (Leighton et al. 1948).

extends from southeast to northwest across the area just south of Decatur, glacial drift is more than 200 feet thick, while drift across the neighboring uplands generally ranges from 50 to 100 feet thick. Drift thickness increases northward in Macon County to more than 300 feet.

A cover of Woodfordian loess (pronounced "luss"), windblown silt, mantles the glacial drift in Macon and neighboring counties. These fine-grained dust deposits of Wisconsinan age are about 9 feet thick in the western part of the area, but they thin to less than 4 feet in eastern Macon County. The fertile soils in the field trip area have developed in the loess and the underlying glacial tills.

Physiography

This is the general term used for describing landforms; a physiographic province is a region in which the relief or landforms differs markedly from those is adjacent regions. The Decatur field-trip area is situated in the Till Plains Section of the Central Lowlands Province (fig. 7). The present gross features of the Till Plains Section are determined largely by its preglacial topography. The Till Plains Section has seven divisions in Illinois; we encounter two of them on this field trip—the Springfield Plain and the Bloomington Ridged Plain.

The Springfield Plain on the western and southwestern part of the field trip area includes the level area of the Illinoian glacial drift. Although the plain generally is flat with tabular uplands in this part of our state, its surface locally is gently undulating with modern shallowly entrenched drainage. Even though glacial deposits are somewhat thinner than those in the area covered by younger glaciers, surface topography is essentially the result of glacial deposition and subsequent erosion by streams. The Springfield Plain averages about 75 feet lower than the crest of the Shelbyville Moraine to the east.

The eastern part of the field trip area is on the younger Bloomington Ridged Plain of Wisconsinan age, whose southern boundary is marked by the Shelbyville Moraine. This plain generally is characterized by low, broad ridges (moraines), separated by wide stretches of relatively flat or gently undulating land. Although the larger Wisconsinan moraines are conspicuous from a distance, they generally are less obvious up close because of their gentle outer slopes. Glacial deposits are fairly thick throughout the Bloomington Ridged Plain and generally conceal the bedrock surface, except locally.

Drainage The field trip area is drained by the Sangamon River and its tributaries into the Illinois River approximately 80 miles west-northwest of Decatur. The tributary network is much more extensive on the Springfield Plain than on the Bloomington Ridged Plain. In addition, the broad, younger Wisconsinan surface between tributaries contains numerous sags and undrained depressions that may be a few hundred feet across.

Relief The highest land surface on the field trip route is just south of Johns Avenue and east of Maffit Street (0.8 mile along our route). The crest of this glacial kame is slightly more than 720 feet mean sea level (msl) elevation. Another kame with about the same elevation is just across Mound Road northwest of Mound Junior High School in the northern part of Decatur (3.7 miles north and 0.8+ miles west of Johns Hill). The lowest elevation is slightly less than 575 feet msl in the Sangamon River below the bridge on Macon County Highway (MCH) 27, north of Stop 6. The surface relief of the field trip route, calculated as the difference between the highest and lowest elevations, is a little more than 145 feet. Local relief generally ranges from 30 to 70 feet.

MINERAL PRODUCTION

Among the 102 Illinois counties, Macon County ranked 60th in 1988 for its total value of minerals extracted. Sand and gravel production, which is only reported in even-numbered years, tops the list in mineral extraction. However, its total is grouped with 17 other counties in District 4, where 42 companies have 52 operations. Sand and gravel production for this district totaled 6,475,000 tons, valued at $19,368,000. Crude oil production, down about 2 percent from 1987, amounted to 76,000 barrels, valued at $1,124,000. Cumulative crude oil production in Macon County from 1888 to 1988 amounts to 2,496,000 barrels.

Christian County ranked 13th in 1988 for the value of minerals extracted (coal, crude oil, and stone). Coal production, all from one mine, amounted to 1,888,895 tons, valued at $53,927,952. This mine operated at the junction of Christian, Montgomery, and Sangamon Counties, but all production was reported in Christian County where the tipple is located. The cumulative coal production from 1833 through 1988 totaled 347,613,876 tons, which ranked Christian County third among the state's 71 coal-producing counties.

Crude oil production in Christian County totaled 377,000 barrels, valued at $5,579,000, an 8.7-percent increase from 1987. The cumulative crude oil production from 1888 to 1988 amounted to 29,663,000 barrels, which ranked the county 18th among the state's 48 crude oil-producing counties. Stone production is reported only in odd-numbered years, and its production and value are grouped with 14 other counties in District 2. Stone production from this district during 1977 totaled 5,560,000 tons, valued at $39,300,000.

Of the 102 counties in Illinois, 99 reported mineral production during 1988, the last year for which complete records are available. The total value of all minerals extracted, processed, and manufactured in Illinois during 1988 was $2,807,600,000, a decline of some $418 million (13 percent) from 1987.

During 1988, the value of minerals extracted in Illinois was $2,492,200,000, a decline of 4.9 percent from 1987. Mineral fuels (coal, crude oil, and natural gas) comprised 82 percent of the total. Illinois ranked 17th among the 50 states in total production of nonfuel minerals, but continued to lead all other states in production of fluorspar, industrial sand, and tripoli. The state ranked 15th among the 31 oil-producing states in 1988. Oil was produced from 47 counties, mainly in southern Illinois. Nine counties produced more than 1 million barrels each, which accounted for about 66 percent of the state's total oil production.

Water Supply In the Field Trip Area

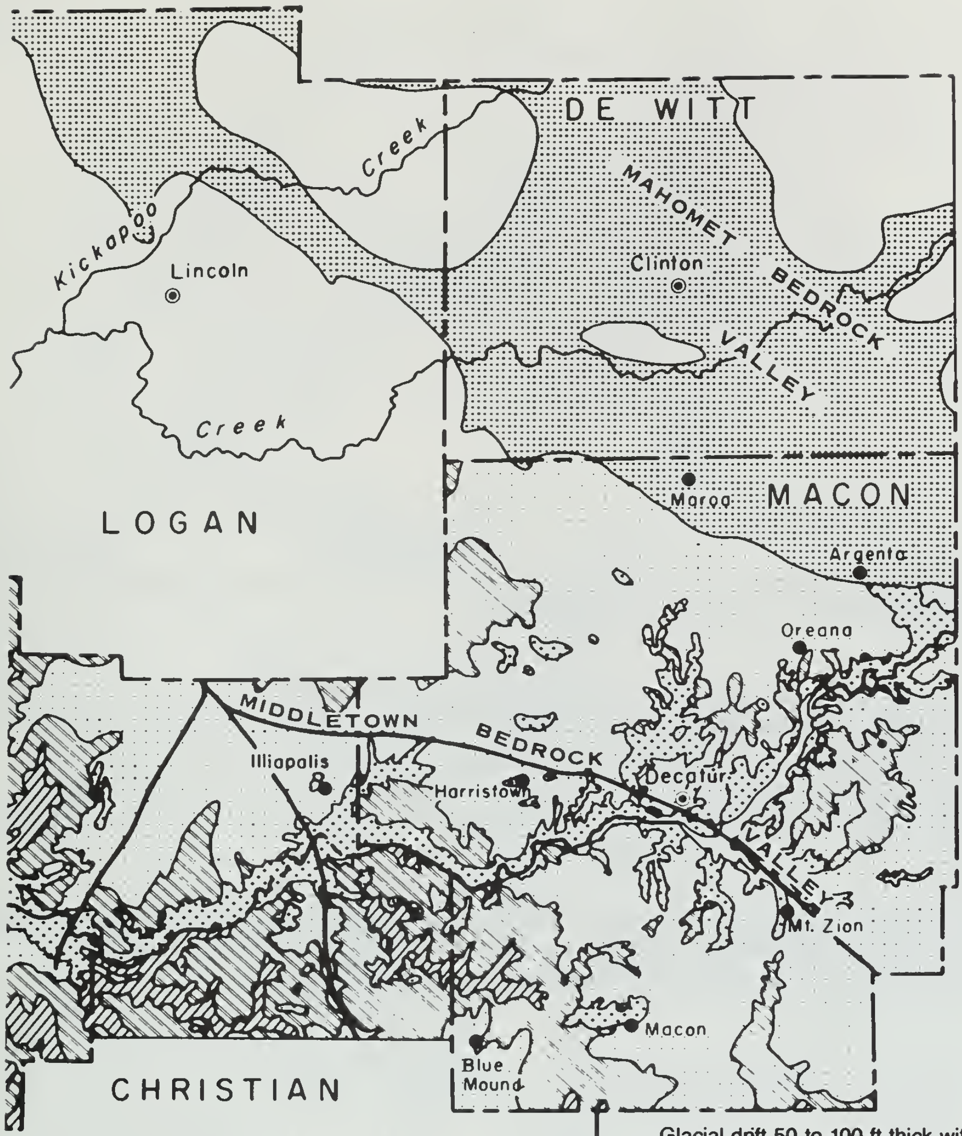
Surface water The Sangamon River and its tributaries are the principal sources of surface water in Macon County. Lake Decatur, the largest impoundment of the Sangamon River in the county, currently supplies annually about 11 billion gallons of good quality water from two intakes for industrial and municipal uses. Upstream near Oreana, surface water flow to the lake is augmented during dry periods with groundwater pumped from two large-capacity wells, averaging 249 feet deep, which were drilled into sands and gravels of the buried Ancient Mahomet Valley. Some 239 million gallons were pumped from the Mahomet Sand in these wells during 1989. In addition, a new Decatur well field is being developed some 18 miles northeast of the city and about 4 miles southwest of Weldon. There, eight wells averaging 330 feet deep are designed for 90-day operation to produce 25 million gallons per day once every 5 years, the dry-spell periodicity. The water will be discharged into a tributary of Friends Creek, which drains into the Sangamon River upstream from Oreana. At a later date, water from this well field may be sent through a pipeline to Decatur, if desirable.

Groundwater Most of us generally do not think of groundwater as a mineral resource when assessing the natural resource potential of an area. Yet the availability of groundwater is essential for orderly economic and community development. More than 48 percent of the state's 11 million citizens depend on groundwater for their water supply.

The source of groundwater in Illinois is precipitation that infiltrates the soil and percolates downward into the groundwater system, which lies below the water table in the zone of saturation. Groundwater is stored in and transmitted through saturated earth materials called *aquifers*. An aquifer is a body of saturated earth materials of variable thickness that will yield sufficient water for some use. The pores and other void spaces in the earth materials must be permeable, that is, they must be large enough and interconnected so that water can overcome confining friction and move readily toward a point of discharge, such as a well, spring, or seep. Generally, the water-yielding capacity of an aquifer can be evaluated by constructing wells into it. The wells are then pumped to determine the quantity and quality of groundwater available for use.

Because geologic conditions differ from place to place, groundwater is readily available in some areas and extremely difficult to obtain in others. Figure 8 shows the variability of groundwater conditions in the field trip area. Wells tapping sand and gravel layers within the unconsolidated deposits of glacial drift are the main source of groundwater throughout Macon County.

Groundwater from the underlying bedrock is considerably more mineralized (salty) and not considered as important a source as the supply from the unconsolidated deposits. Although not



Continuous, permeable sand and gravel aquifers more than 30 ft thick. May provide large ground-water supplies.

Glacial drift 50 to 100 ft thick with thin, discontinuous sand and gravel beds; over Pennsylvanian bedrock. Small ground-water supplies locally available.

Continuous to discontinuous sand and gravel aquifers more than 15 ft thick. May provide moderate to large ground-water supplies.

Thick glacial drift with scattered sand and gravel aquifers usually less than 15 ft thick. Small ground-water supplies usually available.

Glacial drift less than 50 ft thick with a few sand and gravel beds; over Pennsylvanian bedrock. Small ground-water supplies locally available.

conditions not mapped

Figure 8 Groundwater conditions in and adjacent to the Springfield-Decatur region (modified from Bergstrom et al. 1976).

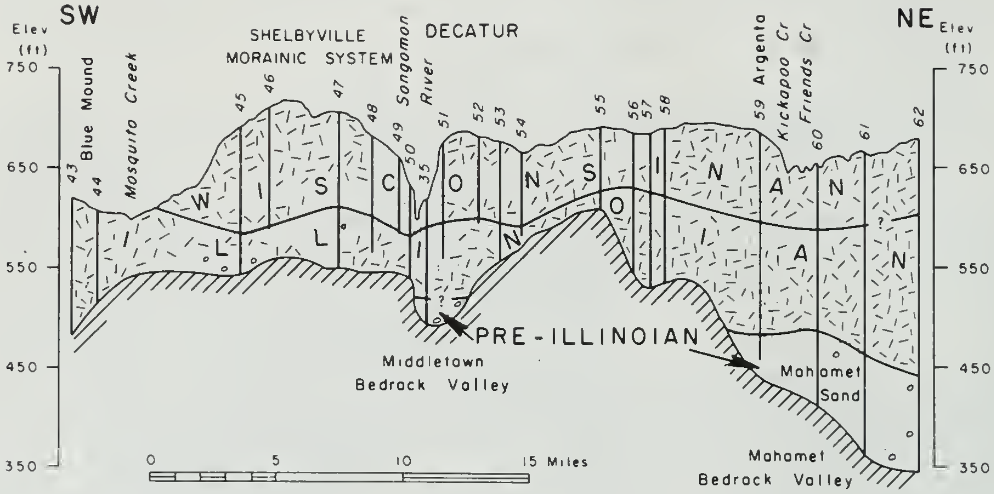
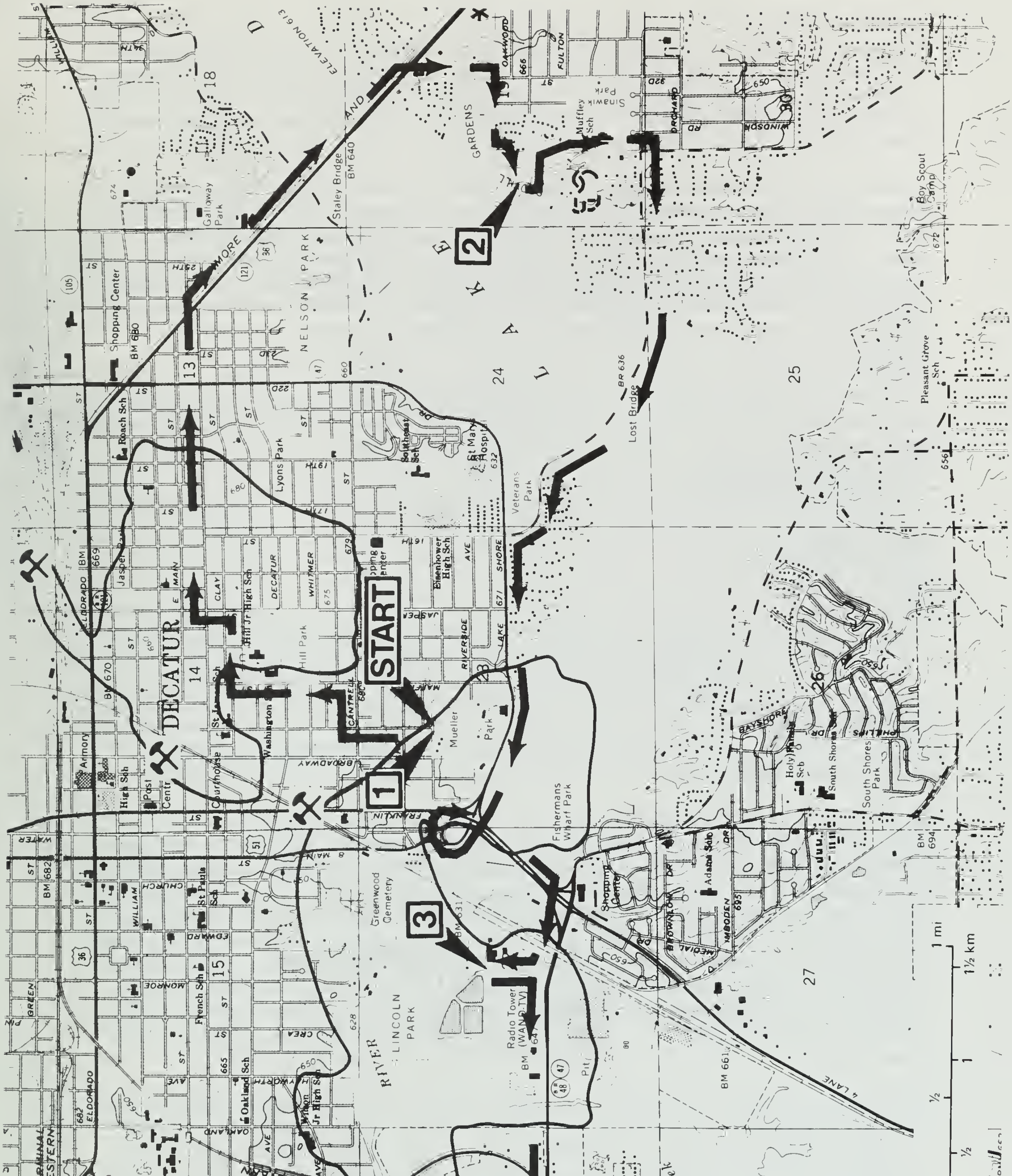


Figure 9 Cross section showing nature of the unconsolidated deposits and the surficial and bedrock topography of the Decatur area (Bergstrom et al. 1976).

generally utilized, some moderately mineralized water from bedrock aquifers can be given to livestock when better quality water is in short supply. The cross section illustrated in figure 9 represents a slice through the glacial drift in Macon County and shows the variability and distribution of some of these deposits. The most productive wells in the glacial drift are in northeastern Macon County where they are finished in the Mahomet Sand, shown between the 350 to 470 foot (msl) markers on the cross section.

