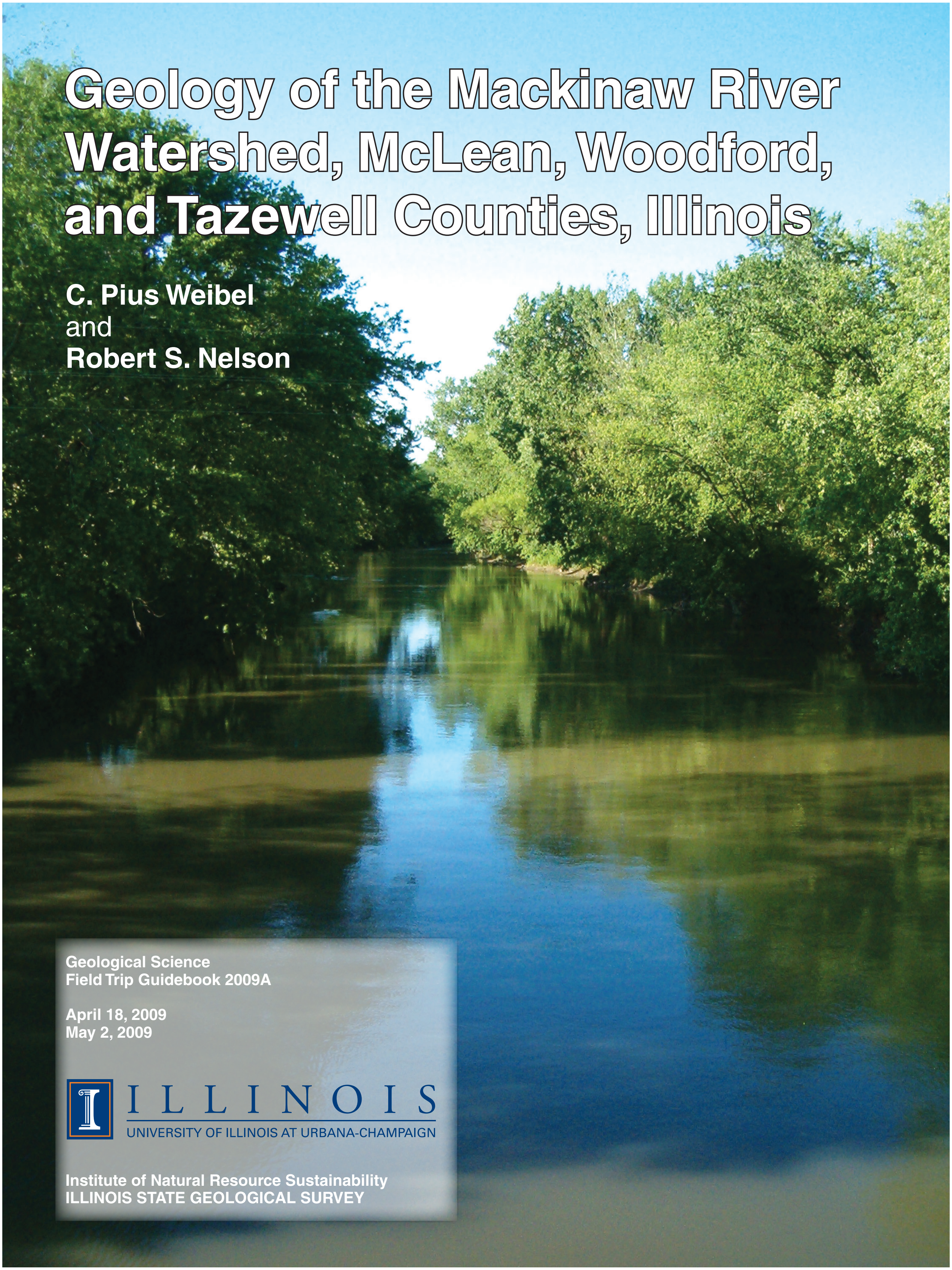

Geology of the Mackinaw River Watershed, McLean, Woodford, and Tazewell Counties, Illinois

C. Pius Weibel
and
Robert S. Nelson

Geological Science
Field Trip Guidebook 2009A

April 18, 2009
May 2, 2009

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Institute of Natural Resource Sustainability
ILLINOIS STATE GEOLOGICAL SURVEY

Cover photograph: *View of the Mackinaw River (photograph by W.T. Frankie).*

Acknowledgment The information in the first part of this guidebook is adapted from ISGS Field Trip Guidebook 2004A, Guide to the Geology of the Pekin Area, Tazwell and Mason Counties, Illinois, by Wayne T. Frankie, Russell Jacobson, and Robert S. Nelson.

Geological Science Field Trips The Illinois State Geological Survey (ISGS) conducts four tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that have led to their origin. Each 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 who prepare earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for every ten students.

The inside back cover shows a list of guidebooks of earlier field trips. Guidebooks may be obtained by contacting the Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820-6964 (telephone: 217-244-2414 or 217-333-4747). Guidebooks may also be ordered from the Shop ISGS link at the top of the ISGS home page: http://www.isgs.illinois.edu.

Twelve USGS 7.5-minute quadrangle maps (Arrowsmith, Holder, Merna, Cooksville, Normal East, Normal West, Danvers, Secor, Mackinaw, Minier, Hopedale, and Morton) provide coverage for this field trip area.

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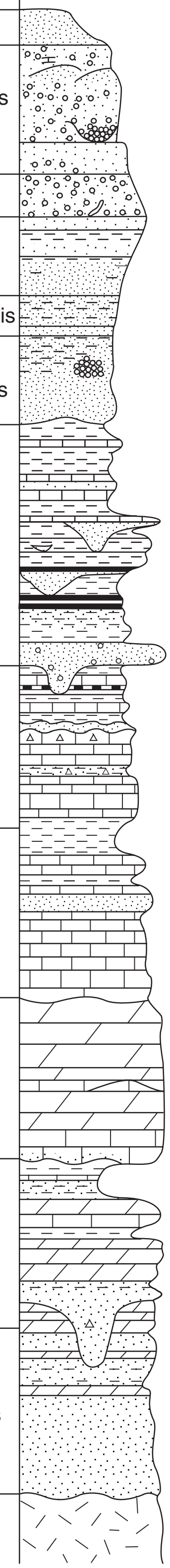
CONTENTS

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	1.8 m	Glacial till, glacial outwash, gravel, sand, silt, lake deposits of clay and silt; wind deposits of loess and sand dunes. Deposits cover nearly all of state except northwest corner and southern tip
		Tertiary 0–500'	Pliocene	5.3 m 33.7 m	Chert gravel, present in northern, southern, and western Illinois
			Eocene	54.8 m	Mostly micaceous sand with some silt and clay; present only in southern Illinois
			Paleocene	65 m	Mostly clay, little sand; present only in southern Illinois
MESOZOIC "Middle Life"	Age of Reptiles	Cretaceous 0–300'		144 m 290 m	Mostly sand, some thin beds of clay, and, locally, gravel; present only in southern and western Illinois
PALEOZOIC "Ancient Life"	Age of Amphibians and Early Plants	Pennsylvanian 0–3,000' ("Coal Measures")		323 m	Largely shale and sandstone with beds of coal, limestone, and clay
		Mississippian 0–3,500'		354 m	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
	Age of Fishes	Devonian 0–1,500'		417 m	Thick limestone, minor sandstones, and shales; largely chert and cherty limestone in southern Illinois; black shale at top
	Age of Invertebrates	Silurian 0–1,000'		443 m	Principally dolomite and limestone
		Ordovician 500–2,000'		490 m	Largely dolomite and limestone but contains sandstone, shale, and siltstone formations
		Cambrian 1,500–3,000'		543 m	Chiefly sandstones with some dolomite and shale; exposed only in small areas in north-central Illinois
		Precambrian			Igneous and metamorphic rocks; known in Illinois only from deep wells



Generalized geologic column for Illinois.

MACKINAW RIVER WATERSHED

INTRODUCTION

This geological science field trip will acquaint you with the geology, landscape, and resources for part of McLean, Tazewell, and Woodford Counties, Illinois. The field trip more or less follows a semicircular route about Bloomington-Normal, which is located in McLean County.

McLean County was created on December 25, 1830, formed partially from a portion of an originally much larger Tazewell County and partially from a previously unorganized area. McLean County was named for John McLean, a pioneer lawyer, territorial judge, and the first Representative in Congress from Illinois (1818). Later, he became a U.S. Senator (1824–1825). The county is the largest in Illinois (1,184 square miles).

Tazewell County was established on January 31, 1827, from a previously unorganized area. The county is named for Littleton W. Tazewell, an eminent U.S. Senator (1824–1832) and later Governor (1834–1836) of Virginia at the time the county was named. Tazewell County has the distinction of having the site of the first settlement by Europeans in Illinois. In January 1680, Robert de LaSalle, Father Louis Hennepin, Henry de Tonti, and about thirty other explorers, landed their canoes on the eastern bank of the Illinois River and built Fort Crevecoeur just below Peoria Lake. Thus, the French flag was the first to fly over the area, but the fort was abandoned just a few months after it was built.

Woodford County was portioned out of originally much larger Tazewell and McLean Counties in February 1841; the final boundary adjustment with McLean occurred in 1843. The county was named for Woodford County, Kentucky, which had been named for General William Woodford, who fought in several revolutionary war battles (Battles of Great Bridge, Brandywine, and Monmouth, Siege of Charleston) before dying in captivity in 1780.

GEOLOGIC FRAMEWORK

Precambrian Era (3.8 bya to 543 mya)

Through several billion years of geologic time, the area surrounding McLean, Tazewell, and Woodford Counties, like the rest of present-day Illinois, has undergone many changes (see generalized geologic column, facing page). The oldest rocks beneath the field trip area belong to the ancient Precambrian basement complex. These ancient rocks consist mostly of granitic and rhyolitic igneous rocks and possibly metamorphic, crystalline rocks formed about 1.5 to 1.0 billion years ago. The depth to the Precambrian rocks within McLean, Tazewell, and Woodford Counties ranges from about 4,500 to 5,000 feet.