Information regarding the distribution of earth materials and groundwater is upgraded constantly as new data are collected and compiled from drillers, logs, test borings, and geophysical studies conducted by the Illinois State Geological Survey.


START
1
2
3
DECATUR
LAKE DECATUR
Mueller Park
Lincoln Park
Fishermans Wharf Park
Nelson Park
Lyons Park
Hill Park
Greenwood Cemetery
Veterans Park
Galloway Park
South Shores Park
Sinawik Park
Staley Bridge
Lost Bridge
Radio Tower (WAND-TV)
Eisenhower High Sch
Washington Sch
Hill Jr High Sch
Roach Sch
French Sch
Oakland Sch
Dennis Sch
Wilson Jr High Sch
Adams Sch
Muffley Sch
South Shores Sch
Pleasant Grove Sch
Enterprise Sch
Southeast Sch
St Patrick Sch
High Sch
Millikin University
Courthouse
Armory
Shopping Center
Boy Scout Camp
RIVER
Creek
GARDENS
ELEVATION 613
1 mi
1½ km

GUIDE TO THE ROUTE

Assemble on East Marion Street, east of Martin Luther King Drive (formerly Broadway), near the Frontiers Building in the northwest corner of Decatur's Mueller Park (NW NW SE NW Sec. 23, T16N, R2E, 3rd P.M., Macon County; Decatur 7.5-Minute Quadrangle [39088G8]*). Mileage calculations start at the intersection of East Marion Street and South Webster Street, just east of the building.

Please note—you must travel in the caravan. Some stops on our field trip itinerary are on private property. The owners have graciously given us permission to visit their property on the day of the field trip only. Please obey all instructions from the trip leaders and conduct yourselves as guests. So that we may be welcome to return on future field trips, please do not litter or climb on fences. Leave all gates as you found them. These simple rules of courtesy also apply to public property. If you plan to use this booklet for a field trip with your students, youth group, or family, because of trespass laws and liability constraints, you *must* get permission from property owners or their agents, before entering private property.

Please drive with your headlights on while in the caravan. Drive safely but stay as close as you can to the car in front of you. Please obey all traffic signs unless the road crossing is protected by an emergency vehicle with flashing lights and flags. When we stop, park close to the car in front and turn off your lights.

Miles to next point	Miles from start	
0.0	0.0	While we're in Mueller Park, we'll take the opportunity to discuss the interesting background of the Decatur Park District and the early years of mineral resource development in the area. Then we'll start our tour.

STOP 1 Although Decatur had been platted as the county seat of Macon County and all official business was conducted here, most of the early settlers lived outside of the village.

Along the west side of the Sangamon River, what was originally known as Wilson Park was developed from a large acreage of timber as a recreational area for the workers of Decatur to enjoy on their time off. The private park was reached by taking the interurban (electric railway). Later, when the land was owned by Robert Faries, it became known as Faries Park. Early in 1924, Faries' daughters, Mrs. L. P. Walbridge and Mrs. E. P. Irving, offered the property to the City of Decatur, on the condition that a park district would be formed to administer the property. In August 1924, an election was held and the petition carried for the formation of the Decatur Park District. The district boundary originally coincided with the township boundary. Acreage outside of the original boundary was added as new subdivisions were developed and annexed to the city. The Park District, the City, various local manufacturing firms, and individuals have always cooperated in establishing and enhancing the park network and programs.

The first land for what is now Mueller Park was purchased by the new Park District through its first land condemnation suit. Additional land was acquired in 1925 for South Side Park, as it was called until mid-1945 when it was named Adolph Mueller Park. In 1933, a nearby coal

* The number in brackets [39088G8] after the topographic map name is the code assigned to that map as part of the National Mapping Program. The state is divided into 1° blocks of latitude and longitude. The first two numbers refer to the latitude of the southeast corner of the block; the next three numbers designate the longitude. The blocks are divided into sixty-four 7.5-minute quadrangles; the letter refers to the east-west row from the bottom, and the last digit refers to the north-south column from the right.

mine supplied shale to be used as fill material in the park. The Park District Headquarters was constructed here in 1954.

The first brickyard, located south of what is now Fairview Park on the west side of town, was probably operating during the early 1830s, according to the *History of Macon County* (Lamm 1982). Bricks from this yard were used for the old jail at Wood and Church Streets. People said it could be picked to pieces with a darning needle. About 1852, William Martin tested clay from Decatur for making bricks, and within a short time he had set up a brickyard in a lot at the intersection of Broadway (Martin Luther King Drive) and Gault Streets, about 0.55 mile north of Marion Street. The first bricks were used for a barn foundation on his farm a little more than 0.25 mile to the east. There he constructed Decatur's first brick home and gave it to his daughter, Mrs. Jane M. Johns. The Johns property was located on a prominent hill, a glacial kame, which is shown incorrectly as "Hill Park" rather than "Johns Hill Park" on the topographic map.

Captain D. L. Allen built a dam across the Sangamon River at the foot of Maffit Street to power his grist and saw mills. Across the river he built a lime kiln—Decatur's "first industry." The source of the limestone for lime production is unknown.

The annual *Coal Report for 1882* does not list any mines in Macon County. The Decatur Coal Company was reported as new in 1883; it operated until 1915 in the Springfield Coal (No. 5), which was reported to be 51 inches thick at a depth of 612 feet. This mine shaft was located along the south edge of the SW SE SE SE Sec. 11, T16N, R2E, 3rd P.M., approximately 1.4 miles northeast of here (see the route map). In 1886, the company sank another shaft in adjacent Sec. 14 as an escape route; but production was reported from this shaft too. A few years later, the roles of the two shafts were reversed and the original shaft was used for air and emergencies. The No. 2 shaft was abandoned in 1926. Manufacturers and Consumers Coal Company reported coal production from its new 600-foot deep shaft into 4 feet of Springfield Coal in 1904 (fig. 10). This mine was located in the SW NW SW SW Sec.14, T16N, R2E, 3rd P.M., less than 0.5 mile northwest of here on the northwest side of the Illinois Central Railroad. The name was changed to the Macon County Coal Company in 1918 and production continued until 1947 when it was abandoned.

0.0	0.0	Leave Stop 1. HEAD NORTH on south Webster Street.
0.1-	0.1-	STOP: 2-way at east Cleveland Avenue. CONTINUE AHEAD (north).
0.15+	0.25-	STOP: 2-way; East Cantrell Street. TURN RIGHT (east).
0.15	0.4-	TURN LEFT (north) on South Maffit Street.
0.05+	0.45+	Begin ascent of hill—a glacial feature called a kame.
0.1	0.55+	To the right is Johns Hill Park.
0.2+	0.75+	TURN RIGHT (east) on Johns Avenue and ascend the higher portion of the kame.
0.05+	0.85	To the right at the crest of the kame, more than 720 feet above mean sea level (msl), stands Johns Hill Magnet School. This is the highest hill in Decatur. An unknown thickness of material was removed from the crest of the hill before the various buildings were constructed.
		CONTINUE AHEAD (east) and descend the east slope of the kame.

Time-stratigraphic units		Rock-stratigraphic units			Average thickness of formation (ft)	Description
System	Series	Group	Formation	Selected members		
Pennsylvanian	Missourian	McLeansboro	Mattoon		100+	Shales, siltstones, sandstones, and thin limestones, claystones, and coals.
			Bond	Millersville Limestone	200	
				Shoal Creek Limestone		
			Modesto	Chapel (No. 8) Coal	250	
	Desmoinesian			Trivoli Sandstone		
				Lonsdale Limestone		
		Kewanee	Carbondale	Danville (No. 7) Coal	225	
				Brereton Limestone		
				Herrin (No. 6) Coal		
				St. David Limestone		
				Springfield (No. 5) Coal		
				Summum (No. 4) Coal		
				Colchester (No. 2) Coal		
			Spoon	Litchfield Coal	150	
	Atokan	McCormick	Abbott		150	

Figure 10 Rocks of the Pennsylvanian system directly underlie the unconsolidated deposits in the Springfield-Decatur region (Bergstrom et al. 1976).

0.15+	1.0+	STOP: 2-way intersection with South Jasper Street. The elevation is slightly less than 670 feet msl, nearly 55 feet lower than the present crest of Johns Hill. TURN LEFT (north) and get into the outside lane.
0.1+	1.1+	STOPLIGHT: East Wood Street. TURN RIGHT (east).
0.75	1.85+	STOPLIGHT: 22nd Street. CONTINUE AHEAD (east).
0.25	2.1+	STOPLIGHT: Nelson Boulevard and US 36. CONTINUE AHEAD (southeast) onto US 36.
0.4+	2.55	STOPLIGHT: T-road intersects from left. CONTINUE AHEAD (southeast).
0.15+	2.7+	Lake Decatur lies to the right.

0.1+	2.8+	Cross Staley Bridge over Lake Decatur.
0.2+	3.05	Prepare to TURN RIGHT ahead.
0.1	3.15	STOPLIGHT: Country Club Road. TURN RIGHT (south).
0.2+	3.35+	CURVE RIGHT (west) on Country Club Road.
0.35+	3.75	CAUTION: TURN RIGHT (west) and enter Scovill Gardens.
0.05+	3.8+	TURN LEFT (south) into the parking area.
0.05	3.85+	PARK along the east side of the parking lot and walk west to the pavilion and Oriental Garden.

STOP 2 While we enjoy the Oriental Garden, we'll examine a collection of glacial erratics and discuss Lake Decatur (parking lot entrance: NW NE NW SW Sec. 19, T16N, R3E, 3rd P.M., Macon County, Decatur 7.5-minute Quadrangle [39088G8]).

Wells dug in this area only furnished limited amounts of water. So in the early 1870s, a pumping station was built to bring water from the Sangamon River. When flooding made the water too muddy for use, residents quickly realized the urgent need for a reservoir. A filtration reservoir 100 feet long by 10 feet wide by 6 feet deep was constructed in 1874. Three years later, it was increased to 500 feet in length. During 1878, a wooden dam was built across the river near where the lower dam is now located. In 1910, the lower dam was constructed of concrete. It was several feet higher than the wooden dam, so it impounded more water. A new dam 1,900 feet long and about 20 feet high was completed in 1922, producing a lake 14 miles long by nearly 1 mile at its widest. The reservoir was designed to cover about 2,805 acres and store more than 6.4 billion gallons.

Scovill Gardens was given to the Decatur Park District in 1948 by Guy and Rose Scovill. For many years, the pavilion was used as a summer home and a museum for their collection of Chinese artifacts. Jack Swing, Landscape Architect at the University of Illinois, designed the oriental garden, which was constructed by park personnel in 1964-65.

In this sumptuous setting, you'll have the opportunity to examine many different igneous and metamorphic glacial erratics—rocks carried into this area from regions far to the north (see ISGS *Geogram 2*, *Erratics are Erratic* at the back of this guidebook). Igneous rocks were originally molten or partly molten material, called magma, which solidified into granite, gabbro, prophyry, and basalt (fig. 11). Metamorphic rocks have metamorphosed or changed mineralogically, chemically, and/or structurally from preexisting rocks, such as granite, shale, and limestone, into new rocks, such as gneiss, schist, marble, slate, and quartzite.

0.0	3.85+	Leave Stop 2 and CONTINUE (south and east) out of the parking area.
0.05+	3.9+	STOP: 1-way at the T-intersection with Country Club Road. TURN RIGHT (south). CAUTION: visibility is somewhat restricted to the left.
0.35+	4.3	STOPLIGHT: TURN RIGHT (west) on Lost Bridge Road.

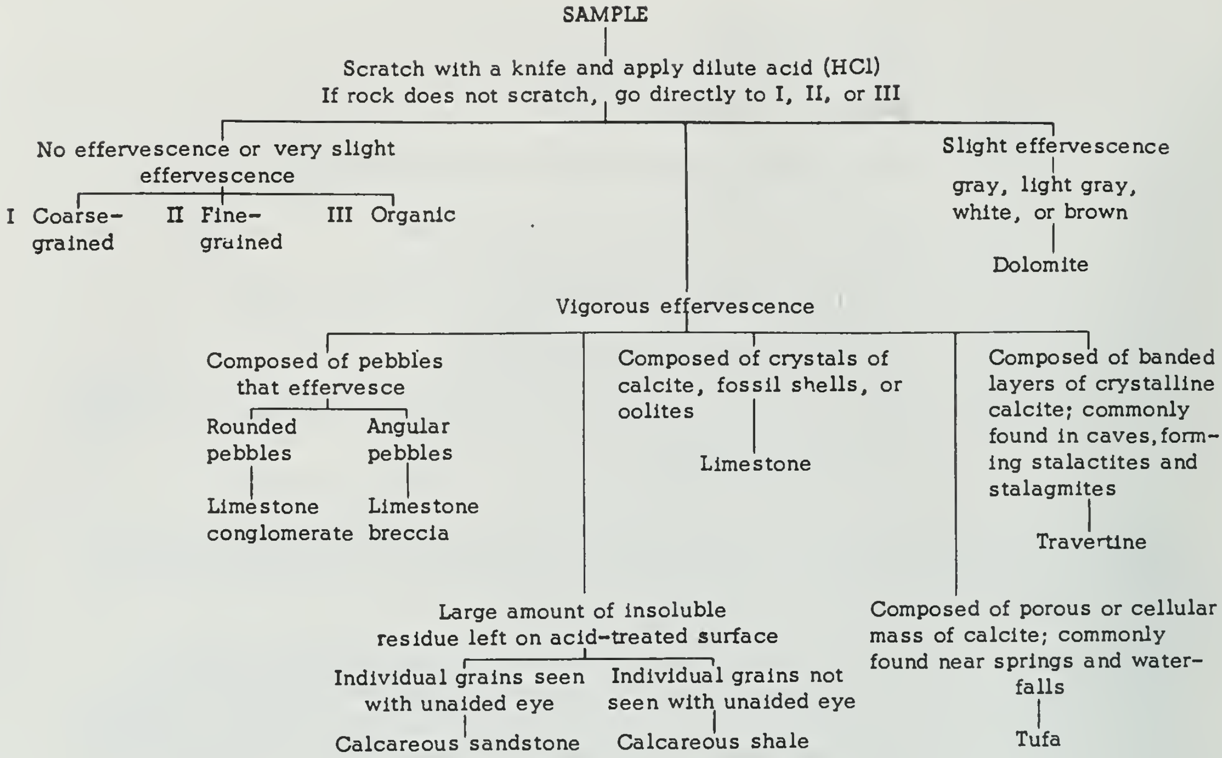


Figure 11 Rock identification key (modified from ISGS 1959). *Continued on page 21.*

0.5+	4.8+	CAUTION: Enter the causeway to Lost Bridge.
0.25	5.05+	Cross Lost Bridge. This bridge got its name from the fact that before Lake Decatur formed, the old bridge was virtually "lost" for a good part of the year because it was surrounded by dense woods and during floods it was surrounded by water.
0.7+	5.8+	STOPLIGHT: TURN LEFT (west) on East Lake Shore Drive.
0.25-	6.05	STOPLIGHT: South Jasper Street. CONTINUE AHEAD (west) and work your way to the inside lane.
0.45+	6.5	To the right is the Decatur Park District headquarters. CONTINUE AHEAD (west).
0.2	6.7	CONTINUE AHEAD (west and then north) to State Route (SR) 105 (south).
0.05+	6.75+	Pass under the 4-lane highway. Just beyond the underpass, you'll curve tightly to the right up to SR 105.
0.15+	6.95+	MERGE LEFT on the overpass.
0.15+	7.15+	Cross bridge over Lake Decatur. The dam is to the right.