From about 1 billion to about 0.6 million years ago, these Precambrian rocks were exposed at Earth's surface. During this long period, the rocks were deeply weathered and eroded and formed a barren landscape that was probably quite similar to the topography of the present Missouri Ozarks.

There is no rock record in Illinois that represents the long interval of weathering and erosion that lasted from the formation of the Precambrian rocks until the first Cambrian age sediments accumulated. This interval of weathering and erosion is almost as long as the time from the beginning of the Cambrian Period to the present.

Because geologists cannot see the Precambrian basement rocks in Illinois except as cuttings and cores from boreholes, various other techniques, such as measurements of Earth's gravitational and magnetic fields and seismic exploration, are used to map the regional characteristics of the basement complex.

Paleozoic Era (543 to 248 mya)

During the latter part of the Precambrian Era, and continuing until the Late Cambrian Period of the Paleozoic Era, the movement of crustal plates (plate tectonics) began to rip apart the North American continent, forming rift valleys in southernmost Illinois (Figure 1). These rift valleys were initially filled with sands and gravels that were shed from the adjacent uplands. About 520 million years ago in the Late Cambrian, rifting stopped, and the hilly Precambrian landscape began to sink slowly on a broad regional scale, allowing the invasion of a shallow sea from the south and southwest. These continual tectonic movements caused repeated invasions and withdrawals of the seas across the region.

During the following 270 million years of the Paleozoic Era, the area that is now called the Illinois Basin (Figure 1) continued to accumulate sediments that were deposited in the shallow seas that repeatedly covered this subsiding basin. The region continued to sink until at least 20,000 feet of sedimentary strata were deposited in the deepest part of the Illinois Basin, located in southeastern Illinois and western Kentucky. At various times during this era, the seas withdrew, and deposits were weathered and eroded, resulting in gaps in the sedimentary record in Illinois.

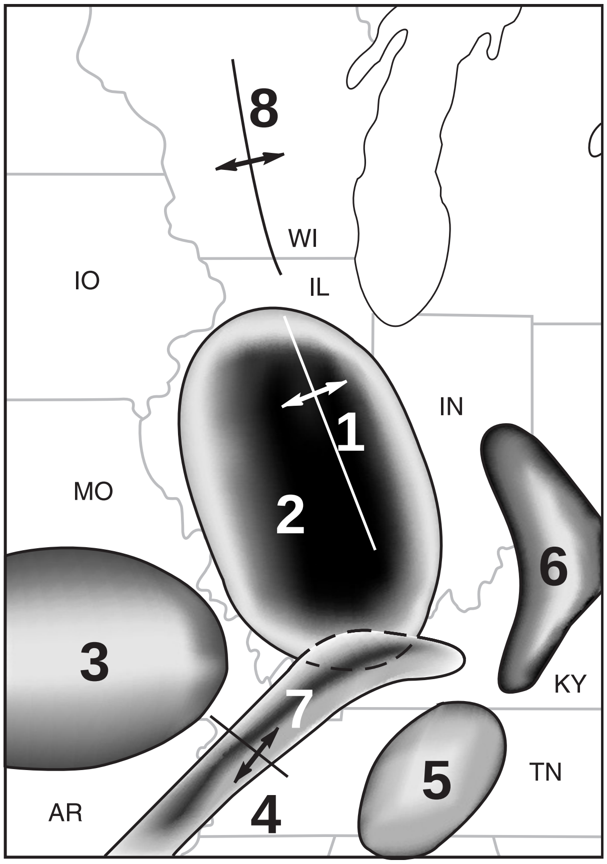


Figure 1 Location of some of the major structures in the Illinois region: (1) La Salle Anticlinorium, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, (7) Rough Creek Graben–Reelfoot Rift, and (8) Wisconsin Arch.

Near the close of the Mississippian Period, gentle arching of the rocks in eastern Illinois initiated the development of the La Salle Anticlinorium (Figure 1). This complex structure contains domes, anticlines, and synclines superimposed on it. Further arching continued through the Pennsylvanian Period. Because the youngest Pennsylvanian strata are absent from the area of the anticlinorium (they either were not deposited or were eroded), we cannot determine just when folding ceased—perhaps by the end of the Pennsylvanian or during the Permian Period a little later, near the close of the Paleozoic Era.

The Paleozoic Era rocks (compacted and hardened sediments) constitute the bedrock. In the field trip area, bedrock strata range in age from more than 520 million years (the Cambrian Period) to less than 320 million years old (the Pennsylvanian Period). In central Illinois, older, generally deeper bedrock is mainly composed of limestone, dolomite, shale, and sandstone (Figure 2).

In the field trip area, just below a cover of glacial deposits, younger, Pennsylvanian age bedrock strata consist of shale, siltstone, sandstone, limestone, coal, and underclay that were deposited as sediments in shallow seas and swamps between about 323 and 290 million years ago. Some of these rocks are exposed in scattered road cuts and stream cuts immediately north and west of the field trip area. Some of these exposures were visited during the 1995 and 2004 ISGS field trips (Frankie et al. 1995, 2004).

The field trip area is underlain by as much as 5,000 feet of Paleozoic sedimentary rocks. Figure 2 shows the succession of rock strata a drill bit would penetrate in this area if the rock record was complete and all the strata were present.

Stratigraphic Units and Contacts Sedimentary rock commonly occurs in units called formations. A formation is a body of rock that has a distinctive set of characteristics and easily recognizable top and bottom boundaries. It is also thick enough to be readily traceable in the field and sufficiently widespread to be represented on a map. Most formation names are derived from geographic names and predominant rock types (for example, St. Peter Sandstone or Scales Shale). When no single rock type is characteristic, the word "formation" becomes a part of the name (for example, Carbondale Formation). A group (for example, the Galena Group) consists of vertically adjacent formations having many similarities. A member, or bed, is a subdivision of a formation that is too thin to be classified as a formation or that has minor characteristics setting it apart from the rest of the formation.

Many formations have conformable contacts—that is, no significant interruption in deposition occurred as one formation was succeeded by another (Figure 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 was virtually continuous. In contrast, in other places, the top of the lower formation was at least partially eroded before the next formation was deposited. In these instances, fossils and other evidence indicate a significant age difference between the lower unit and the overlying unit. This type of contact is called an unconformity. Unconformities occur throughout the Paleozoic rock record and are shown as wavy lines in the generalized stratigraphic column (Figure 2). The geologic map (Figure 3) shows the distribution of the rock systems of the various geologic time periods as they would appear if all of the glacial, windblown, and surface materials were removed.

AGE		ROCK UNITS	
SYSTEM	SERIES	FORMATION	MATERIALS
QUATERNARY	HOLOCENE	Grayslake Peat	peat and muck, interbedded with silt and clay
	PLEISTOCENE	Peoria Silt	loess, windblown silt, and clay
		Equality Formation	lake deposits, stratified silty clay and sand
		Henry Formation	outwash, sand and gravel
PENNSYLVANIAN	DESMOINESIAN	Shelburn Formation	shale, sandstone, limestone, clay, coal
		Carbondale Formation	shale, sandstone, coal, clay, limestone
		Tradewater Formation	sandstone, shale, clay, coal, limestone
	ATOKAN		sandstone, clay, shale
MISSISSIPPIAN	VALMEYERAN	St. Louis Limestone	limestone
		Salem Limestone	limestone, shale
		Warsaw Shale	shale, limestone
		Keokuk Limestone	limestone
		Burlington Limestone	limestone
		Meppen Limestone	limestone, dolomite
	KINDERHOOKIAN	Chouteau Limestone	limestone
		Hannibal Shale	shale, siltstone
		Glen Park Limestone	limestone, oolite
DEVONIAN	UPPER	Louisiana Limestone	limestone
		Saverton Shale	shale, gray
		Grassy Creek Shale	shale, black
		Sweetland Creek Shale	shale, gray
		Sylamore Sandstone	sandstone
SILURIAN	NIAGARAN	Joliet Dolomite	dolomite
	ALEXANDRIAN	Kankakee Dolomite	dolomite
		Edgewood Dolomite	dolomite
ORDOVICIAN	CINCINNATIAN	Brainard Shale	shale, limestone, siltstone
		Fort Atkinson Limestone	limestone, dolomite, shale
		Scales Shale	shale, limestone
	CHAMPLAINIAN	Galena Group	dolomite, limestone
		Platteville Group	limestone, dolomite
		St. Peter Sandstone	sandstone
	CANADIAN	Shakopee Dolomite	dolomite, sandstone, shale
CAMBRIAN	ST. CROIXAN	Eminence Formation	dolomite
		Potosi Dolomite	dolomite
		Franconia Formation	sandstone, shale
		Ironton-Galesburg Sandstone	sandstone, dolomite
		Eau Claire Formation	shale, sandstone, dolomite
		Mt. Simon Sandstone	sandstone

Figure 2 Generalized stratigraphic column of the rock formations in the field trip area (modified from Willman 1973).