I COARSE-GRAINED ROCKS

A. Rock consists of interlocking grains or crystals, easily seen; too hard to scratch with a knife

1. Crystals aligned in one direction

a) Crystals in parallel bands with layers of quartz and feldspar separated by mica and other minerals — Gneiss

b) Crystals in thin parallel bands; tends to split into thin sheets parallel to banding; some varieties may be scratched with a knife — Schist

2. Crystals not aligned in any particular direction

a) Light gray, pink, red, or tan with only a few dark minerals; feldspar and quartz principal minerals — Granite

b) Dark to medium gray; composed of feldspar and dark minerals with little quartz — Gabbro

c) Dark green to black; essentially dark minerals, may have some feldspar; quartz generally lacking — Peridotite

d) Light color; similar to granite in texture but lacks quartz; composed of feldspar and some dark minerals — Syenite

e) Large, easily seen crystals set in a fine- to extremely fine-grained background; any color — Porphyry

f) Essentially quartz; grains may be identifiable; specimens break through rather than around grains — Quartzite

B. Rock composed of individual rock particles or fragments, non-interlocking crystals, cemented or not cemented together; may or may not be scratched with a knife

II FINE-GRAINED ROCKS

A. Cannot be scratched easily with a knife; crystals or particles not easily seen with the unaided eye; very hard; difficult to break; may contain a few crystals or particles large enough to see; granular

1) Dense; brittle; splintery or conchoidal fracture; sharp edges and corners when broken; often associated with limestone; usually white or gray; very dense, dull varieties called flint — Chert

2) Light gray, pink, red, or tan varieties common; boulders or fragments in the glacial drift — Felsite

3) Dark gray, greenish, black, or maroon varieties common; may have small mineral-filled cavities; occurs as boulders or fragments in the glacial drift — Basalt

4) Essentially quartz; grains may be identifiable; specimens break through rather than around grains — Quartzite

Figure 11 *continued*

0.2+	7.4+	CURVE RIGHT (westerly) on SR 105 (west).
0.15+	7.6	Illinois Central (IC) Railroad overpass. Prepare to turn right.
0.05	7.65	CAUTION: TURN RIGHT (north) on South Monroe Street and then TURN LEFT (west) on the blacktop around the car and truck repair facility. CURVE RIGHT (north) on the west side of the garage.
0.2	7.85	CAUTION: TURN LEFT (west) into the Vulcan Materials Company, Decatur Plant. People who enter these premises MUST HAVE PERMISSION. When we continue our tour, mileage calculations resume from this entrance gate.

STOP 3 We'll examine a dredging operation for sand and gravel resources (entrance: SW SW SW NE Sec. 22, T16N, R2E, 3rd P.M., Macon County, Decatur 7.5-Minute Quadrangle [39088G8]).

A few years ago, the hydraulic operation was moved here after having been located for many years about 1 mile west in the north half of Section 21. A hydraulic dredge with a 36-inch cutter head digs sand and gravel from the bottom of the deposit, then pumps the less than 8-inch-diameter material to the washing and screening plant. There it is separated into various sand and gravel products, sized to meet construction aggregate specifications of the Illinois State Department of Transportation (fig. 12). The local construction industry uses the high grade sand (fine) aggregates in portland-cement concrete roads and other building projects. Somewhat lower grade, fine-grained gravel products are used in asphalt-based seal coats on roads. Another important application is as fill in septic-field laterals. Some gravel is also used in landscaping. The overburden materials, mainly black silts and clays (removed by a drag line), are marketable as top soil or fill material.

MATERIAL		MAXIMUM SIZE[a]		MINIMUM SIZE[b]	
		(in.)	(cm)	(in.)	(cm)
Silt and clay (mud)		0.0029[c]	0.0074	no limit	no ilmit
Sand		0.187[d]	0.476	0.0029	0.0074
Gravel	Pebbles	2.5	6.4	0.187	0.476
	Cobbles	10.0	25.6	2.5	6.4
	Boulders	no limit	no limit	10.0	25.6

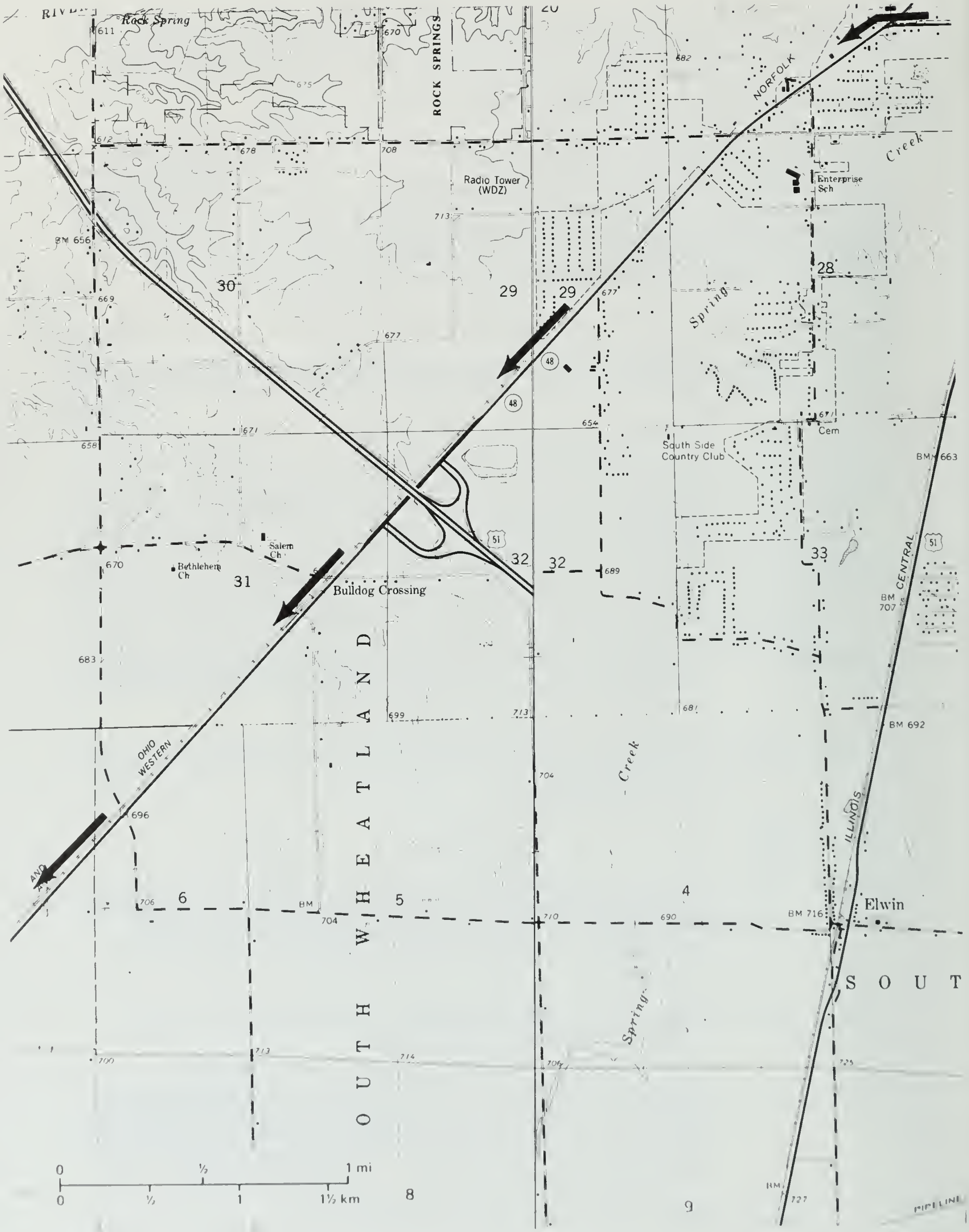
[a] Particles will pass through a sieve with square openings with the following side measurements.
[b] Particles will be retained on a sieve with square openings with the following side measurements.
[c] Number 200 mesh sieve.
[d] Number 4 mesh sieve.

Figure 12 Particle-size names in general use by the sand and gravel industry (Masters 1978).

The sand and gravel deposits are in the Sangamon River Valley. The top of the deposit extends from about 10 feet above the water level, which is the water table here, down to about 30 to 40 feet below the water level. The deposit is basically sand with some fine gravel and occasional coarse gravel and boulders, mainly in the upper part. However, at the base of the deposit is a gravel lag that is too coarse for the cutter head to pick up.

The Sangamon River Valley was formed by meltwater draining southwestward away from the Wisconsinan-age (youngest) continental glacier. The valley was eroded about 40 feet below the present river level, and formed a boulder-lined bed before the volume of meltwater began to decrease, allowing outwash sand and gravel to begin filling the valley. Later erosion of some of this material left terraces along the valley walls. The lowest level is covered by floodplain silts and clays of the postglacial Sangamon River. The floodplain deposits (overburden) are generally 5 to 10 feet thick. This pit is mining into a low terrace in its southwest corner.

0.0	7.85	Leave Stop 3. TURN RIGHT (south) on Monroe Street. Retrace the route to SR 105.
0.2	8.05	STOP: 1-way at the T-intersection with SR 105. TURN RIGHT (west) and move to the inside lane.
0.75+	8.8+	STOPLIGHT: TURN LEFT (southwest) on SR 48. Highway narrows; STAY in the inside lane.
2.0	10.8+	USE CAUTION entering the US 51 interchange.
0.3+	11.1+	US 51 overpass. CONTINUE AHEAD (southwest) on SR 48.
0.85+	12.0	We are crossing the crest of the Wisconsinan Shelbyville end moraine. A little more than 1 mile to the east, the moraine is nearly 725 feet in elevation msl—25 to 30 feet higher than it is here.
1.75+	13.75	To the right at about 2 o'clock, you'll see the older Illinoian till plain below us in the distance. The knob with the water tower on it about 11 miles to the west is Mount Auburn.
0.2	13.95	CAUTION: enter village of Boody.
1.1	15.05	Cemetery crossroad. CONTINUE AHEAD (southwest) and descend from the Shelbyville Moraine. For good views across the Illinoian till plain, look to your right. To the left the moraine front gradually merges into the Illinoian till plain. The grain elevator straight ahead is at Blue Mound, 4 miles away.
4.55	19.6	CAUTION: enter town of Blue Mound. The hill to the right at about 2 o'clock is our destination, a glacial kame.
0.3	19.9	The abandoned shaft of the Blue Mound Coal Company was located in the immediate vicinity. Here the Herrin Coal Member (No. 6) ranges from 48 to 78 inches thick and averages 60 inches at a depth of 467 feet. The Springfield Coal Member (No. 5) occurs 25 feet below the Herrin Coal and is 64 inches thick in this mine.
0.6	20.5	TURN RIGHT (west) toward Griswold County Nature Center.


Rock Spring
ROCK SPRINGS
Radio Tower
(WDZ)
NORFOLK
Creek
Enterprise
Sch
Spring
Cem
South Side
Country Club
Salem
Ch
Bethlehem
Ch
Bulldog Crossing
OHIO
WESTERN
CENTRAL
ILLINOIS
Creek
Spring
Elwin
SOUT
OUTH WHEATLAND
0
½
1 mi
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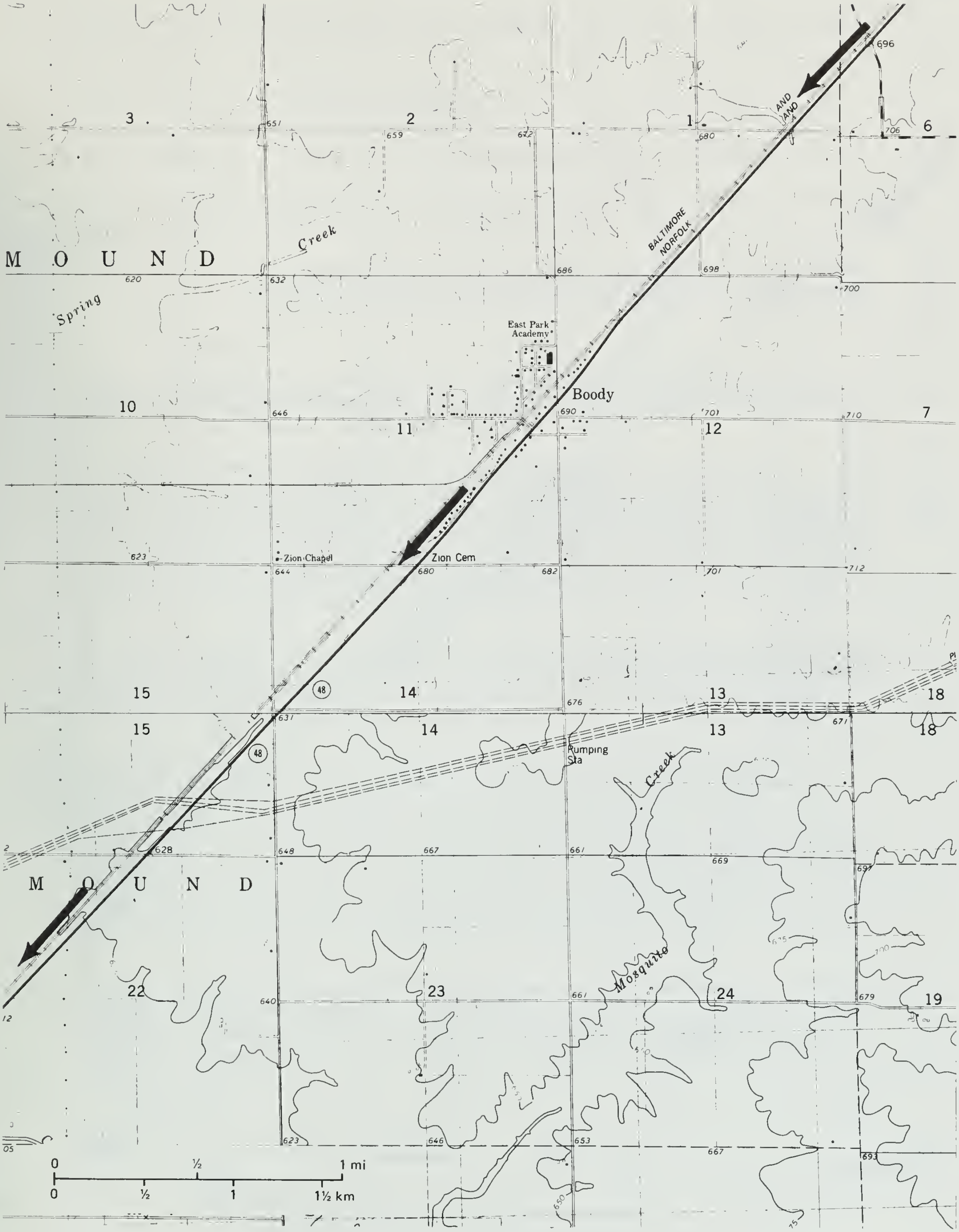
½
1
1½ km



MOUND
Spring
Creek
BALTIMORE AND
NORFOLK AND
East Park Academy
Boody
Zion Chapel
Zion Cem
Pumping Sta
Creek
Mosquito
MOUND
3
2
1
6
10
11
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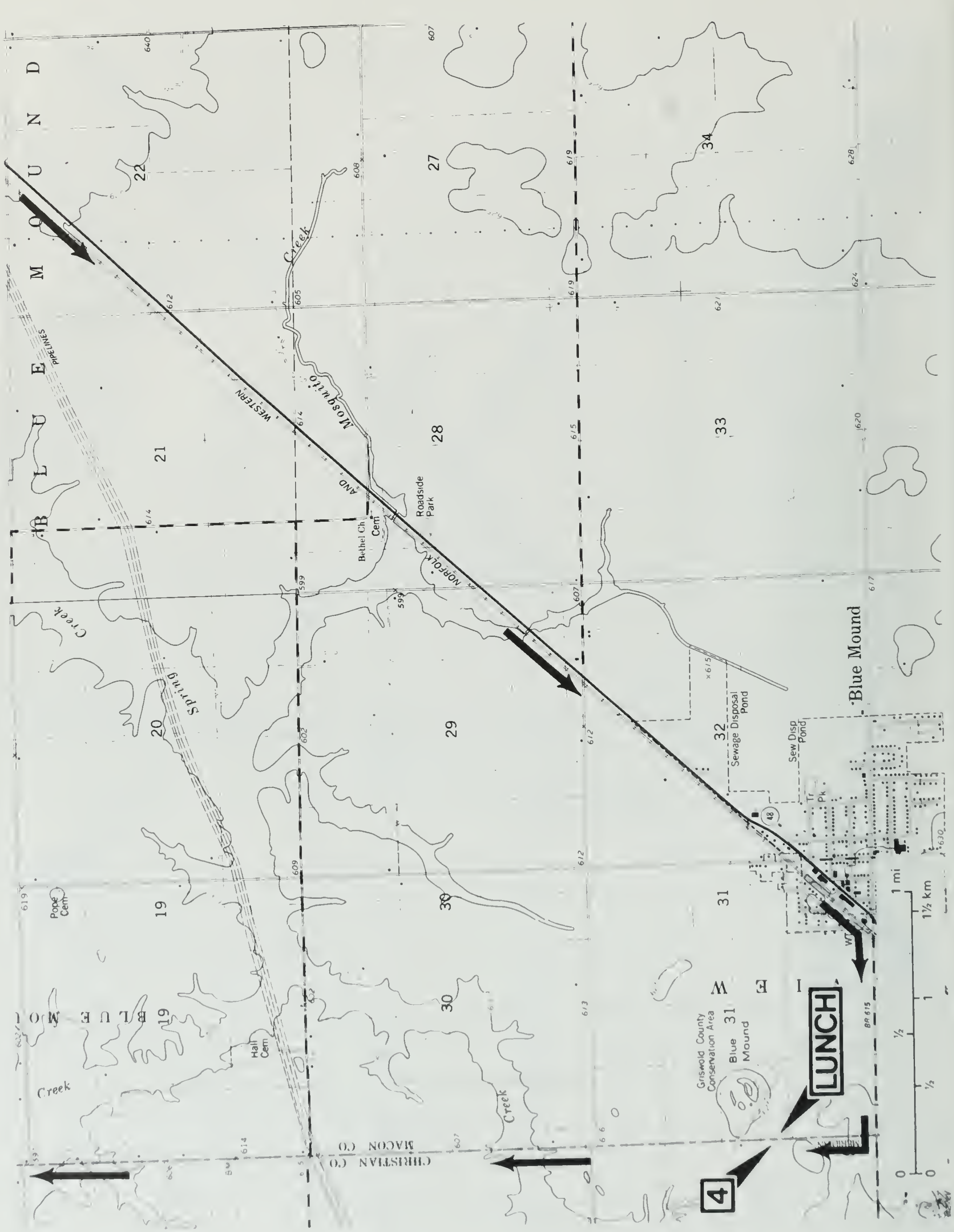

BLUE MOUND
NORFOLK AND WESTERN
PIPELINES
Mosquito Creek
Spring Creek
Creek
Bethel Ch Cem
Roadside Park
Pope Cem
Hall Cem
Sewage Disposal Pond
Sew Disp Pond
Blue Mound
Griswold County Conservation Area
Blue Mound
LUNCH
4
CHRISTIAN CO
MACON CO
1 mi
1½ km

0.05+	20.55+	Cross Norfolk and Southern Railroad (N&S) tracks on West Seiberling Street.
0.2	20.75+	CAUTION: cross bridge. To the left at 11 o'clock is the larger of two kames west of Blue Mound.
0.15+	20.95	Begin your ascent of the low saddle between the two kames.
0.3+	21.25+	STOP: 2-way. TURN RIGHT (north) on the Macon-Christian County Line Road.
0.3+	21.6	TURN RIGHT (east) at the entrance to the Griswold Conservation Area. Mileage calculations will resume from the entrance later. Proceed ahead and park.

STOP 4 LUNCH. With a panoramic view of the surrounding area, we'll picnic and then examine the kame deposit (entrance: NW SW NW SW Sec. 31, T15N, R1E, 3rd P.M., Macon County, Stonington 7.5-Minute Quadrangle [39089F2]).

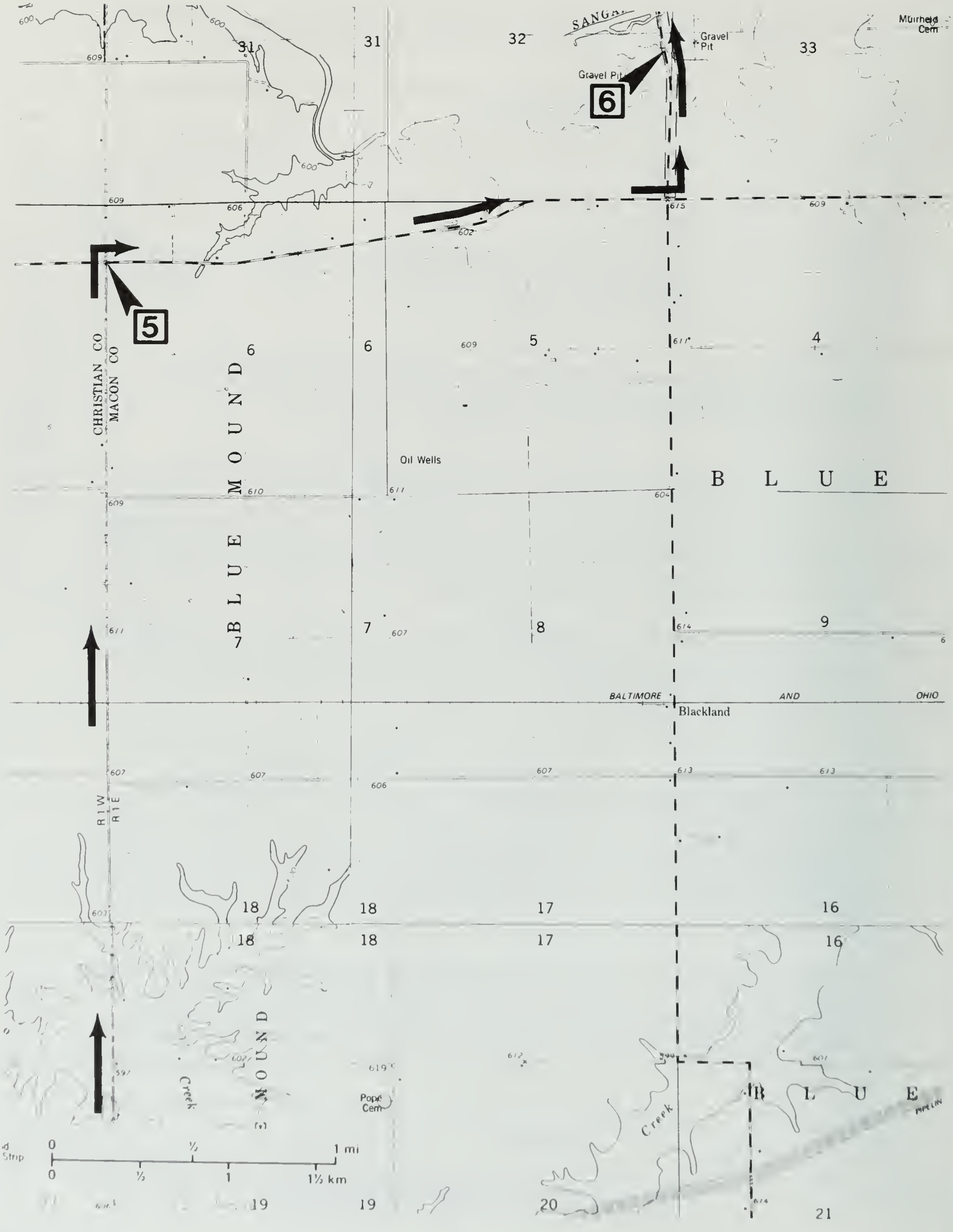
Blue Mound, this prominent glacial kame, encompasses about 50 acres within the area delimited by the lowest enclosing contour line on the topo map, 615 feet msl. The top of the kame is slightly more than 690 feet msl, about the same as the larger kame, Long Mound, to the south-southwest in Christian County. How much material may have been removed from the top of the kame during excavation of gravel is not known. Right now, the relief is slightly more than 75 feet. For the best view of the surrounding area, take your turn on the observation platform by the shelterhouse near the top of the kame.

ISGS field notes by R. W. Brown in 1929 indicate that the railroad to the south (N&S, originally the Norfolk and Western) prospected this hill for gravel several years before that time. They reportedly found gravel cemented with lime and did not develop the deposit. Instead they opened a pit 0.5 mile south-southwest in Long Mound.

Sometime between 1929 and 1964, a gravel pit was operating in the northwest part. When another ISGS geologist, C. A. Ross, visited the mound in 1964, the pit had not been in operation for several years. Because of slumping and vegetation, the sequences of some materials exposed in the pit are not too clear; but along the north side, soil and colluvium (slope wash) are intermixed above 3.5 to 4 feet of loess and silt. The lower part of the loess appears to be slightly pink, perhaps because of being deposited on the reddish Sangamon weathering profile, which is about 3 feet thick. At that time the loess and Sangamon Soil had been stripped from the top of the mound. It is not clear whether the materials had been removed during the gravel pit operation or whether the removal was from erosion.

Below the Sangamon Soil, developed in Illinoian glacial till and sand and gravel, is a thick body of crossbedded sand and gravel lenses that dip to the northwest. At least 60 feet of sand and gravel has been exposed in this pit. Lime cement through much of the deposit slows the collapse of the steep, exposed face. ***We must not climb up or destroy this exposed face.***

0.0	21.6	Leave Stop 4 and TURN RIGHT (north) on the Macon-Christian County Line Road.
0.65	22.25+	USE CAUTION at the unguarded, offset crossroad. No Macon County highway grid numbers are present—only those from Christian County, (CC) 2500N, 2100E. CONTINUE AHEAD (north).


SANGA
Gravel Pit
Gravel Pit
Muirheid Cem
6
5
CHRISTIAN CO
MACON CO
BLUE MOUND
Oil Wells
B L U E
BALTIMORE AND OHIO
Blackland
R1W R1E
Creek
MOUND
Pope Cem
Creek
B L U E
0 ½ 1 mi
0 ½ 1 1½ km

0.95+	23.2+	Pipeline crossing.
0.05-	23.25+	CAUTION: unguarded, offset crossroad, CC 2600N, 2100E.
0.95+	24.25+	CAUTION: unguarded, offset crossroad, CC 2700N, 2100E.
0.1+	24.35+	CAUTION: narrow 1-lane iron bridge crosses Mosquito Creek. Weight limit, whether for one or more vehicles, is 8 tons (16,000 pounds).
0.2	24.55+	Pipeline facility lies to the left.
0.65+	25.25+	CAUTION: unguarded, offset crossroad, CC 2800N, 2100E.
1.0+	26.25	CAUTION: unguarded, offset crossroad, CC 2900N, 2100 E. Cross the small creek between the offset east and west roads. Notice how flat the slightly undulating Illinoian till plain is in this area.
0.8+	27.1	STOP: 2-way at CC 2980N, 2100E. Christian County Highway (CCH) 2 lies to the left and Macon County Highway (MCH) 28, to the right. Watch for FAST cross traffic; PARK along the roadside.

STOP 5 At the concrete marker on the SW corner of the intersection (SE SE NE NE Sec. 1, T15N, R1W, 3rd P.M., Christian County, Niantic 7.5-Minute Quadrangle [39089G2]), we'll discuss the system of land surveys in Illinois.

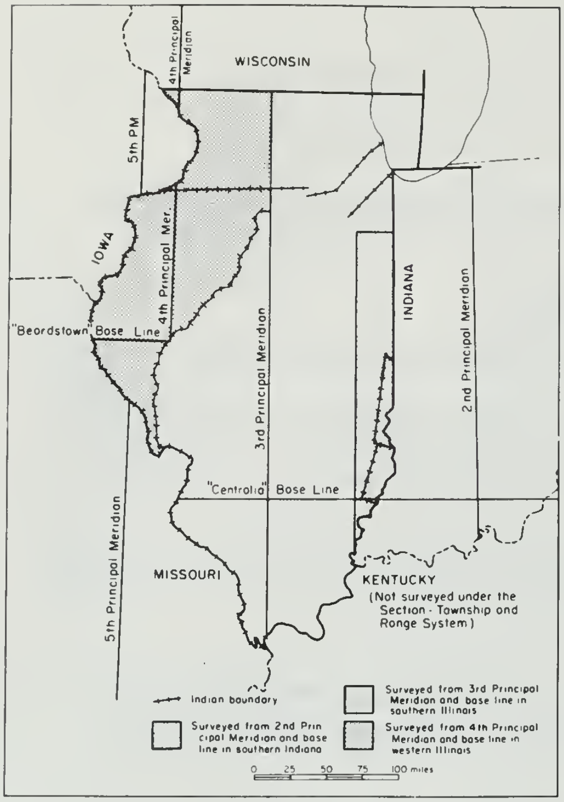
ABRAHAM LINCOLN
Traveled this way as he rode
the circuit of the
Eighth Judicial District
1847 1859

During his early years in New Salem, about 1831-32, Lincoln worked as a surveyor, one of his many endeavors. So he would have become acquainted with the land survey system in Illinois.

An examination of the 15- and 7.5-minute quadrangle maps of the field trip area shows that section lines do not form a perfect rectangular grid pattern over the whole area. Some sections are different sizes from others. Some sections also are somewhat misshapen because of slightly slanted section and quarter-section lines.

In 1804, initial surveying from the 2nd P.M. (fig. 13) continued westward from Vincennes, Indiana; this survey became the basis for surveying about 10 percent of what is now eastern Illinois. Because the western boundary of this tract had not been established with certainty, in 1805, the 3rd P.M. was established as beginning at the mouth of the Ohio River and extending northward to facilitate surveying new land cessions. By late 1805 a base line had been run from the 3rd P.M. due east to the Wabash River and due west to the Mississippi River. During March 1806, surveying commenced northward on both sides of the 3rd P.M. Sometime after the selection of an initial point from which to establish a base line, and from which the surveys were to be laid out, the base line apparently was arbitrarily moved northward 36 miles, where it roughly coincides with the base line of the 2nd P.M.