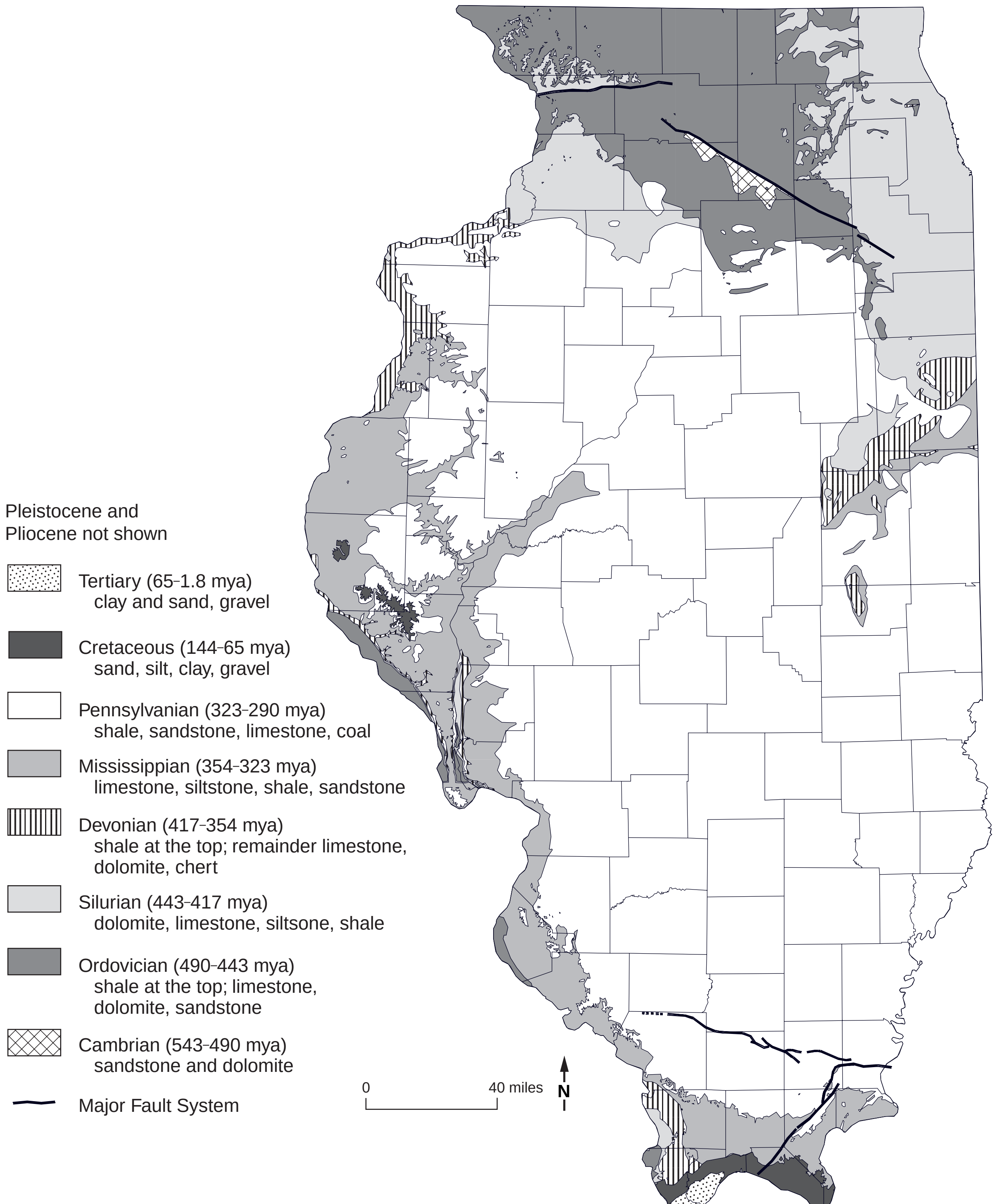


Figure 3 Bedrock geology beneath the surficial deposits in Illinois.

Mesozoic Era (248 mya to 65 mya)

During the Mesozoic Era, the rise of the Pascola Arch (Figures 1 and 4) in southeastern Missouri, northeastern Arkansas, and western Tennessee by uplifting strata in southern Illinois produced a structural barrier, helping to form the Illinois Basin's present asymmetrical, spoon-shaped configuration (Figure 5).

Younger rocks of the latest Pennsylvanian and perhaps the Permian (the youngest rock systems of the Paleozoic) might have once covered the southern and northern portions of Illinois. Mesozoic and Cenozoic rocks (see the generalized geologic column at the front of the guidebook) might also have been present here.

During the more than 240 million years after the end of the Paleozoic Era and before the onset of glaciation 1 to 2 million years ago, several thousands of feet of strata may have been eroded. Nearly all traces of any post-Pennsylvanian bedrock that may have been present in Illinois were removed. During this extended period of erosion, deep valleys were carved into the gently tilted bedrock formations (Figure 6).

The field trip area is in the north-central part of the Illinois Basin (Figure 4). The only large-scale structural feature that has been mapped in the area is the Downs Anticline (Heigold et al. 1964) in McLean and DeWitt Counties. The Downs Anticline is an asymmetrical anticline that contains a series of domes, including the Hudson Dome (Clegg 1972), which is used as a natural gas storage field (see Guide to the Route).

GLACIAL HISTORY OF ILLINOIS

During the past 1.8 million to 2 million years, during the Pleistocene Epoch of the Quaternary Period (also known as the Ice Age), much of northern North America was repeatedly covered by huge glaciers as a result of climate cooling. The advances of these continental ice masses into the central lowland of the United States altered the landscape across much of the Midwest. The topography of the bedrock surface throughout much of Illinois is largely hidden from view by glacial deposits except along the major streams and in the driftless areas of northwestern and southern Illinois (Figure 7).

During the early part of the Pleistocene Epoch, glaciers advanced out of their centers of ice accumulation both east and west of the Hudson Bay area in Canada. As they advanced, the glaciers carried along rock debris incorporated into the ice. The material was dropped out as the ice melted. Prior to glaciation, as just noted, an extensive system of bedrock valleys was deeply entrenched in the bedrock surface of the Illinois Basin. As glaciation began, the ancient streams changed from erosion to deposition, and the bedrock valleys were filled from the large volumes of transported glacial sediments that built up in the channels. Later, during the Ice Age, the repeated advances and melting back of additional continental glaciers scoured and scraped the bedrock surface, but there is no evidence to indicate that the early fills in the preglacial valleys were ever completely flushed from their channels by succeeding meltwater. Glacial erosion modified all of the bedrock surfaces in Illinois. The final melting of the glaciers left behind the non-lithified deposits in which our modern Holocene soils have developed.

The number and timing of these early episodes of glaciation are uncertain and are therefore unnamed, but, because they precede the first named episode, the Illinois Episode (Hansel and Johnson 1996) of glaciation, they are called simply the pre-Illinois Episode (Figures 8a and b, 9, and 10). The pre-Illinois Episode ended about 425,000 years ago.

A long interglacial episode, called the Yarmouth, followed and lasted approximately 125,000 years (Figures 9 and 10). Deep soil formation (Yarmouth Geosol) took place during that long interval. On generally poorly drained areas, fine silts and clays slowly accumulated (accreted) in shallow, wet depressions and formed what are called accretion-gleys. Accretion-gleys are characterized by dark gray to black, massive, and dense gleyed clays.

The Illinois Episode of glaciation began approximately 300,000 years ago and lasted for about 175,000 years. During this episode, ice advanced several times into Illinois (Figures 9 and 10). The North American continental glaciers reached their southernmost position south of Marion in northern Johnson County. During the first advance, Illinois Episode ice reached westward across Illinois and into Iowa, south of the Driftless Area (Figure 8c).

Another long interglacial interval, called the Sangamon (Figures 9 and 10), followed the Illinois Episode and lasted about 50,000 years. The Sangamon Geosol developed during this time. The Sangamon Geosol exhibits both well-drained and poorly drained soil profiles; although accretion-gleys are not as pronounced as they are in the Yarmouth Soil, their occurrence is common across the Sangamon landscape, and they are easily identified by the same characteristics as the Yarmouth accretion-gleys.

About 75,000 years ago, the Wisconsin Episode of glaciation began (Figures 8d, 9, and 10). Ice from the early and middle parts of this episode did not reach into

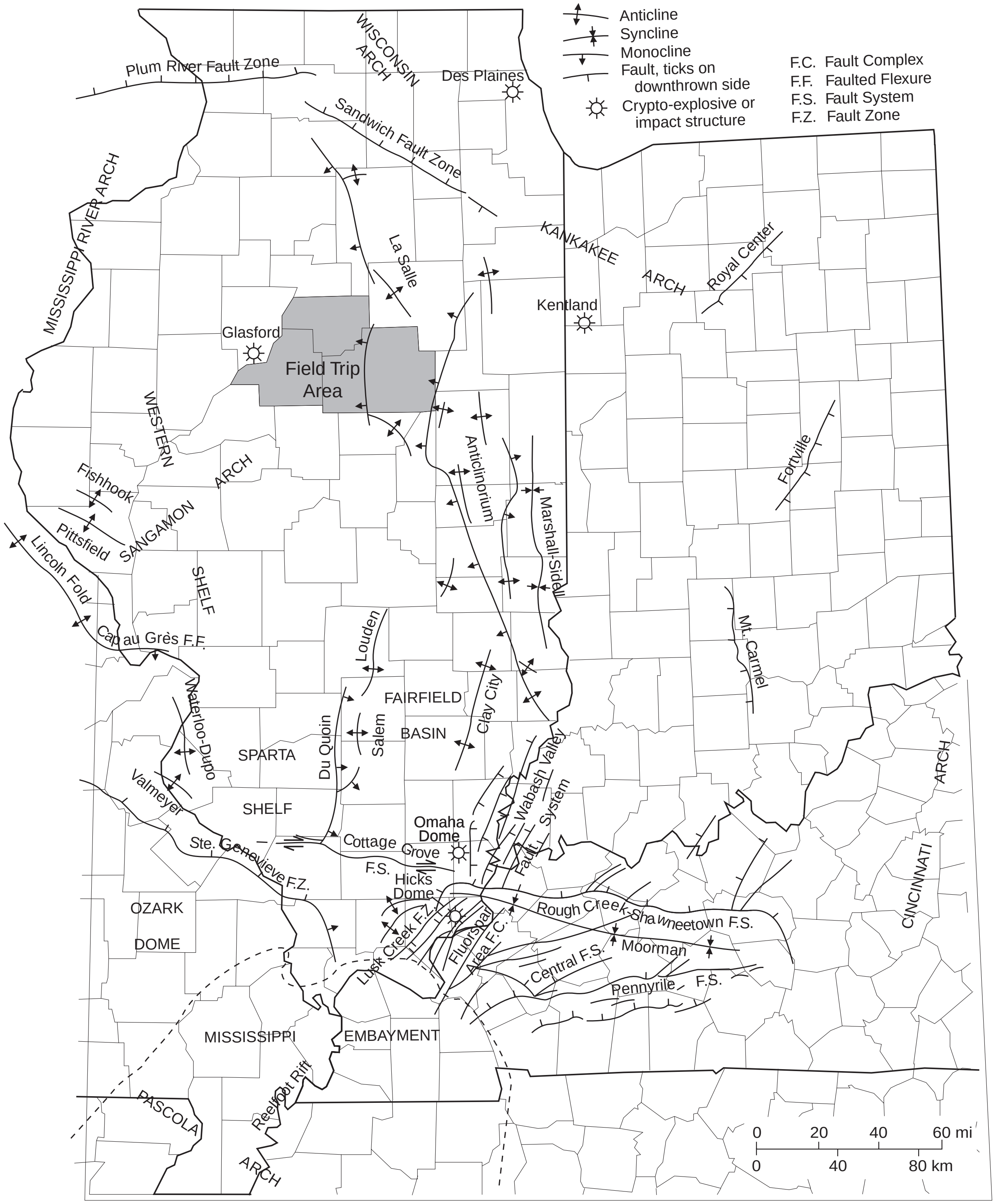


Figure 4 Structural features of Illinois (modified from Buschbach and Kolata 1991).