The township and range system, which permits the accurate identification of most parcels of land in Illinois, facilitates the sale and transfer of public and private lands. In the early 1800s, each normal township was divided (to the best of the surveyor's ability) into 36 sections, each of which was 1 mile square and contained 640 acres (see route maps).



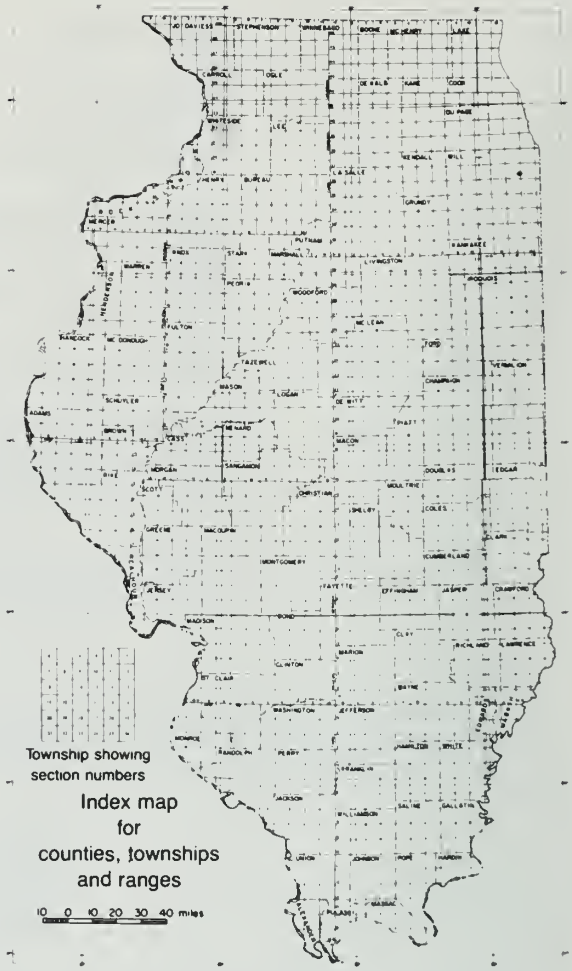


Figure 13 *top* Principal meridians and base lines of Illinois and surrounding states (Cote 1978).

Figure 14 *right* Index map (Cote 1978).

Township and range lines in figure 14 do not form a perfect rectangular grid over the state because of the use of different base lines and principal meridians, and because minor offsets were necessary to compensate for the earth's curvature. The surveying corrections producing the minor offsets were usually made at regular intervals of about 30 miles. Figure 14 shows what happened when the survey from the 2nd P.M. met the survey from the 3rd P.M. From Iroquois County south to White County, only narrow partial townships could be made where the two surveys met. These partial townships are all located in R11E, 3rd P.M., and in most places, they are less than one section wide.

Closer at hand, the road that we have been traveling on along the Macon-Christian County boundary is the 3rd Principal Meridian, and the crossroads are slightly offset. The sections on the west side are more nearly 1 mile square, whereas many on the east side are slightly elongated from north to south. A look at the route map southwest of Decatur, between US 51 and Boody and south of SR 48, shows that the west tier of sections in T15N, R2E is only 0.5 mile wide; the north tier of sections is nearly 1.15 miles long from north to south. What other oddities can you find on your maps?

Get out your quadrangle maps at home and have fun. Get to know the details of the topography and the surveying grid. If your collection of topographic maps is limited, or if you don't have any, the Illinois State Geological Survey will give you a free index to the topographic maps of Illinois. When you decide which you want or need, you can buy them from the ISGS.

0.0	27.1	CAUTION: leave Stop 5 and TURN RIGHT (east) on MCH 28. Watch out for FAST cross traffic!
0.5	27.6	In the distance at about 2 o'clock, you can see the Wisconsinan Shelbyville End Moraine.
0.3+	27.9+	Notice the oil field tank battery on the left and nearby pumpjacks of the Blackland Oil Field.
0.25	28.15+	The discovery well of the Blackland Oil Field was the Sun Oil Company No. 1 J.F. Damery prospect located 0.85 miles to the south in the center of the SW SW SW Sec. 5, T15N, R1E, 3rd P.M., Macon County (Harristown 7.5-Minute Quadrangle [39089G1]). This well was completed in July 1953 with an initial production of 10 barrels of oil from Silurian limestone at a depth of 1,910 feet.
0.95	29.1+	STOP: 4-way at the intersection with MCH 27. TURN LEFT (north) toward Lincoln Trail Homestead State Park.
0.45+	29.6+	CAUTION: TURN LEFT (west) at the Decatur Sand and Gravel Company entrance. Mileage calculations will resume from this point. Follow the posted directions for parking. People who enter these premises MUST HAVE PERMISSION.

STOP 6 At this pit, owned by Lincoln Sand and Gravel Company, we'll discuss why the mining operation that stays above the water table (entrance: NE NE NE SE Sec. 32, T16N, R1E, 3rd P.M., Macon County, Harristown 7.5-Minute Quadrangle [39089G1]).

The pit was operated by the Johnson Sand Gravel Company in 1968 (Hester and Anderson 1969). Several years later the pit was closed, and in 1986, the present operation began. The former operator reported that 6 to 8 feet of silt and clay overburden had to be removed to mine 15 to 18 feet of sand and gravel underlain by 4 to 5 feet of blue clayey till. They used a dragline to remove the underlying till and mine about 40 feet of sand and gravel below the water table. The dragline operation apparently was uneconomical. The present operation uses an endloader to economically mine only the sand and gravel unit above the clay-till. A dry screening plant is currently being used to produce fill sand and road gravel with a clayey binder. Well-washed gravel, stockpiled near the scalehouse, has been trucked in from their plant in Lincoln for sale in the Decatur market.

This deposit is either a low terrace in the Sangamon River Valley or an outwash fan or delta in the apron at the front of the Shelbyville Moraine (Bergstrom et al. 1976). The latter interpretation is favored because the deposit, at the leading edge of the moraine, is coarsest and thickest close to the moraine and thinner and finer-grained to the west, away from the moraine. It also seems to contain more fine-grained material (clay, silt, and fine sand) than is typical of low terrace deposits. Notice that the Sangamon River Valley is narrow upstream, where it had to cut through the terminal moraine and till plain left by the Wisconsinan glacier. Downstream from the moraine, however, the valley widens considerably. Whether the above characteristics also apply to the sand and gravel deposit below the blue clayey till is not known. That fluvial deposit may have been laid down earlier.

In the southwest corner of the pit is an exposure of about 8 feet of pebbly sand that consists of crossbedded layers and lenses of cross-bedded sand, each as much as 1 foot thick. Most of these units contain well-developed planar and trough cross-sets suggestive of deposition from a braided stream in the outer portion of an outwash fan. Soil development can also be seen in these exposures; brown, clay-enriched pendants extend down from the clayey silt (loess) overburden into the sand deposit.

Please be careful as you examine the various stockpiles and collect samples. ***We must not mix or move material from one pile to the next.***

0.0	29.6+	CAUTION: leave Stop 6. TURN LEFT (north) on MCH 27.
0.15+	29.75+	Enter Sangamon River bridge. To the left, look for sand and gravel bars, which are exposed during times of low water.
0.15+	29.95+	To the right, upstream, is a brief view of gravel bars during low water levels.
0.45+	30.4+	TURN HARD RIGHT (south) and enter Lincoln Homestead State Park. Mileage calculations will resume at this entrance (SE SE NE SE Sec. 29, T16N, R1E, 3rd P.M., Macon County, Harristown 7.5-Minute Quadrangle [39089G1]). BEAR LEFT (east) and PARK in the lots at the end of the road.

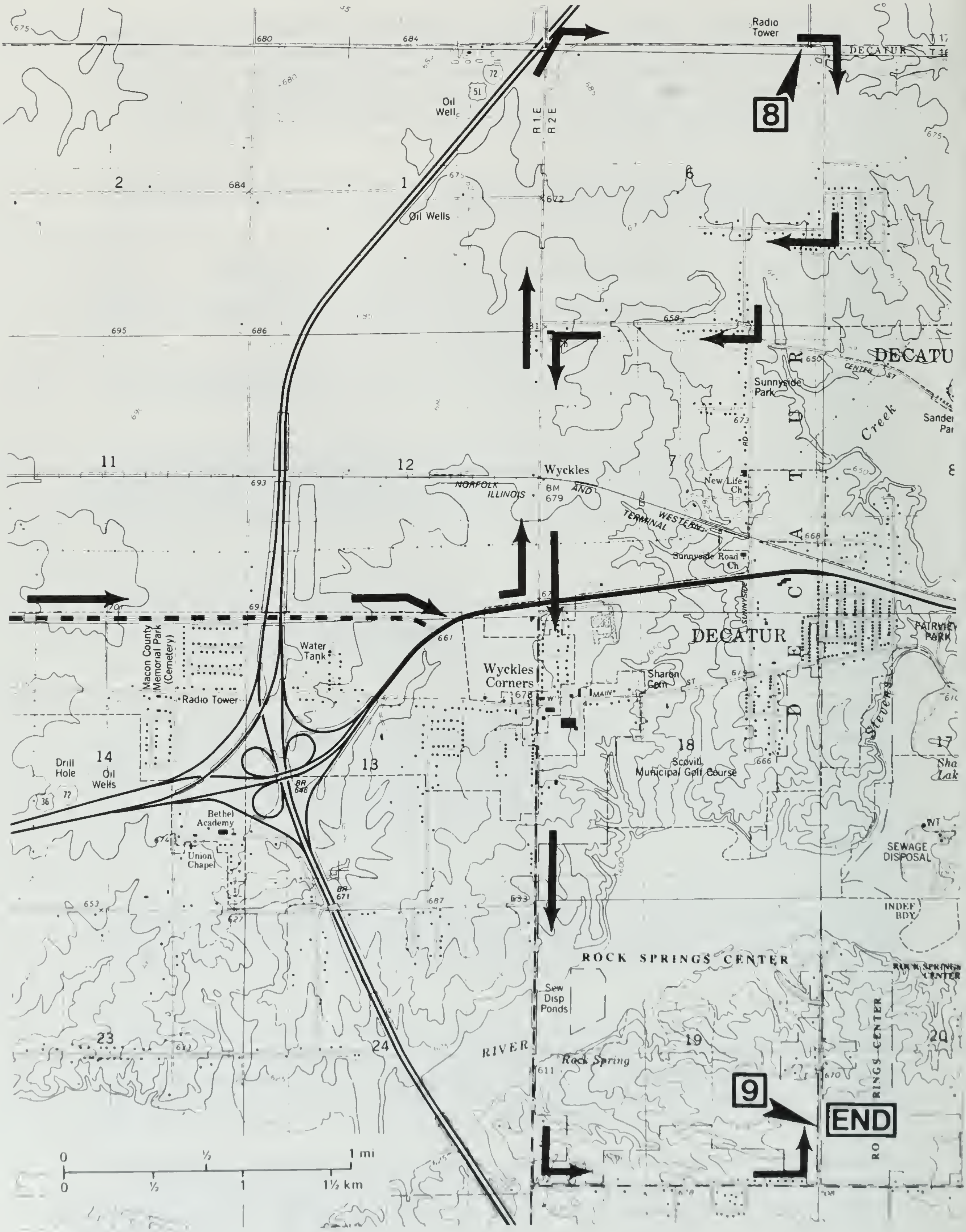
STOP 7 Thomas Lincoln and his family lived here during their first year in Illinois. We'll see some Wisconsinan glacial deposits exposed in the Sangamon River bluff below the home site (SW NE SW SE Sec. 28, T16N, R1E, 3rd P.M., Macon County, Harristown 7.5-Minute Quadrangle [39089G1]).

A relative of Thomas Lincoln's first wife and Abraham's mother suggested that they locate on Government land along the Sangamon about 8 miles southwest of Decatur. Although they built a log cabin here in 1830, there is no record that Thomas ever bought land in the vicinity. They only lived here for about 1 year, until Thomas moved southeast to Coles County. Abraham did not follow the family, but instead went to Springfield and then to New Salem. A replica of a pioneer's log cabin stood just southeast of the east parking lot until a couple of years ago when vandals burned it.

S. G. Whitley (ca. 1843) built a dam and mill in this area. His brother, James, helped him operate the mill for many years. If you stand on the nearly vertical bluff below the Lincoln cabin site, when the water is low, you can see a row of logs side by side on the south side of the river. Possibly, this is part of the old dam and mill, or perhaps the remains of a log ford across the river.

The bluff on the north side of the Sangamon and just upstream is some 30 feet high and the best Pleistocene exposure in the field trip area. You can reach this exposure during low water by taking the wooden stairs from the south parking lot near the Lincoln cabin site. From the bottom of the stairs, the path leads upstream for 125 feet or so; but it is quite uneven because of slump blocks and fallen trees, and quite slippery at times.

Windblown Wisconsinan loess at the top of the exposed section is less than 2 feet thick and overlies about 3 feet of brown loam till that appears to be the Woodfordian Wedron Till, possibly the Piatt or Fairgrange Member. This till is underlain by slightly more than 3 feet of brownish gray loam till. Beneath this is a 2-foot zone of silt and sand that is slightly bedded and



Radio Tower
DECATUR
8
Oil Well
Oil Wells
R1E
R2E
DECATUR
Sunnyside Park
Creek
Wyckles
NORFOLK AND WESTERN
ILLINOIS TERMINAL
New Life Ch
Sunnyside Road Ch
DECATUR
FAIRVIEW PARK
Macon County Memorial Park (Cemetery)
Water Tank
Wyckles Corners
Sharon Cem
Radio Tower
Drill Hole
Oil Wells
Scovill Municipal Golf Course
Bethel Academy
Union Chapel
SEWAGE DISPOSAL
ROCK SPRINGS CENTER
Sew Disp Ponds
RIVER
Rock Spring
9
END
0 ½ 1 mi
0 ½ 1 1½ km

highly contorted in a variegated gray and brown loam till some 3.5 feet thick. A 1-foot lens of fine sand occurs below the variegated till. About 8 feet of gray loam till is exposed below the sand lens to a stone line nearly 10 feet above the river. Much of the lowermost 10 feet is covered; but at water level lies a rounded pod of carbonate-cemented striated and polished pebbles, several of which are 4 to 8 inches in diameter. Some till balls are present at the top of this pod, and some wood fragments had been found in the gray till just above water level.

0.0	30.4+	Leave Stop 7 and BEAR RIGHT (north) on MCH 27.
0.3+	30.75	We are travelling along the lower slope or toe of the Shelbyville Moraine. To the right a short distance, you can see the moraine rising slightly above us. Note the oil pumpjacks on this slope. They're part of the Blackland North Oil Field.
0.35	31.1	Macon County oil fields and tank batteries can be seen on both sides of the road.
0.6	31.7	CAUTION: narrow 2-lane bridge.
0.2	31.9	There is another good view of the Wisconsinan Shelbyville Moraine to the right.
0.2+	32.1+	Cross I-72 overpass.
1.0+	33.15+	STOP: 2-way. TURN RIGHT (east) on the Lincoln National Memorial Highway (Harristown Boulevard).
0.1+	33.25+	NOTE: the historical marker to the south of the road reads as follows: From the site of the Lincoln cabin on the Sangamon three miles south of here, to the Wabash River opposite Vincennes, the Lincoln National Memorial Highway follows substantially the route taken by the Lincoln family in their migration from Indiana to Illinois in the spring of 1830.
0.4+	33.65+	Begin divided highway.
0.4+	34.05	CAUTION: enter the town of Harristown.
2.15	36.2+	I-72/US 51 overpasses: MOVE to the inside lane.
0.55+	36.8	STOP: 1-way at the T-intersection with US 36 on the curve. TURN LEFT (east) and stay in the inside lane.
0.25+	37.05+	Prepare to turn left.
0.1+	37.15+	STOPLIGHT: Wyckles Road. TURN LEFT (north) on Wyckles Road (MCH 41).
0.4+	37.6+	USE CAUTION at the single, rough, guarded N&S Railroad crossing.
1.25	38.85+	Prepare to turn right.

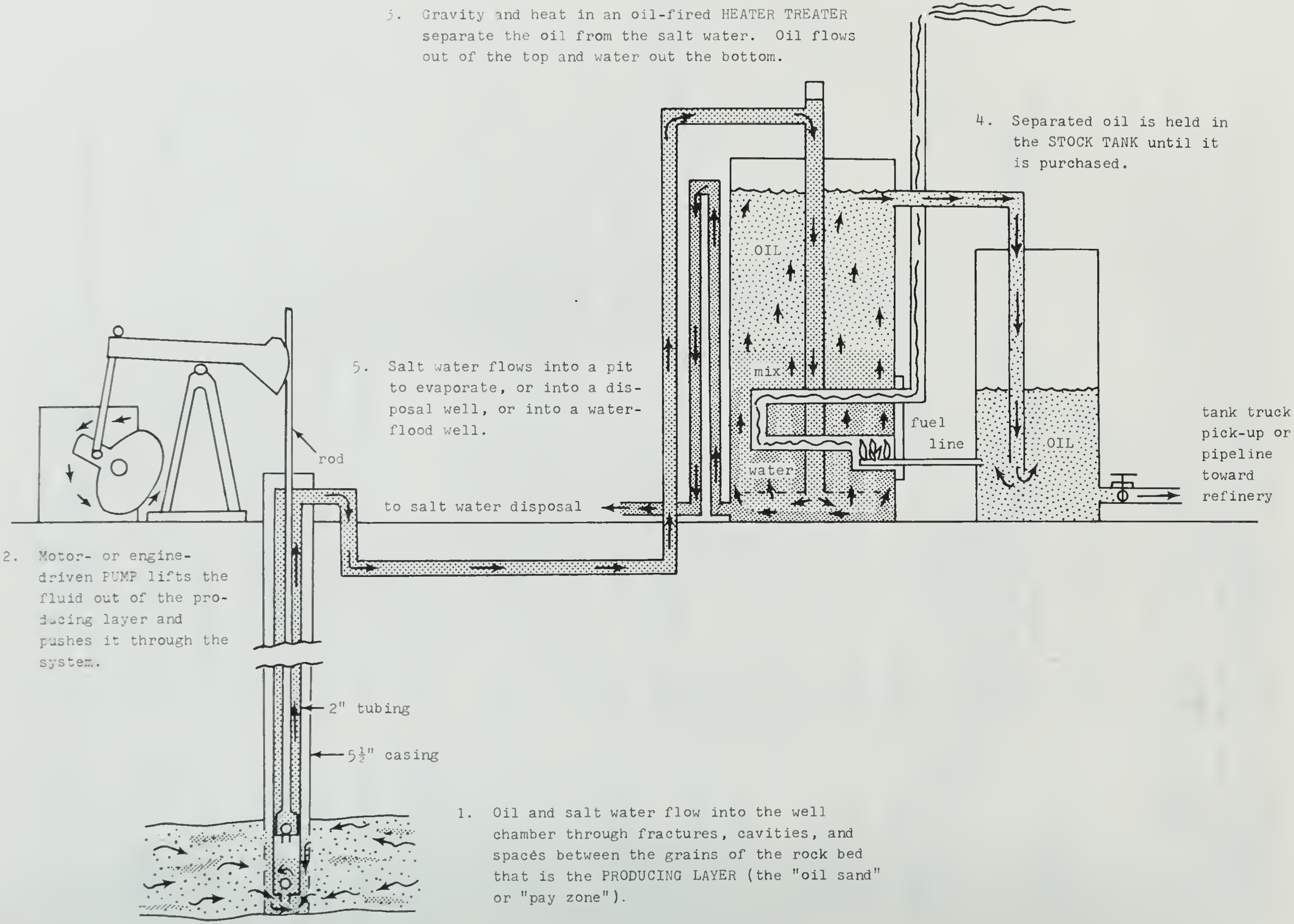


Figure 15 Schematic diagram of a common type of oil production unit in Illinois.

0.1	38.95+	TURN RIGHT (east onto a road that makes an "S" curve).
0.9	39.9+	PARK along the roadside. CAUTION: the road and shoulders are narrow here. WATCH for approaching traffic.

STOP 8 We'll discuss Silurian oil production in the Decatur Oil Field (16-17N, 2E) south of the tank battery located just north of the road (near ctr S edge SE SE SE Sec. 31, T17N, R2E, 3rd P.M., Macon County, Warrensburg 7.5-Minute Quadrangle [39089H1]).

The discovery well for the Decatur Oil Field was completed in September 1953 by the Harmon Oil Company on the Trump property near the center of the SE NE NE Sec. 5, T16N, R2E, 3rd P.M., Macon County (Decatur 7.5-Minute Quadrangle [39088G8]). Initial production was 13 barrels of oil per day from Silurian limestone at a depth of 2,010 feet; total production from this one well was 500 barrels by the end of 1953. (Fig. 15 is a schematic diagram of a common type of Illinois oil production unit.) The field was abandoned in 1959 after having yielded a reported total of 15,000 barrels of oil.

In July 1983, the Watters Oil and Gas Company No.1 Christina Noland well (approximate center of SE SE SE Sec. 31, T17N, R2E, 3rd P.M., Macon County, Warrensburg 7.5-Minute Quadrangle [39089H1]) revived the Decatur Oil Field. This well, which reached the top of Silurian limestone at 2,005 feet, had an initial production of 100 barrels of oil per day with a trace of water. Six more wells extended the productive area into SW Sec. 32, T17N, R2E, and into NE Sec. 6, T16N, R2E (fig. 16). From these seven wells, 219,000 barrels of oil (Watters 1991) have been pumped to the surface in what is called primary recovery. In a secondary recovery (waterflood) project, now getting underway, water will be pumped into depleted parts of the reservoir, thereby driving some of the remaining oil toward the producing wells.

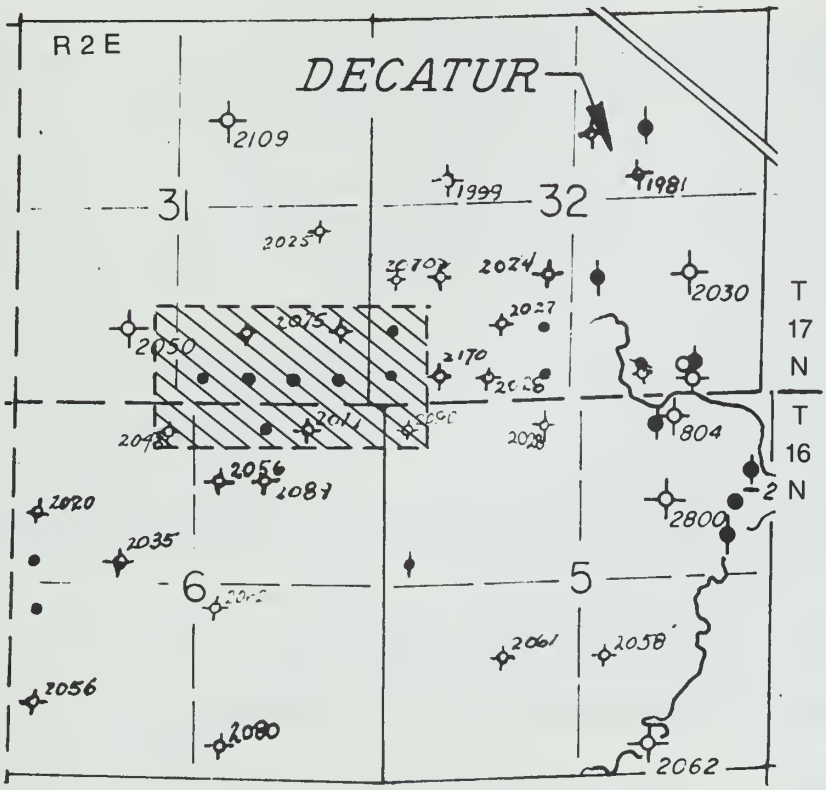


Figure 16 Approximate area (shaded) encompassed by the waterflood operation in the Decatur Oil Field.

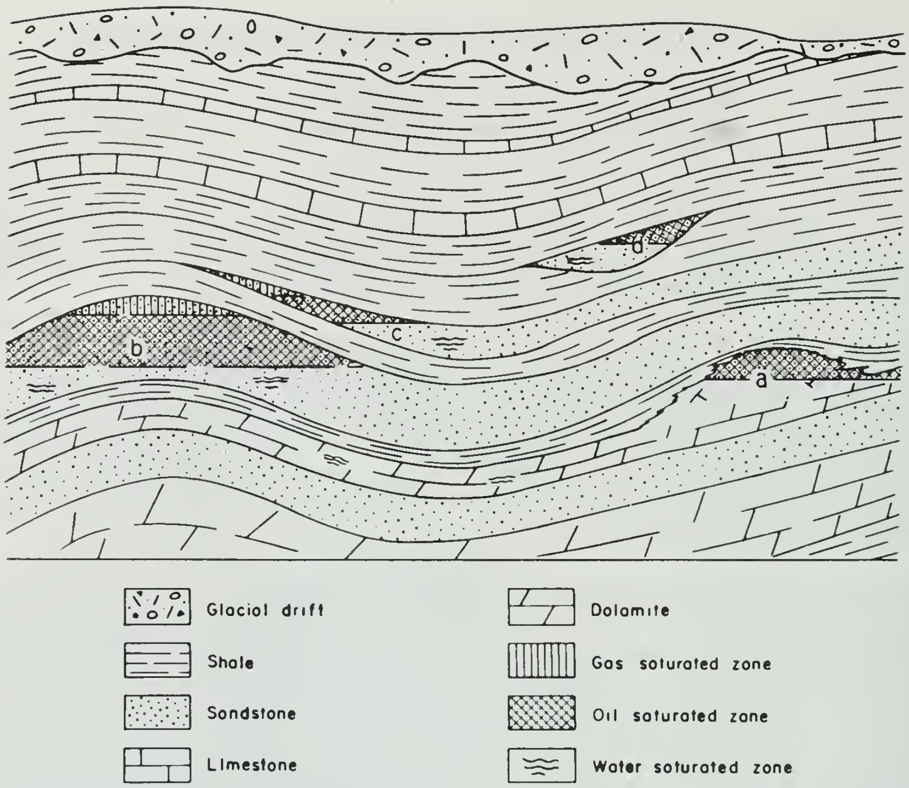


Figure 17 Places where oil occurs in Illinois.

Operators hope to recover as much as one-third of the oil contained in a reservoir by pumping (primary recovery). To recover more oil from the reservoir, water is frequently pumped into wells at the margins of a reservoir to energize the system so that friction can be overcome and more oil can move to the interior producing wells. If this secondary project is successful, perhaps another one-third of the oil can be recovered. Actually, the percentages are not quite that high. When the secondary recovery project is no longer economical to operate, probably more than one-third of the original oil still remains in the reservoir rocks. If the operators feel enough oil is left to make the venture worthwhile, they may attempt tertiary recovery projects—burn part of the oil underground to liquify the rest and drive it to the wellhead. The tertiary recovery methods are quite expensive, so they are used only when the price of oil is high enough to warrant the extra expense. A few of these projects, however, have been carried out as research to learn more about various technologies that might be employed.

Figure 17 shows where oil may be found in Illinois. The Decatur Oil Field lies over a small Silurian reef about 2,000 deep in NW T16N-SW T17N, R2E, Macon County. To be an effective oil reservoir, the reef rock must be higher than the surrounding strata and buried beneath a drape of impervious material, such as shale, through which the oil cannot migrate vertically or horizontally. This field meets these conditions.

0.0	39.9+	Leave Stop 8 and CONTINUE AHEAD (east).
0.05+	40.0+	STOP: 1-way at T-intersection. CONTINUE AHEAD (east, then south).
0.65+	40.65+	TURN RIGHT (west) on Catherine Street from Elizabeth Street.
0.25+	40.95+	TURN LEFT (south) from Catherine Street onto an unmarked street.

0.3+	41.3+	STOP: 1-way at the T-intersection. TURN RIGHT (west).
0.7+	42.0+	STOP: 1-way at the T-intersection. TURN LEFT (south) on Wyckles Road (MCH 41) at Sharon United Methodist Church.
0.55+	42.55+	USE CAUTION at the single, rough, guarded N&S RR crossing.
0.4+	42.95+	STOPLIGHT: intersection with US 36. CONTINUE AHEAD (south) on Wyckles Road.
0.35+	43.35+	USE CAUTION at the intersection with West Main Street at Wyckles Corners in Harristown. Kiick Field, one of the early airfields to serve Decatur, was located here from 1925-32. CONTINUE AHEAD (south).
0.95+	44.3+	Sanitary District of Decatur, Wyckles Road Facility, is located to the right.
0.15+	44.45+	CAUTION: enter Sangamon River bridge.
0.05+	44.55	Cross Sangamon River.
0.35	44.9	Prepare to turn left.
0.1+	45.0+	TURN LEFT (east) on Rock Springs Road (MCH 10).
0.9	45.9	Prepare to turn left.
0.1	46.0+	CAUTION: TURN LEFT (north) at the T-intersection onto Brozio Lane at sign for Macon County Conservation District.
0.2+	46.25	To the left, T-intersection is the entrance to Rock Springs Center for Environmental Discovery. The center and parking lot are about 0.55 mile west and north from the gate of this entrance.

STOP 9 We'll visit Rock Springs Center for Environmental Discovery (entrance gate: E edge NE NE SE Sec. 19, T16N, R2E, 3rd P.M., Macon County, Harristown 7.5-Minute Quadrangle [39089G1]).

In 1966, people living in this area recognized that the few remaining "islands" of native habitat were rapidly disappearing. To help preserve these natural resources, Macon County formed a conservation district. Concerned citizens demanded that some of these acreages be protected, preserved, and enhanced for everyone to enjoy and to learn about their natural environment.

Several natural areas are not open to the public, but four major areas have been set aside as parklands: Friends Creek Regional Park in northeastern Macon County, Fort Daniel Conservation Area in the eastern part, Griswold Conservation Area in the southwest part of the county where we ate lunch, and Rock Springs Center for Environmental Discovery. The latter facility has a modern building with many displays and dioramas depicting some of the geology and many natural wonders of the county. A library, classrooms, and meeting rooms are available in addition to outdoor observation areas and trails. Take some time to become acquainted with part of your natural heritage. What can you do to enhance this heritage for yourself, your family, and others?

End of the Decatur geologic field trip.

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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 Mississiippi, 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.

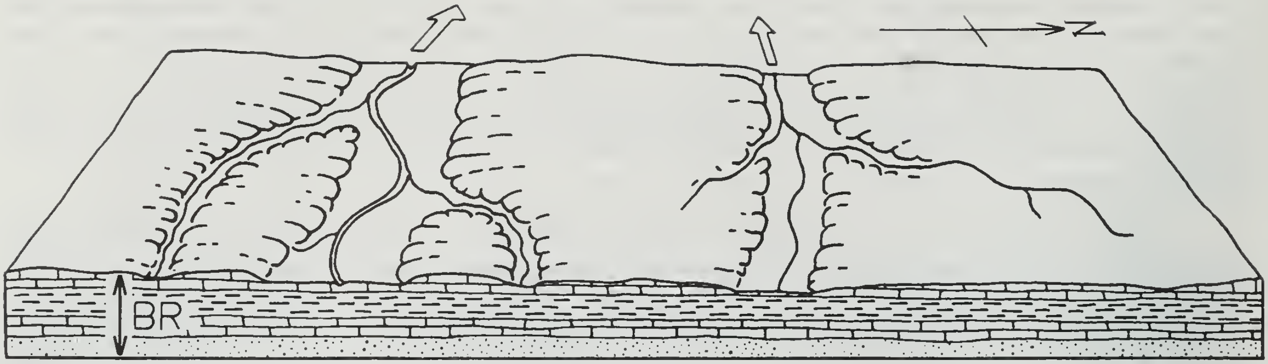
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and 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.