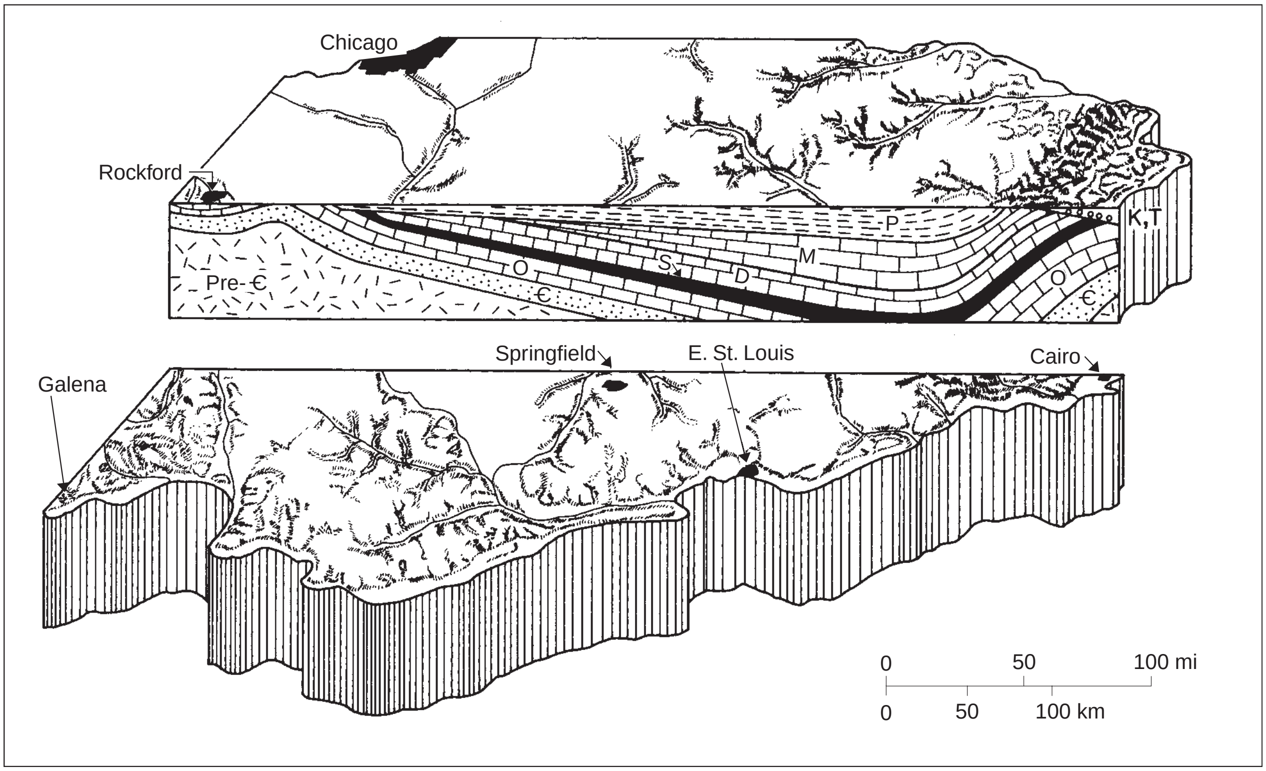
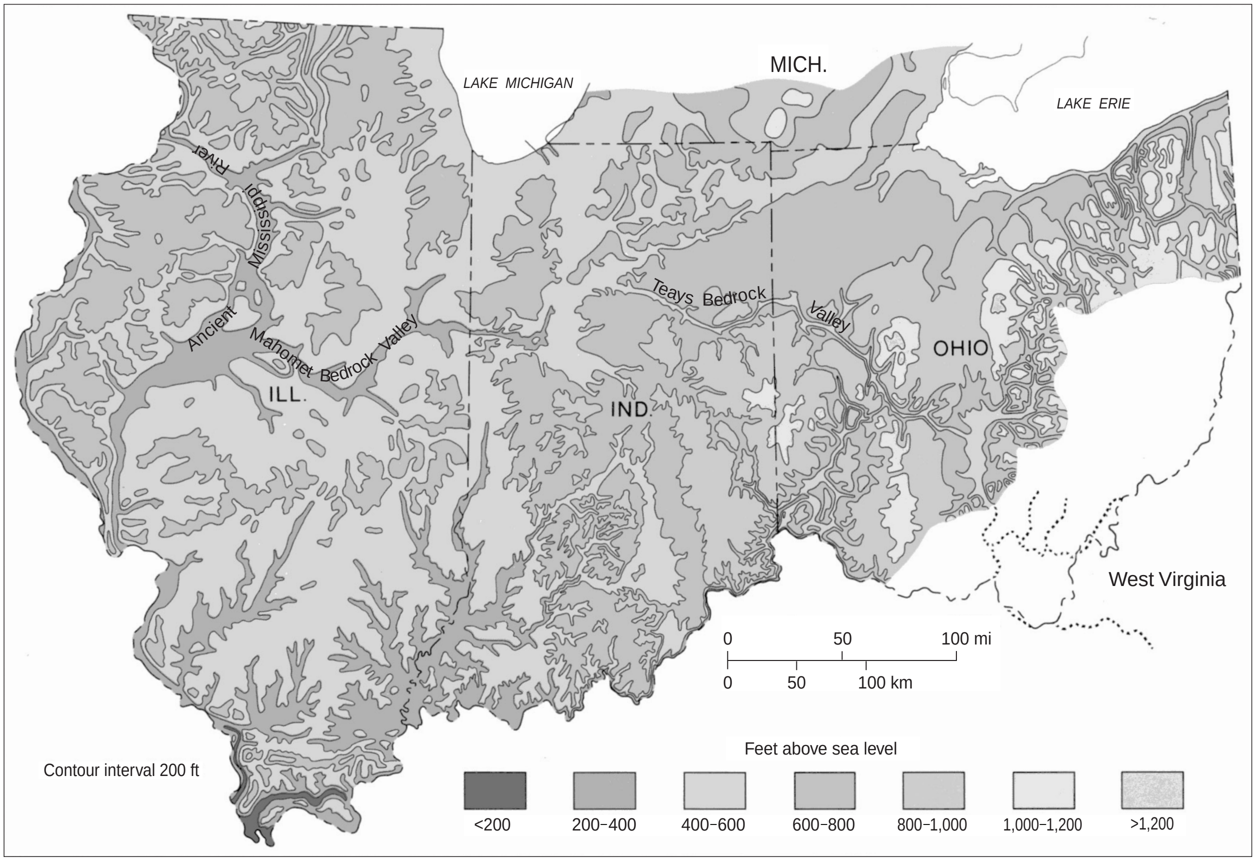


Figure 5 Stylized north-south cross section shows the structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks has been greatly exaggerated, and younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-Є) granites. They form a depression filled with layers of sedimentary rocks of various ages: Cambrian (Є), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). Scale is approximate.

Illinois. Late Wisconsin ice advanced across northeastern Illinois beginning about 25,000 years ago, but did not reach southern or western Illinois (Figures 7, 8d, and 9). The maximum thickness of the later Wisconsin Episode glaciers was about 2,000 feet in the Lake Michigan Basin, but only about 700 feet over most of the Illinois land surface (Clark et al. 1988). The last of these glaciers melted from northeastern Illinois about 13,500 years before present (B.P.).

In general, the glacial deposits in the field trip area consist primarily of (1) till —pebbly clay, silt, and sand, deposited directly from melting glaciers; (2) outwash—mostly sand and gravel, deposited by rapidly flowing meltwater rivers; (3) lacustrine deposits—silt and clay that settled out in quiet-water lakes and ponds; and (4) loess—windblown sand and silt. In addition to these deposits, strata deposited by glaciers often contain numerous erratics (Killey 1997). Erratics are boulders that are transported into an area by glaciers. These exotic rocks are often lithologically very different from the bedrock. Erratics are often faceted (having planar surfaces) and striated. Facets and striations are caused by the rock being dragged along by the glacial ice. In Illinois, erratics came from Canada and the states to the north. During the Pleistocene, glaciers spread southward into the Midwest from two centers of ice accumulation in western and eastern Canada. These continental glaciers 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. The lithology of certain erratics sometimes indicates the original location of the rock. A large boulder of granite, gneiss, or other igneous or metamorphic rock may have come from Canada. Some erratics containing flecks of copper were probably transported here from the “Copper Range” of the upper peninsula of Michigan. Light gray to white quartzite boulders with beautiful, rounded pebbles of red jasper came from Ontario, Canada. Purplish pieces of quartzite, some of them banded, probably originated in Wisconsin. Many erratics were probably dropped directly from the melting front of the glacier. Others may have been rafted to their present resting places by icebergs in ancient lakes or on floodwaters of some long-vanished stream as it flowed away from a glacier.