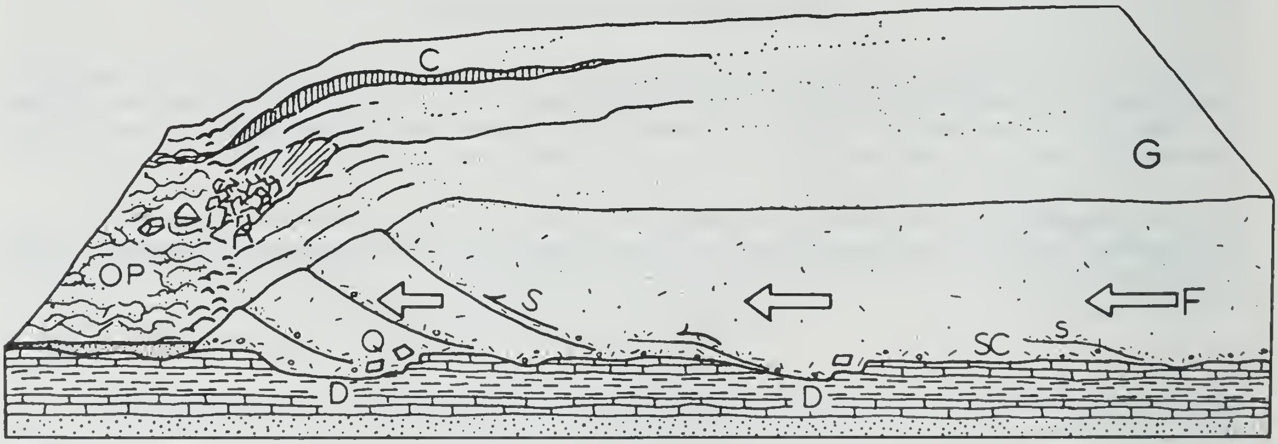
Glaciation in a Small Illinois Region

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.

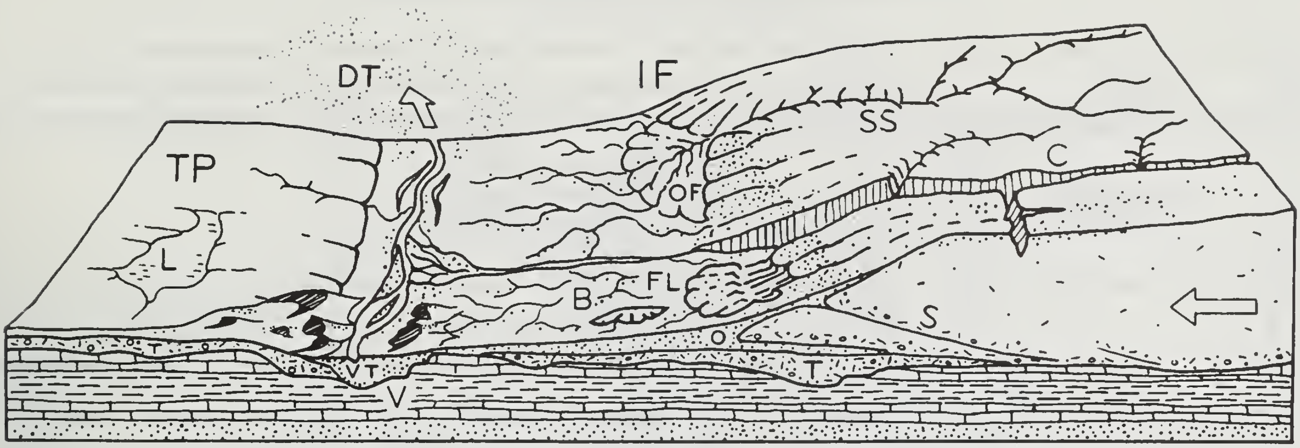
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



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.



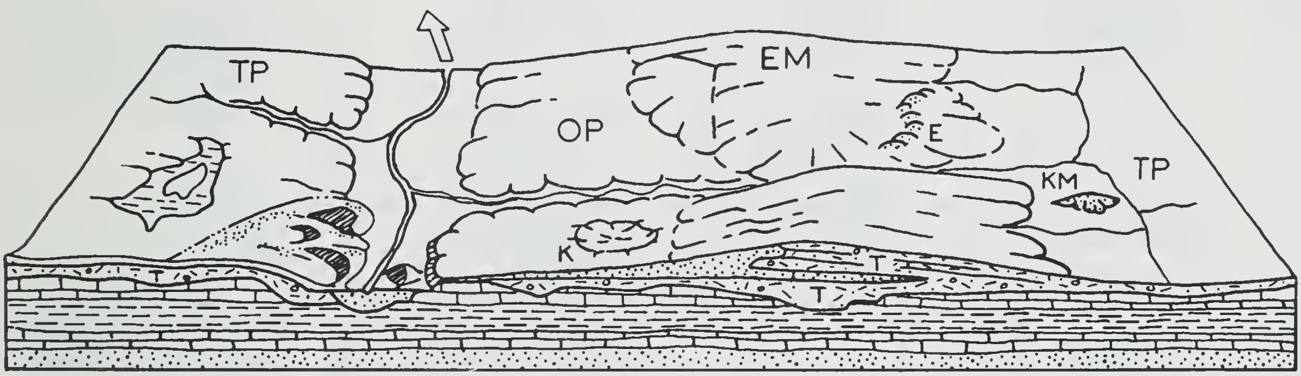
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses 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.

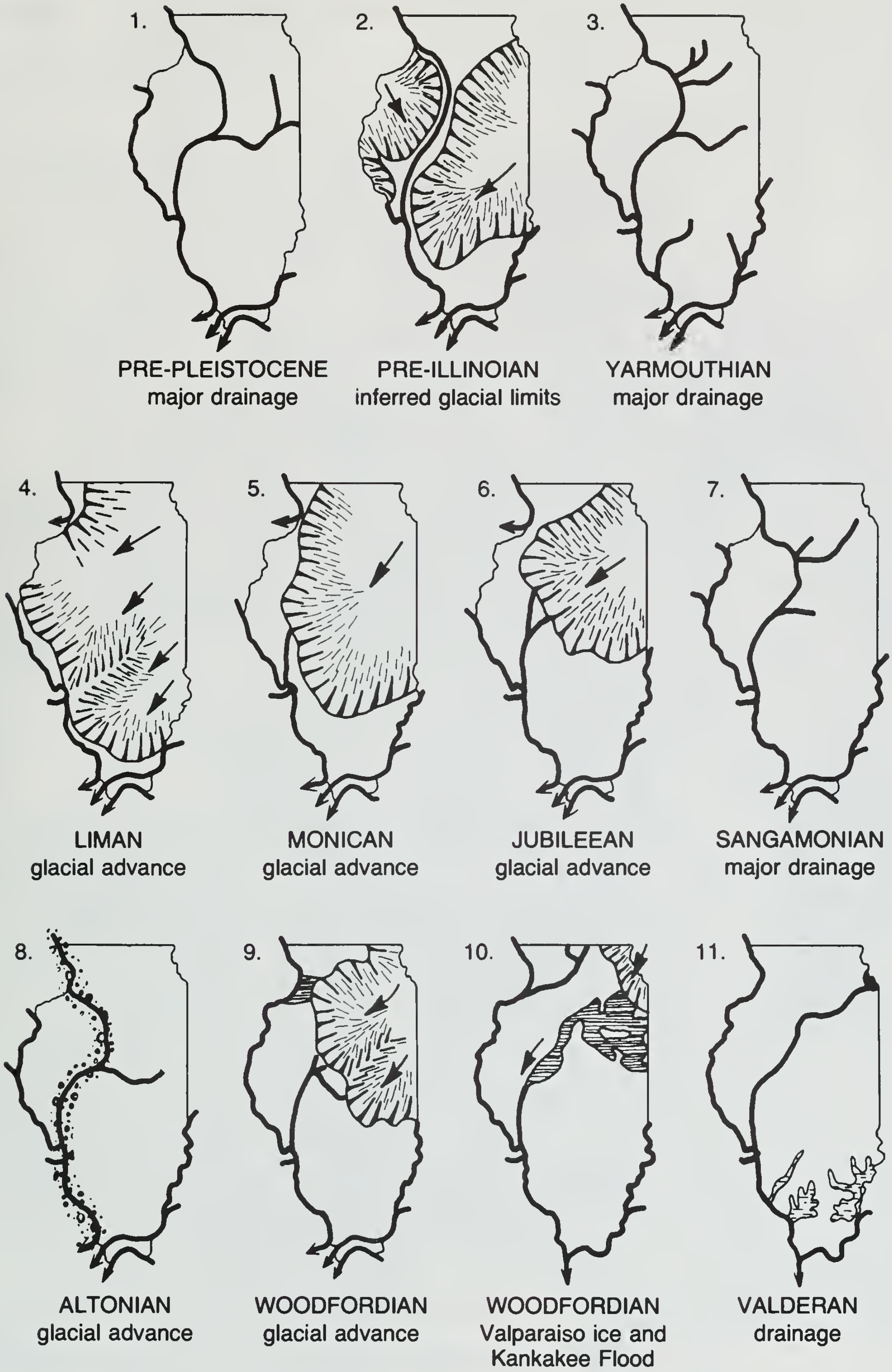
TIME TABLE OF PLEISTOCENE GLACIATION

			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)	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
				11,000		
				Twocreekan	Peat and alluvium	Ice withdrawal, erosion
				12,500		
		late		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		

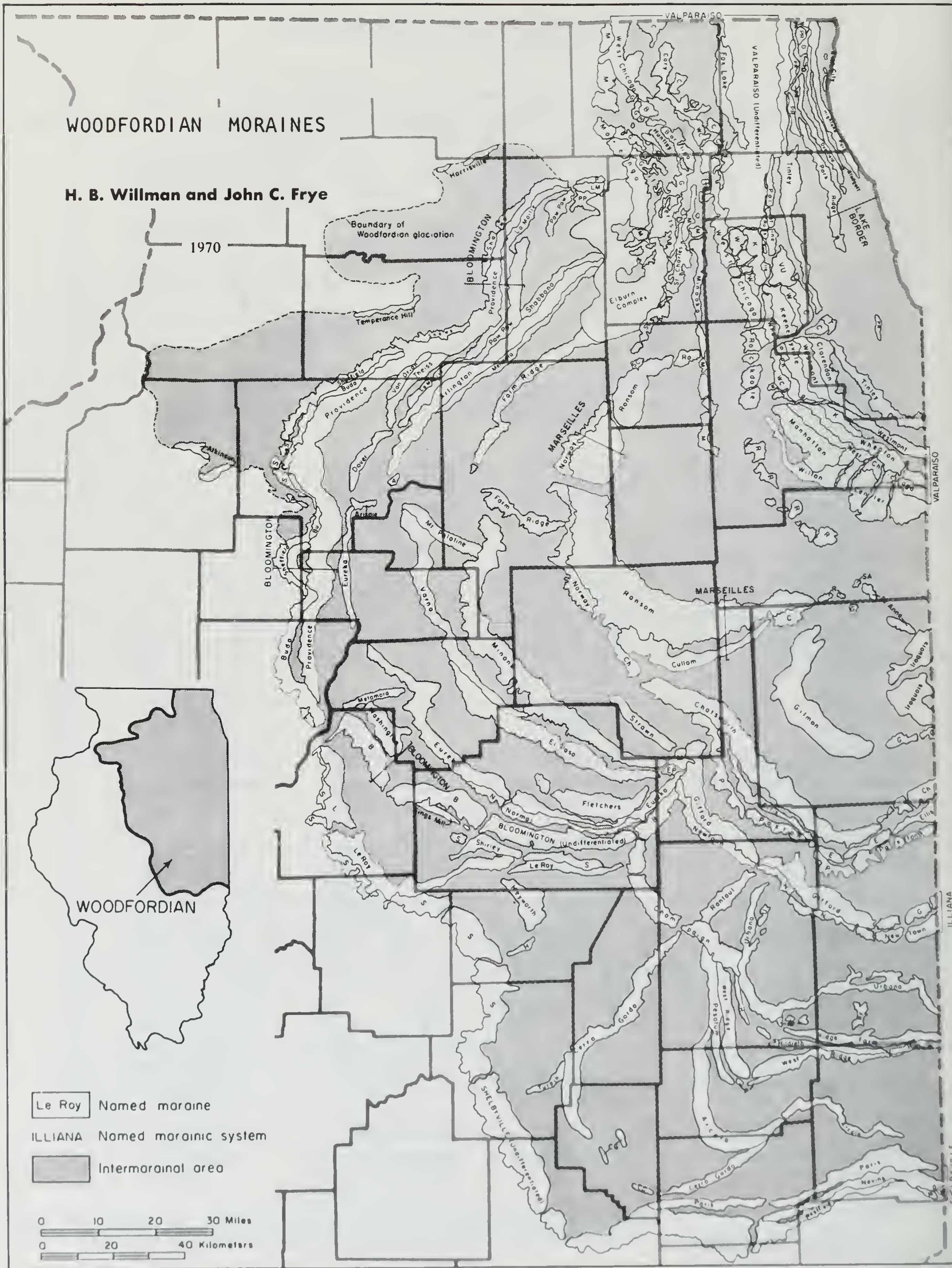
*Old oversimplified concepts, now known to represent a series of glacial cycles.

(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.)

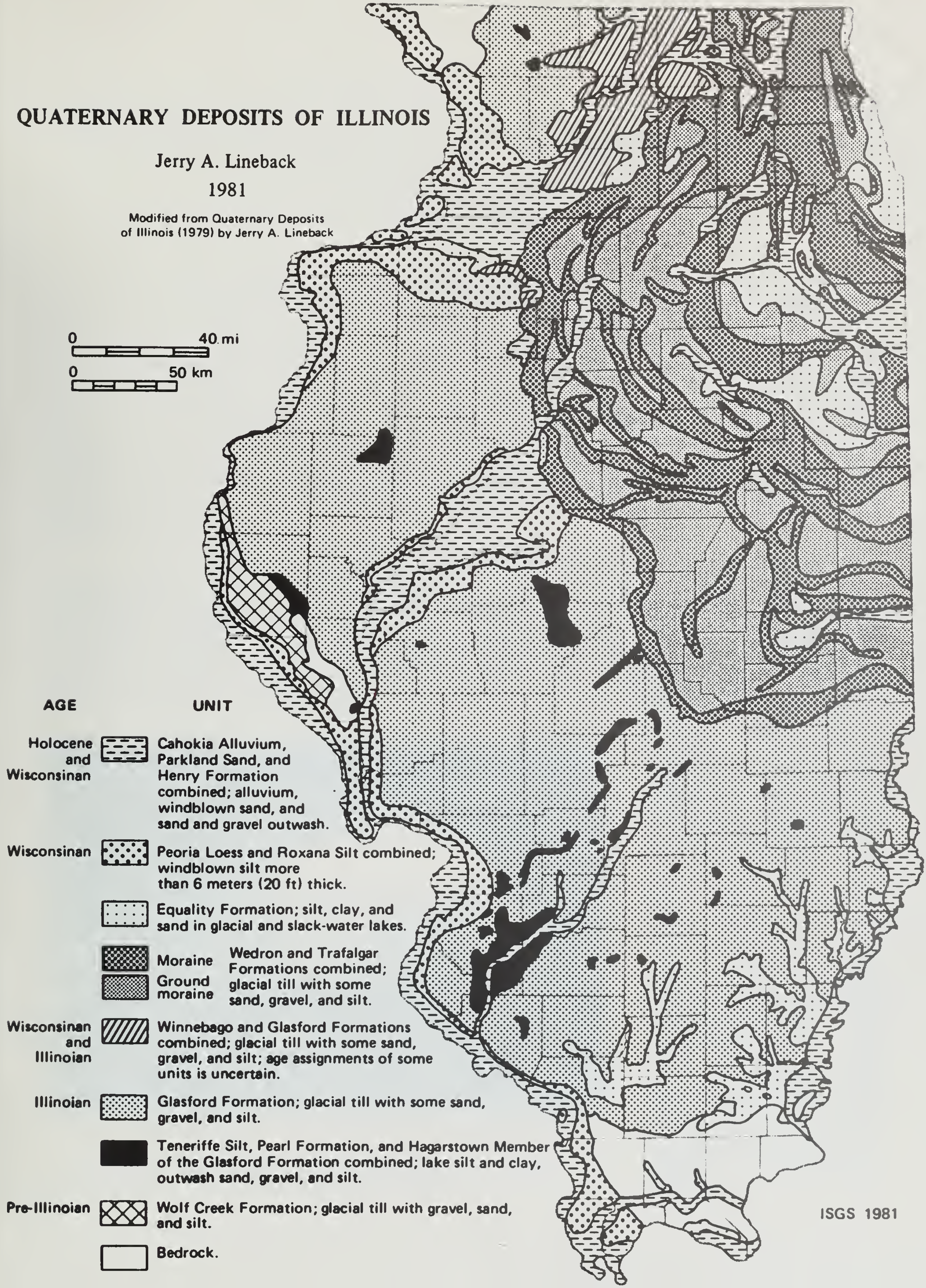

WOODFORDIAN MORAINES
H. B. Willman and John C. Frye
1970
Boundary of Woodfordian glaciation
VALPARAISO
VALPARAISO (Undifferentiated)
LAKE BORDER
BLOOMINGTON
BLOOMINGTON (Undifferentiated)
MARSEILLES
ILLIANA
SHELBYVILLE
SHELBYVILLE (Undifferentiated)
Elburn Complex
Temperance Hill
Providence
Shabbona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