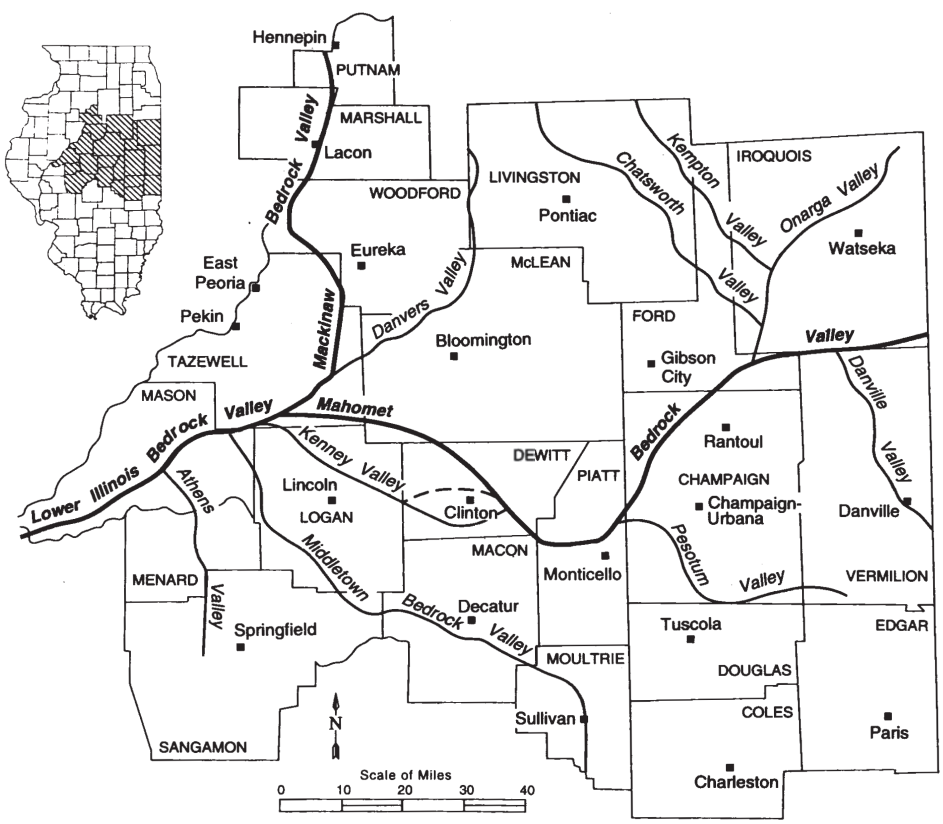


Figure 6 Bedrock valley systems from Ohio to Illinois (modified from Larson et al. 2003).

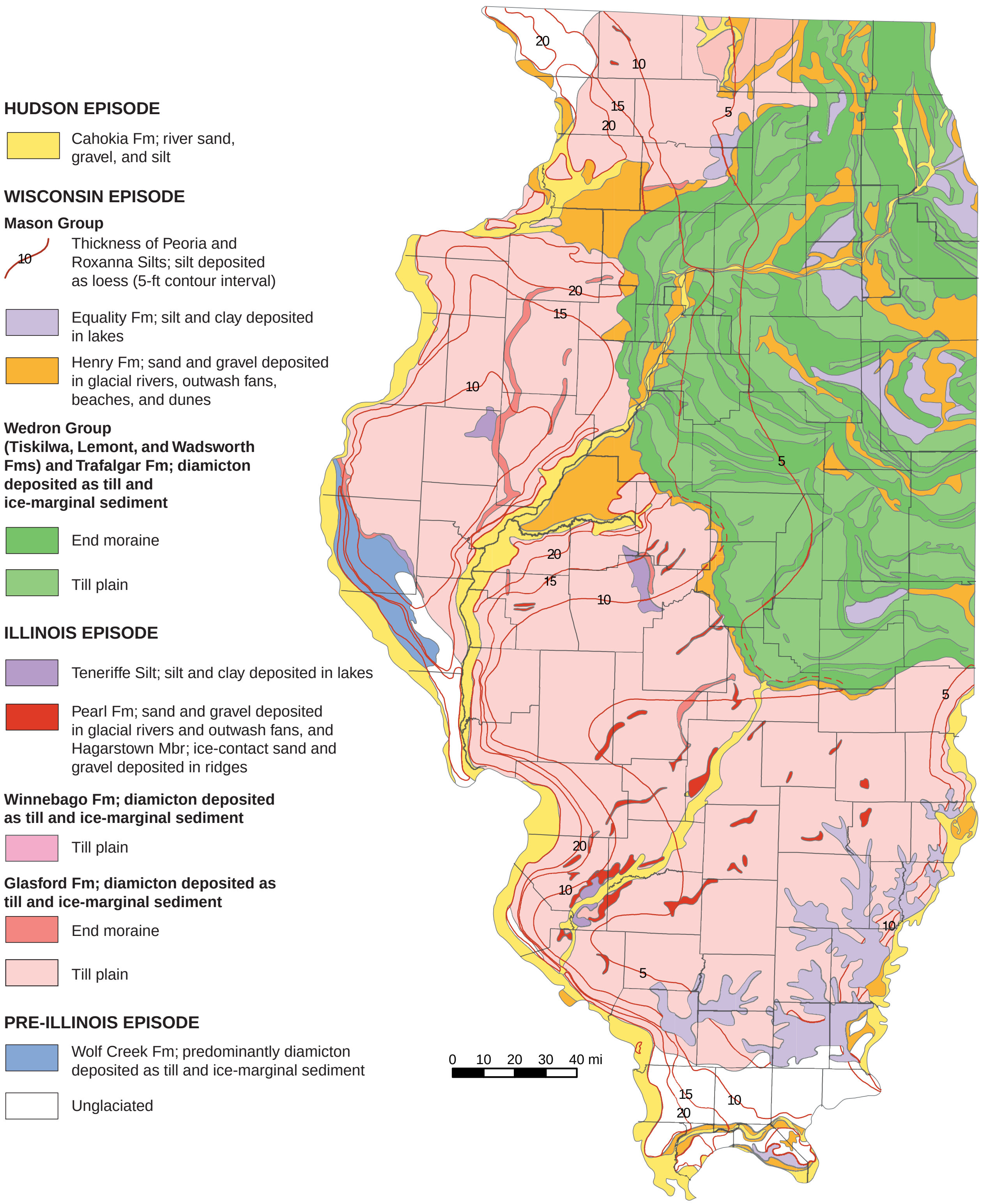


Figure 7 Generalized map of glacial deposits in Illinois (modified from Lineback et al. 1979).

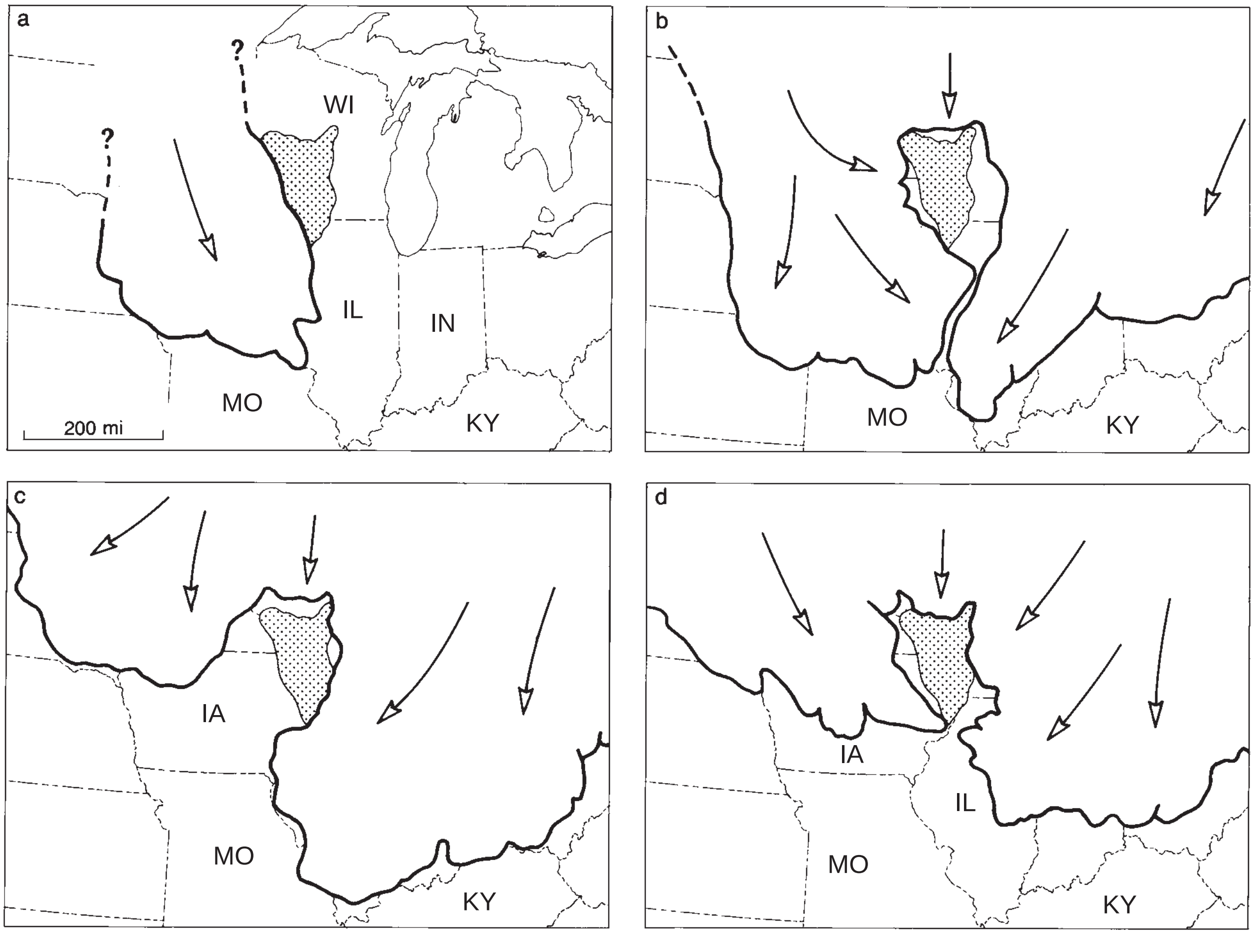


Figure 8 Maximum extent of (a) early pre-Illinois Episode of glaciation (1,000,000 ± years ago); Driftless Area shown by stippled pattern; arrow indicates direction of ice movement; (b) late pre-Illinois Episode (600,000 ± years ago); (c) Illinois Episode (180,000 ± years ago); and (d) late Wisconsin Glacial Episode (22,000 years ago).

Some erratics were buried in the glacial deposits and have worked their way up to the land surface as the surrounding loose soil repeatedly froze and thawed. When the freezing ground expands, the rocks tend to be pushed upward. Many erratics are of notable size and beauty. Erratics are used as monuments in courthouse squares and parks, or along driveways.

Wisconsin Episode moraines were deposited in Illinois from approximately 25,000 to 13,500 years ago (Figures 7 and 11). These moraines were formed along the edge of the ice when the rate of ice advance was approximately equal to the melting rate, depositing large arc-like ridges of till in northeastern Illinois. Although Illinois Episode glaciers probably built ridged moraines ridges similar to those of the later Wisconsin Episode glaciers, the Illinois Episode moraines apparently were not as numerous and have been exposed to weathering and erosion longer than their younger Wisconsin Episode counterparts. For these reasons, younger Wisconsin Episode features dominate.

This field trip area is located among the El Paso, Eureka, Normal, Bloomington, and other moraines, all of which are younger than the late Wisconsin Episode Shelbyville Moraine, the earliest moraine of the Woodfordian Substage, which was deposited about 25,000 years ago.

Outwash deposits of silt, sand, and gravel were dumped along the major river valleys during all of the glacial episodes. When these deposits dried out during the winters, strong prevailing winds from the west (the westerlies) winnowed out the finer materials, such as fine sand and silt, and carried them eastward across the terrain. The fine-grained, windblown silts form a deposit called loess. These deposits were laid down by the wind during all of the glacial episodes, from the earliest pre-Illinois glacial episode (approximately 1.8 million years

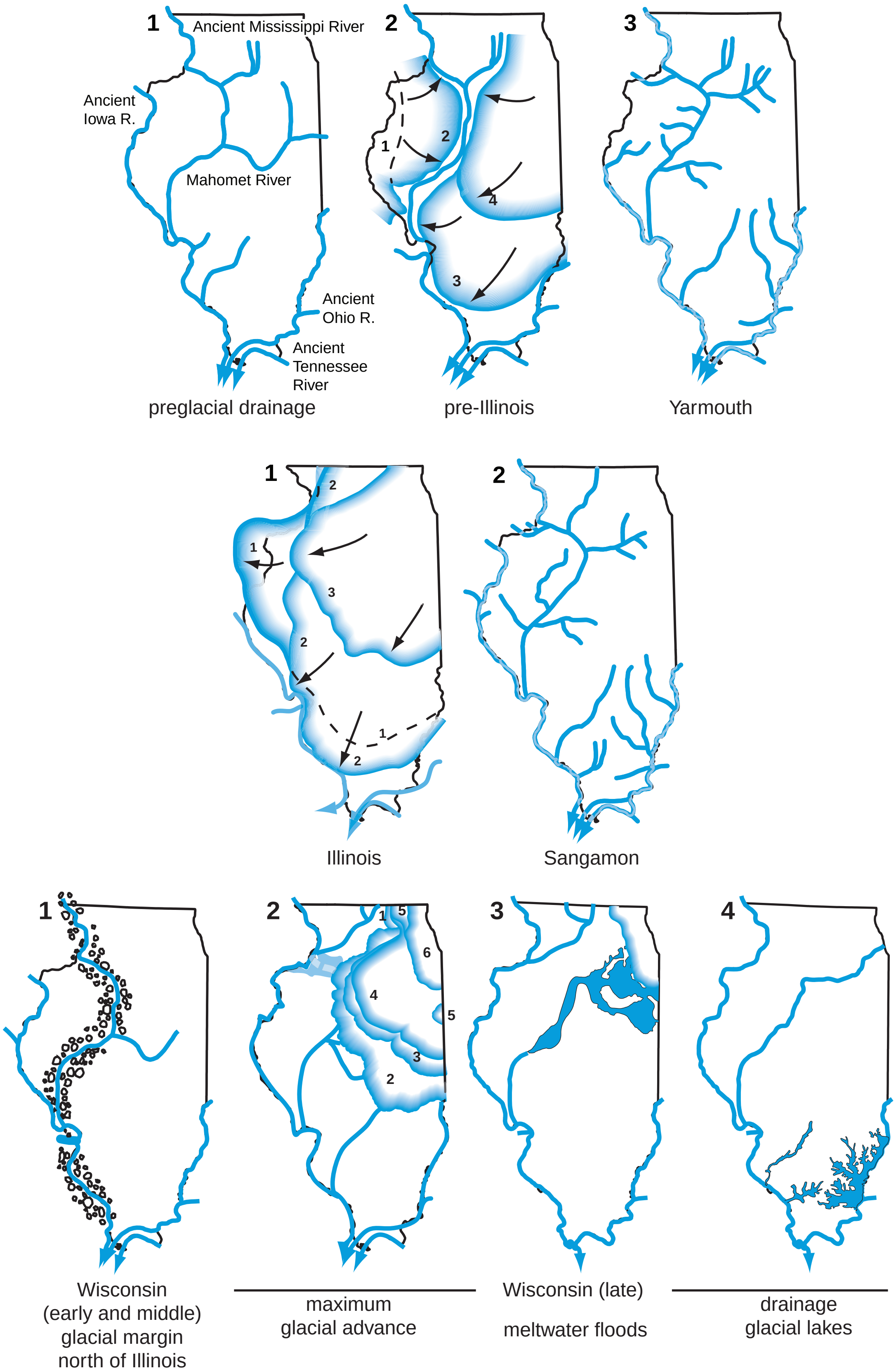


Figure 9 Sequence of glaciations and interglacial drainage patterns in Illinois (modified from Willman and Frye 1970).

Period	Epoch	Years before present	Glacial and interglacial episodes and time-distance diagram (w ⟷ e)	Sediment record	Dominant climate conditions Dominant land-forming and soil-forming events
QUATERNARY	HOLOCENE		HUDSON EPISODE	River, lake, wind, and slope deposits.	Warm; stable landscape conditions. Formation of modern soil; running water, lake, wind, and slope processes.
	Pleistocene	10,000	WISCONSIN EPISODE – Michigan Subepisode	Till and ice-marginal deposits; outwash and glacial lake deposits; loess.	Cold; unstable landscape conditions. Glacial deposition, erosion, and land-forming processes (e.g., formation of end moraines, outwash plains, valley trains, proglacial lakes, kettles), plus running water, lake, wind, and slope processes.
		25,000	WISCONSIN EPISODE – Athens Subepisode	Loess; river, lake, and slope deposits.	Cool; stable. Weathering, formation of Farmdale Geosol and minor soils; wind and running water processes.
		75,000	SANGAMON EPISODE	River, lake, wind, and slope deposits.	Warm; stable. Weathering, soil formation of Sangamon Geosol; running water, lake, wind, and slope processes.
		125,000	ILLINOIS EPISODE	Till and ice-marginal deposits; outwash and glacial lake deposits; loess.	Cold; unstable. Glacial deposition, erosion, and land-forming processes, plus proglacial running water, lake, wind, and slope processes; possible minor soil formation.
		180,000	YARMOUTH EPISODE (PRE-ILLINOIS EPISODE)	River, lake, wind, and slope deposits.	Warm; stable. Long weathering interval with deep soil formation (Yarmouth Geosol); running water, lake, wind, and slope processes.
		425,000 610,000 778,000 830,000 1,800,000 and older	PRE-ILLINOIS EPISODE	Till and ice-marginal deposits; outwash and glacial lake deposits; loess plus nonglacial river, lake, wind, and slope deposits.	Alternating stable and unstable intervals of uncertain duration. Glacial deposition, erosion, and land-forming processes, plus proglacial and interglacial running water, lake, wind, and slope processes; interglacial weathering and soil formation.

Figure 10 Timetable illustrating the glacial and interglacial events, sediment record, and dominant climate conditions of the Ice Age in Illinois (modified from Killey 2007).