QUATERNARY DEPOSITS OF ILLINOIS

Jerry A. Lineback

1981

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



ERRATICS ARE ERRATIC

Myrna M. Killey

You may have seen them scattered here and there in Illinois—boulders, some large, some small, lying alone or with a few companions in the corner of a field, at the edge of a road, in someone's yard, or perhaps on a courthouse lawn or schoolyard. Many of them seem out of place, like rough, alien monuments in the stoneless, grassy knolls and prairies of our state. Some—the colorful and glittering granites, banded gneisses, and other intricately veined and streaked igneous and metamorphic rocks--are indeed foreign rocks, for they came from Canada and the states north of us. Others—gray and tan sedimentary rocks—are native rocks and may be no more than a few miles from their place of origin. All of these rocks are glacial boulders that were moved to their present sites by massive ice sheets that flowed across our state. If these boulders are unlike the rocks in the quarries and outcrops in the region where they are found, they are called erratics.

The continental glaciers of the Great Ice Age scoured and scraped the land surface as they advanced, pushing up chunks of bedrock and grinding them against each other or along the ground surface as the rock-laden ice sheets pushed southward. Hundreds of miles of such grinding, even on such hard rocks as granite, eventually rounded off the sharp edges of these passengers in the ice until they became the rounded, irregular boulders we see today. Although we do not know the precise manner in which erratics reached their present isolated sites, many were probably dropped directly from the melting front of a glacier. Others may have been rafted to their present resting places by icebergs on ancient lakes or on the floodwaters of some long-vanished stream as it poured from a glacier. Still others, buried in the glacial deposits, could have worked their way up to the land surface as the surrounding loose soil repeatedly froze and thawed. When the freezing ground expands, pieces of rock tend to be pushed upward, where they are more easily reached by the farmer's plow and also more likely to be exposed by erosion.

An eight-foot boulder of pink granite left by a glacier in the bed of a creek about 5 miles southwest of Alexis, Warren County, Illinois. (From ISGS Bulletin 57, 1929.)

Generally speaking, erratics found northeast of a line drawn from Freeport in Stephenson County, southward through Peoria, and then southeastward through Shelbyville to Marshall at the east edge of the state were brought in by the last glacier to enter Illinois. This glaciation, called the Wisconsinan, spread southwestward into Illinois from a center in eastern Canada, reaching our state about 75,000 years ago and (after repeated advances and retreats of the ice margin) melting from the state about 12,500 years ago. Erratics to the west or south of the great arc outlined above were brought in by a much older glacier, the Illinoian, which spread over most of the state about 300,000 to 175,000 years ago. Some erratics were brought in by even older glaciers that came from the northwest.

You may be able to locate some erratics in your neighborhood. Sometimes it is possible to tell where the rock originally came from by determining the kind of rock it is. A large boulder of granite, gneiss, or other igneous or metamorphic rock may have come from the Canadian Shield, a vast area in central and eastern Canada where rocks of Precambrian age (more than 600 million years old) are exposed at the surface. Some erratics containing flecks of copper were probably transported here from the "Copper Range" of the upper peninsula of Michigan. Large pieces of copper have been found in glacial deposits of central and northern Illinois. Light gray to white quartzite boulders with beautiful, rounded pebbles of red jasper came from a very small outcrop area near Bruce Mines, Ontario, Canada. Purplish pieces of quartzite, some of them banded, probably originated in the Baraboo Range of central Wisconsin. Most interesting of all are the few large boulders of Canadian tillite. Tillite is lithified (hardened into rock) glacial till deposited by a Precambrian glacier many millions of years older than the ones that invaded our state a mere few thousand years ago. Glacial till is an unsorted and unlayered mixture of clay, sand, gravel, and boulders that vary widely in size and shape. Tillite is a gray to greenish gray rock containing a mixture of grains of different sizes and scattered pebbles of various types and sizes.

Many erratics are of notable size and beauty, and in parts of Illinois they are commonly used in landscaping. Some are used as monuments in courthouse squares, in parks, or along highways. Many are marked with metal plaques to indicate an interesting historical spot or event. Keep an eye out for erratics. There may be some of these glacial strangers in your neighborhood that would be interesting to know.

ILLINOIS STATE GEOLOGICAL SURVEY
Urbana, Illinois 61801

GEOGRAM 5
October 1975

ANCIENT DUST STORMS IN ILLINOIS

Myrna M. Killey

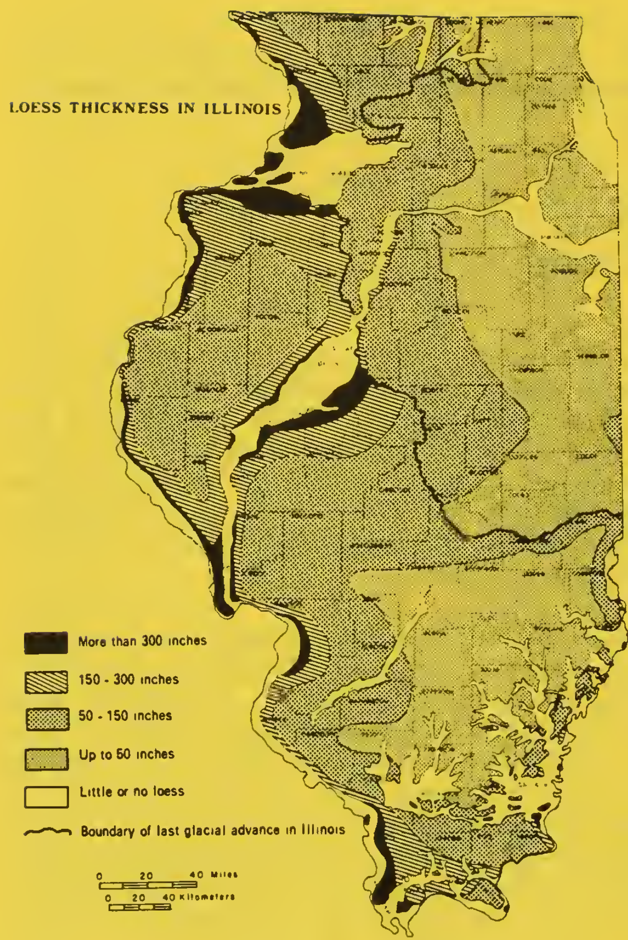
Fierce dust storms whirled across Illinois long before human beings were here to record them. Where did all the dust come from? Geologists have carefully put together clues from the earth itself to get the story. As the glaciers of the Great Ice Age scraped and scoured their way southward across the landscape from Canada, they moved colossal amounts of rock and earth. Much of the rock ground from the surface was kneaded into the ice and carried along, often for hundreds of miles. The glaciers acted as giant grist mills, grinding much of the rock and earth to "flour"—very fine dust-sized particles.

During the warm seasons, water from the melting ice poured from the glacier front, laden with this rock flour, called silt. In the cold months the meltwater stopped flowing and the silt was left along the channels the water had followed, where it dried out and became dust. Strong winds picked up the dust, swept it from the floodplains, and carried it to adjacent uplands. There the forests along the river valleys trapped the dust, which became part of the moist forest soil. With each storm more material accumulated until the high bluffs adjacent to major rivers were formed. The dust deposits are thicker along the eastern sides of the valleys than they are on the western sides, a fact from which geologists deduce that the prevailing winds of that time blew from west to east, the same direction as those of today. From such clues geologists conclude that the geologic processes of the past were much like those of today.

The deposits of windblown silt are called loess (rhymes with "bus"). Loess is found not only in the areas once covered by the glaciers but has been blown into the nonglaciated areas. The glaciers, therefore, influenced the present land surface well beyond the line of their farthest advance.

Loess has several interesting characteristics. Its texture is so fine and uniform that it can easily be identified in roadcuts—and because it blankets such a vast area many roads are cut through it. Even more noticeable is its tendency to stand in vertical walls. These steep walls develop as the loess drains and becomes tough, compact, and massive, much like a rock. Sometimes cracks develop in the loess, just as they do in massive limestones and sandstones. Loess makes good highway banks if it is cut vertically. A vertical cut permits maximum drainage because little surface is exposed to rain, and rainwater tends to drain straight down through it to the rock underneath. If the bank is cut at an angle more water soaks in, which causes the loess to slump down. Along Illinois roads the difference between a loess roadcut and one in ordinary glacial till is obvious. The loess has a very uniform texture, while the till is composed of a random mixture of rock debris, from clay and silt through cobbles and boulders.

Many loess deposits are worth a close look. Through a 10-power hand lens separate grains can be seen, among them many clear, glassy, quartz grains. Some loess deposits contain numerous rounded, lumpy stones called concretions. Their formation began when water percolating through the loess dissolved tiny

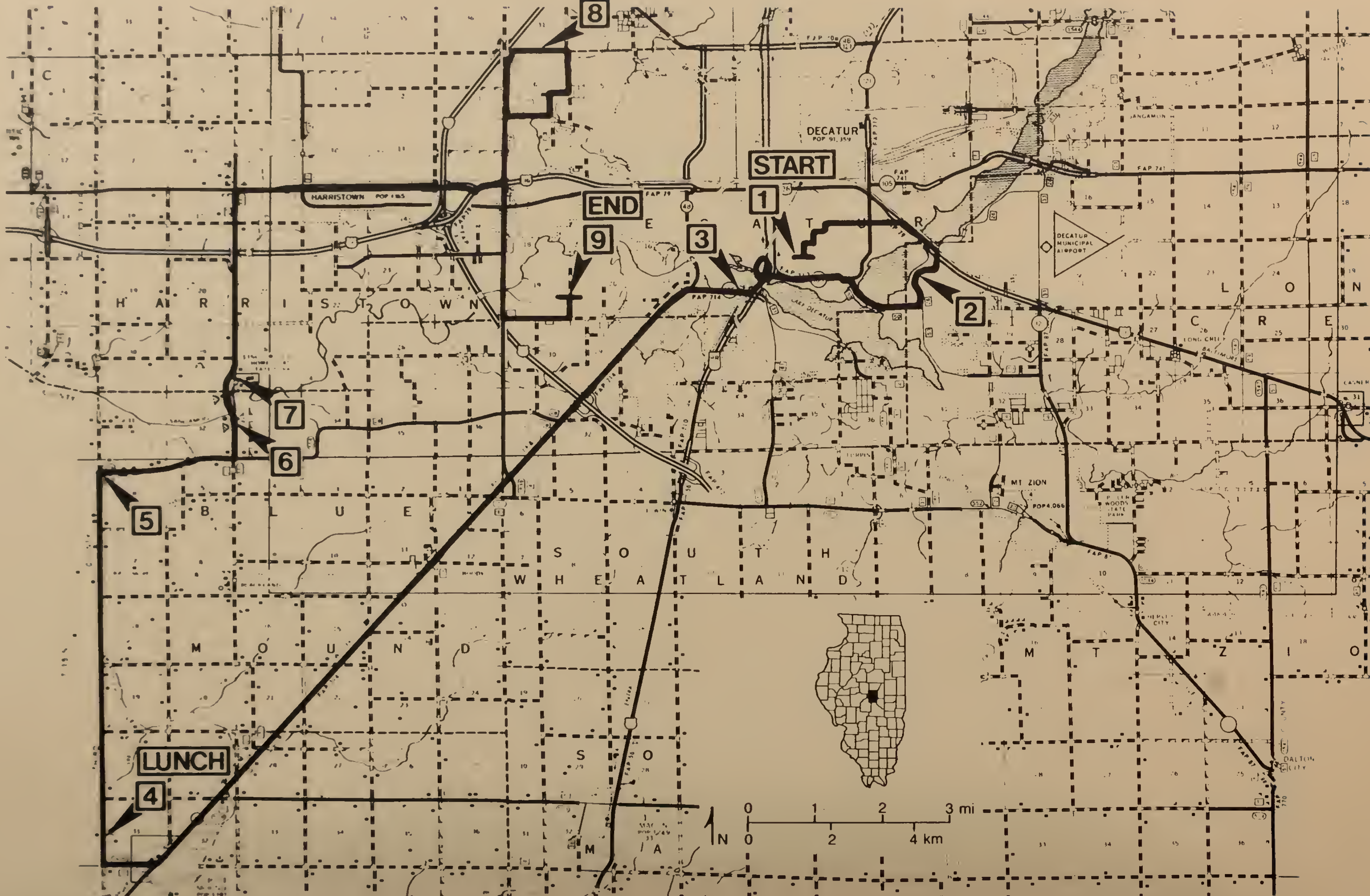


limestone grains. Some of the dissolved minerals later became solid again, gathering around a tiny nucleus or along roots to form the lumpy masses. A few such concretions are shaped roughly like small dolls and, from this resemblance, are called "loess kindchen," a German term meaning "loess children." They may be partly hollow and contain smaller lumps that make them rattle when shaken.

Fossil snails can be found in some loess deposits. The snails lived on the river bluffs while the loess was being deposited and were buried by the dust. When they are abundant, they are used to determine how old the loess is. The age is found by measuring the amount of radioactive carbon in the calcium carbonate of their shells.

Some of the early loess deposits were covered by new layers of loess following later glacial invasions. Many thousands of years passed between the major glacial periods, during which time the climate was as warm as that of today. During the warm intervals, the surface of the loess and other glacial deposits was exposed to weather. Soils developed on most of the terrain, altering the composition, color, and texture of the glacial material. During later advances of the ice, some of these soils were destroyed, but in many places they are preserved under the younger sediments. Such ancient buried soils can be used to determine when the materials above and below them were laid down by the ice and what changes in climate took place.

The blanket of loess deposited by the ancient dust storms forms the parent material of the rich, deep soils that today are basic to the state's agriculture. A soil made of loess crumbles easily and has great moisture-holding capacity. It also is free from rocks that might complicate cultivation. Those great dust storms that swirled over the land many thousands of years ago thus endowed Illinois with one of its greatest resources, its highly productive soil.


START
1
2
3
4
LUNCH
5
6
7
8
9
END
DECATUR
POP 91,359
HARRISTOWN
MT ZION
POP 4,066
DECATUR MUNICIPAL AIRPORT
H A R R I S T O W N
L O N G C R E E K
S O U T H W H E A T L A N D
B L U E M O U N D
M T Z I O N
DALTON CITY
LONG CREEK
0 1 2 3 mi
0 2 4 km
N