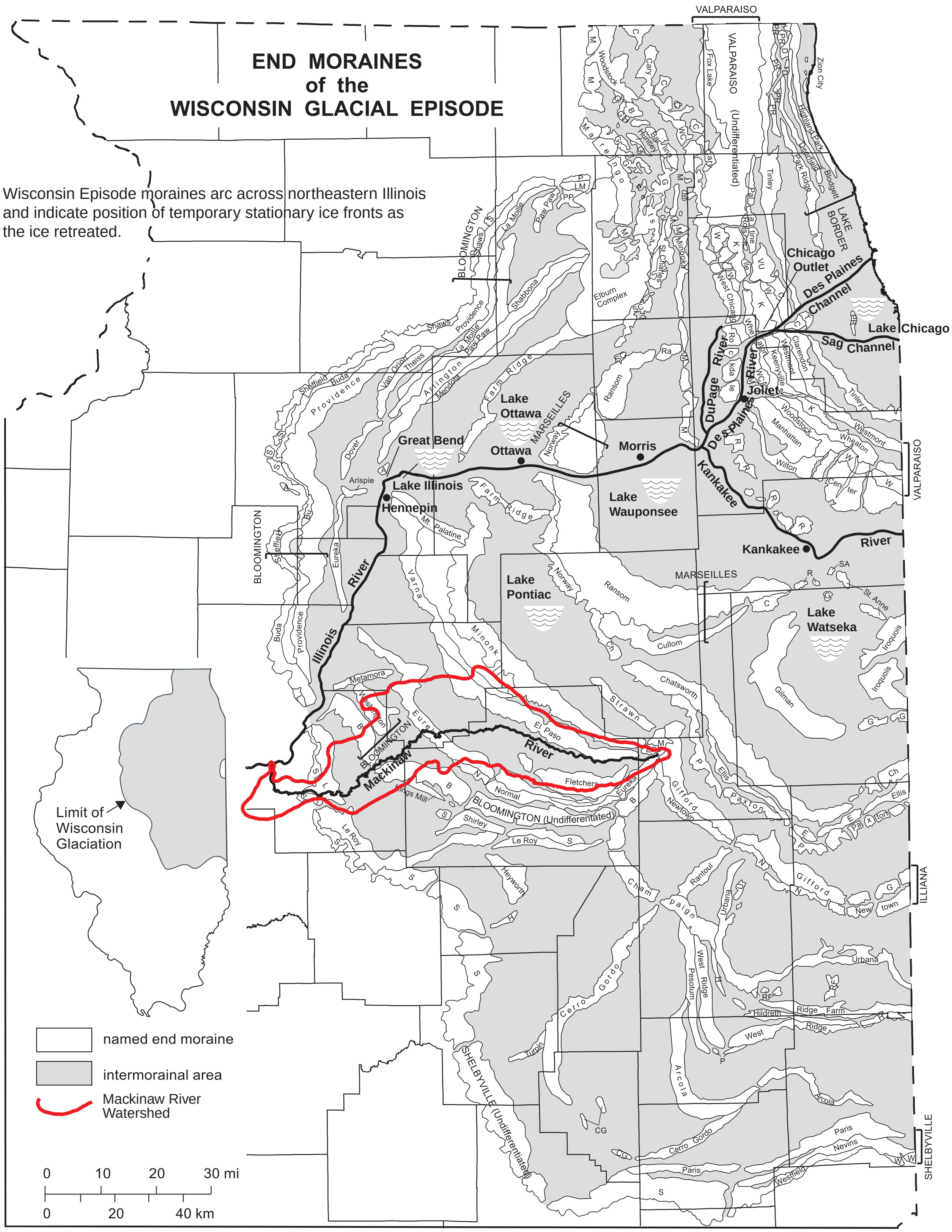


Figure 11 Areal distribution of Wisconsin Episode moraines of the Wedron Group (modified from Hansel and Johnson 1996). Mackinaw River watershed is outlined in red.

ago) to the last glacial episode, the Wisconsin Episode (which occurred approximately 75,000 to 13,500 years ago).

These windblown silts blanket the landscape and compose the parent materials for our modern Holocene soils. Fresh loess exposures are generally yellowish brown. In general, loess thickness decreases to the east, but is almost always thicker on the east side of major river valleys.

The loess, which covers most of Illinois, is up to 10 feet thick along the Mackinaw River valley in McLean, Tazewell, and Woodford Counties. Erosion has completely removed the loess in scattered areas.

REGIONAL DRAINAGE

Some time (probably many tens of millions of years) after the deposition of the Pennsylvanian age strata, the entire central area of the United States was slowly lifted above sea level, and a drainage network of streams began to form.

In the Mackinaw River area, the ancient buried bedrock drainage network includes the Mahomet Valley, Mackinaw Valley, Danvers Valley, and the ancestral Mississippi River valley (Figures 6 and 12). Because of the irregular bedrock surface and erosion, glacial drift is unevenly distributed across McLean, Tazewell, and Woodford Counties. The ancient Mahomet-Teays (Mahomet in Illinois) was a major river that drained the western flank of the Appalachian Mountains in West Virginia and flowed westward across Ohio, Indiana, and into central Illinois (Figures 6). In central Illinois, it was joined by the ancestral Mississippi River. The ancestral Mississippi River, headed in Minnesota, followed the course of the modern Mississippi from its headwaters to near Savanna, Illinois, flowed eastward to near Hennepin, and then flowed southward to join the ancestral Mahomet River in southeastern Tazewell County (Figure 12). The combined rivers flowed southwestward along what is now the lower Illinois River valley.

The present surface topography within the field trip area reflects the landforms that were left after the melting of the last continental glacier and subsequent weathering and erosion. The principal topographic features include the relatively high morainal ridges that trend generally northwest-southeast, modern low elevation stream valleys that trend generally northeast-southwest, and river terraces (abandoned floodplains) within the modern Illinois and Mackinaw River valleys.

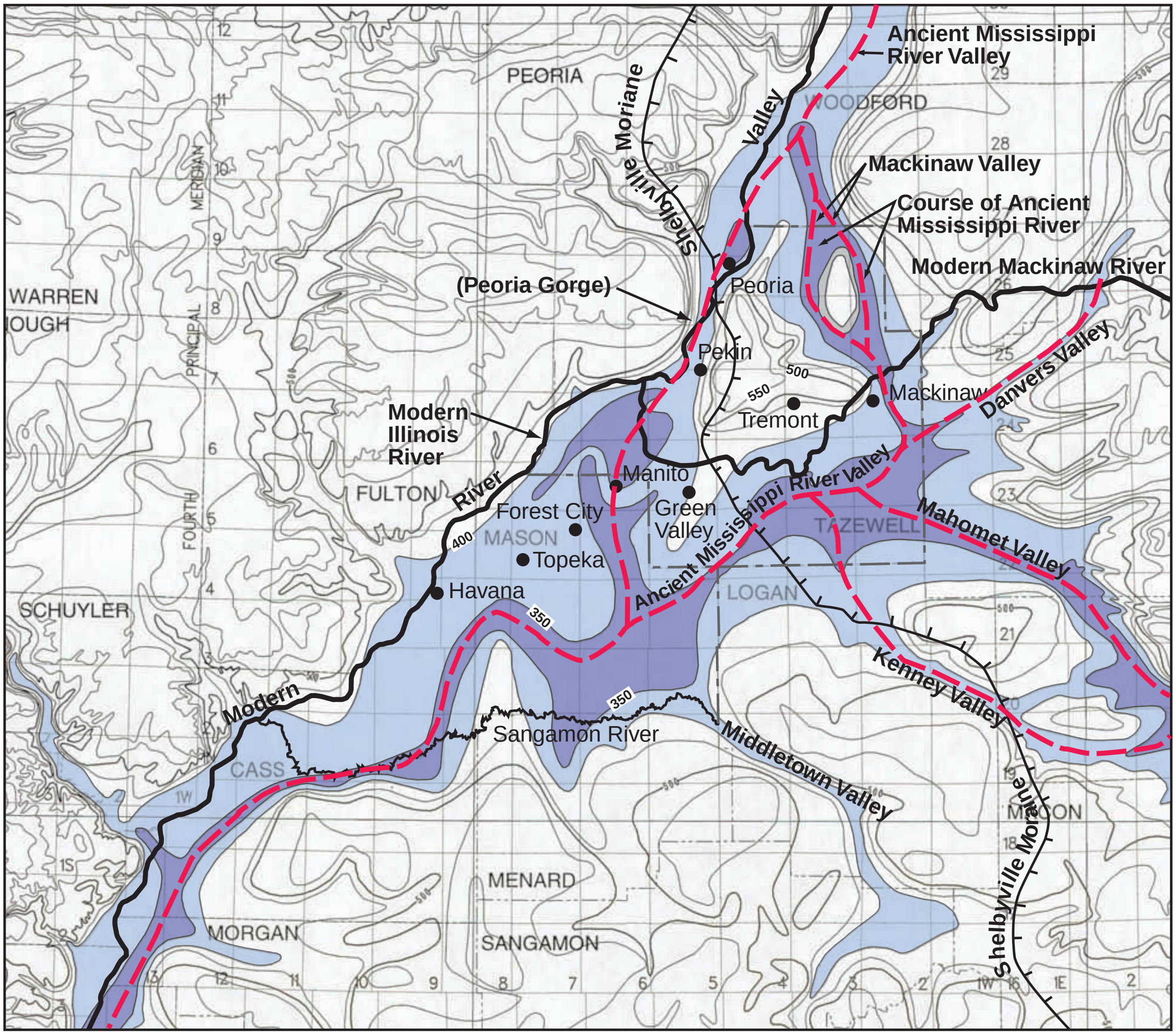
The two major bedrock valley systems in central Illinois—the Mahomet system from the east, and the ancient Mississippi system from the north—converged in Tazewell County. The onset of the pre-Illinois Episode profoundly changed the landscape of the bedrock surface of east-central Illinois by disrupting drainage paths and by initially deepening the existing bedrock valleys through erosion from the surges of meltwater and later partially filling them with coarse sands and gravels. Later glaciation ultimately filled and buried the preglacial bedrock valleys. Deposits left by the glacial advances and retreats of the Illinois and Wisconsin Episodes filled these channels with additional deposits of unlithified gravels, sands, silts, and clays (water and ice-laid deposits). Near the convergence of the Mahomet and Mackinaw Bedrock Valleys, the extensive basal sands and gravels of the Mahomet and Sankoty Sands of the Banner Formation are overlain by additional layers of sands and gravels, glacial till, and/or lacustrine sediments. These upper sand and gravel deposits represent important aquifers or saturated bodies of earth materials that can yield sufficient groundwater to wells. The main aquifer in the field trip area is the Mahomet-Sankoty aquifer, which lies within the base of the Mahomet and Mackinaw Bedrock Valleys.

Horberg (1946) and Horberg et al. (1950) were among the first to map the general shape of the Mahomet Bedrock Valley and the Mackinaw Bedrock Valley in this region, as shown on Horberg's (1950) benchmark bedrock topography map. He later defined the Mahomet Sand in the Mahomet Valley and the Sankoty Sand in the Mackinaw Valley (Horberg 1953). The Mahomet and Sankoty Sands are members of the Banner Formation (pre-Illinois Episode).

As the Wisconsin glacier advanced into the area from the north and east, meltwater streams carried tremendous amounts of sand and gravel into where the ancient Mahomet Valley and ancestral Mississippi Valley merged. This outwash was deposited as a large alluvial fan that spread westward from the position of the early Shelbyville Moraine and later Le Roy Moraine.

Torrents

The Wisconsin Episode glacier advanced to Peoria and deposited the Shelbyville Moraine about 20,000 years ago. In the area of the Big Bend at Hennepin, it diverted the ancestral Mississippi River westward to its modern position (Curry 1998, McKay et al. 2008). In the Peoria area, the glacier blocked the ancestral (or ancient) Mississippi River valley north of its junction with the Mahomet Valley (Figures 11 and 12), which produced a large lake that filled part of the ancestral Mississippi River valley. Eventually the lake overflowed and cut a new valley around the edge of the glacier (the Peoria Gorge). The modern Illinois River flows through this valley at Peoria.



< 350 feet above mean sea level   < 350–400 feet above mean sea level   contour interval = 50 feet

Figure 12 Junction of buried bedrock valleys within the field trip area, with the western limit of the Wisconsin age Shelbyville Moraine and position of modern Illinois, Mackinaw, and Sangamon Rivers identified (base map modified from Herzog et al. 1994). The shaded relief map of the bedrock surface (Abert 1996) shows paths of the ancient Mississippi River and the Mackinaw, Danvers, and Mahomet Bedrock Valleys.

This overflow event released a spectacular flow of "energy" in the form of water from the lake. As the torrents from the overflow cut down through the Pennsylvanian strata, coal and other bedrock materials were incorporated into the coarse sediments that choked the valley just below the point of release. Some of the lake sediments (laminated clays and silty clays) that had accumulated in the blocked river valley were ripped from the lake floor and tumbled with sand and gravel to produce armored mud balls. These armored mud balls were deposited in the coarse sediment. These proglacial lake deposits are mapped as the Equality Formation.

Further upstream, along what is now the upper Illinois River valley, above the "Great Bend" at Hennepin and between LaSalle and Lake Michigan, several later episodes of massive flooding occurred as lakes that had formed behind moraines overtopped and breached the moraines. These large floods, collectively called the Kankakee and Fox River torrents, reworked the sediments and formed large sand and gravel bars (called valley train deposits) that were oriented along the direction of stream flow. These outwash deposits spread out over the large pre-existing alluvial fans within the modern Mackinaw Valley from Pekin south toward Havana and west to the Shelbyville Moraine, forming a second alluvial fan. The coarser deposits concentrated along the ancestral Mississippi River valley. However, as the floodwater rose and spread out over the already existing alluvial fan deposits of the Mackinaw Valley, large volumes of sand were deposited.

During the flooding events of the Kankakee and Fox River torrents, erosion was followed by deposition, generally of coarser materials forming the basal deposits, followed by finer-grained sands, silts, and finally clays during the waning stages of the floods. Wind reworked the finer sediments on the alluvial fan. Much of the silt and clay was blown away to become part of the Richland Loess, which forms a thin blanket over the most recent glacial tills to the east. The sand was mobilized to form sand dunes. The dunes within this area form the type section for the Parkland facies of the Peoria Silt.

The combined actions of the Illinois and Mackinaw Rivers cut away at the alluvial fan and the sand dunes, producing three terrace levels. The highest level is the Manito Terrace. There are abundant sand dunes on the Manito Terrace. The middle level is the Havana Terrace, which has scattered, small sand dunes. The lowest terrace is the Bath Terrace, where sand dunes have been removed by the Mackinaw River as it meandered within its valley.

The Mackinaw River has cut a broad, shallow valley into the alluvial sands, gravels, and overlying sand dunes. Its course is typical of rivers building deltaic alluvial fans in that the direction of flow in the lower reaches changes over time in response to changes in sediment load, compaction, and distance to its discharge point (confluence with the Illinois River). The lower Mackinaw actually flows north (opposite direction to flow of the master stream) to join the Illinois River instead of directly west as is expected. The ancestral lower Mackinaw used to flow to the south toward Havana.

Geomorphology: Physiography and Drainage

The Mackinaw River field trip area is located within the Bloomington Ridged plain of the Till Plains Section, Central Lowland Physiographic Province (Figure 13). This area is covered with a variety of glacial landforms.

As described in detail in the road log, most of the field trip is within the Mackinaw River watershed, which flows to the west and southwest until it joins with the Illinois River, where it flows to the north for a short distance. Most streams in the field trip area have medium to high gradients (bottom slopes) where they are actively eroding into the sides of the Woodfordian Moraines and have low gradients where they enter into the floodplain of the Mackinaw River.

NATURAL RESOURCES

Mineral Production

The only economic minerals currently mined in the field trip area are sands and gravels from glacial outwash deposits. Currently, there are seven active sand and gravel operations in McLean County, eight in Tazewell County, and five in Woodford County. According to the USGS (2005, unpublished), Woodford County (four pits reporting) produced about 5 million tons of sand and gravel, McLean County produced about 1.6 million tons, and Tazewell County (six pits reporting) produced about 1.35 million tons.

Coal seams more than three feet thick and relatively thick underclay units within the sequence of Pennsylvanian age rocks in the field trip area have been commercially exploited. These major coal units have been mined: Colchester Coal (mostly in Woodford County and part of McLean County), Springfield Coal (Tazewell County and part of McLean County), Herrin Coal (McLean County) and Danville Coal (McLean and Woodford Counties). Coal mining dates back to the 1870s and the last mines closed down in the 1950s. The Lakeside Coal Company, Lakeside Mine was the last active mine in Tazewell County, closing in 1956. Most of the mining occurred in Tazewell County near Pekin and East Peoria, in Woodford County near Minonk and

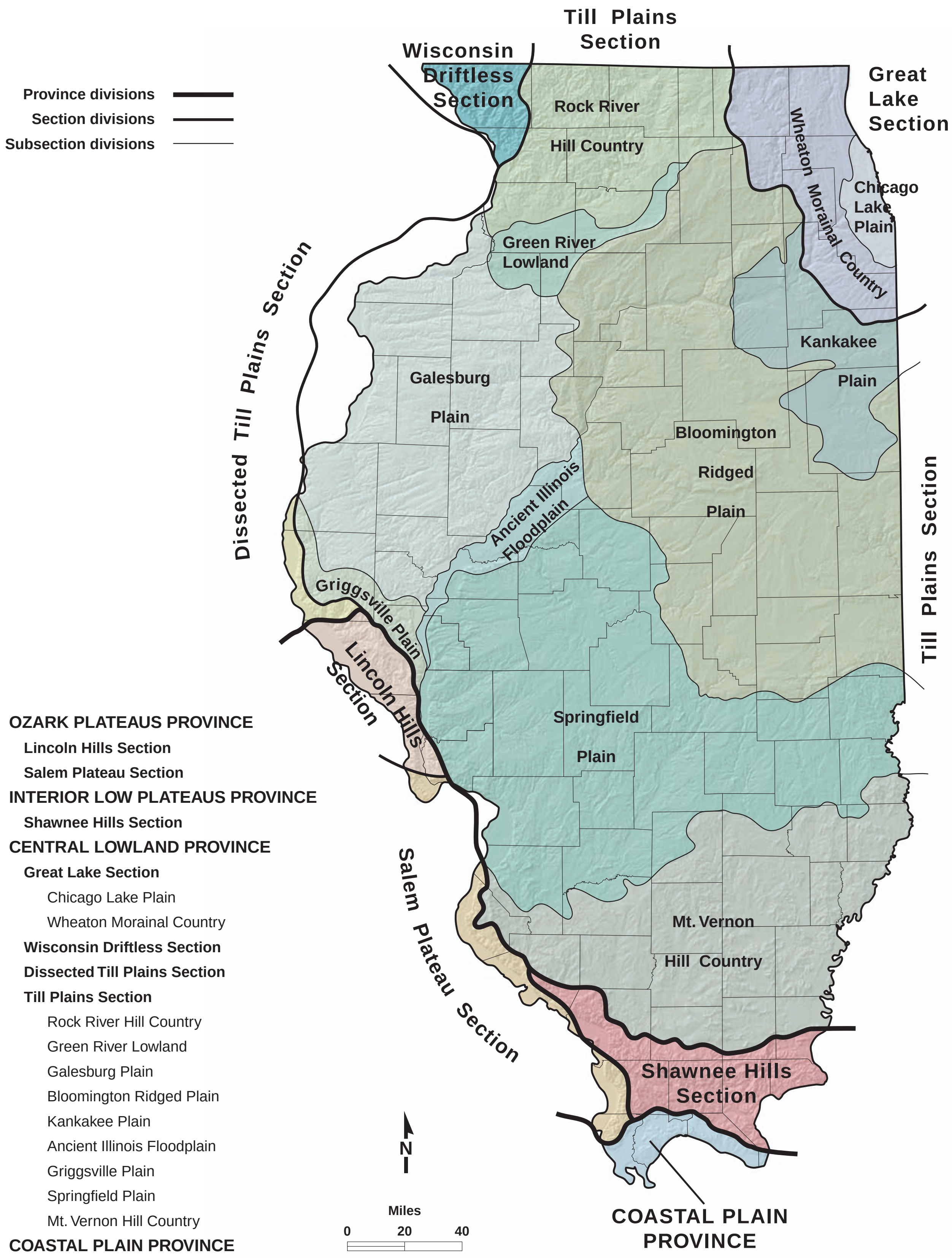


Figure 13 Physiographic divisions of Illinois (modified from Leighton et al. 1948).

Roanoke, and in McLean County in Bloomington and Colfax. The Colfax coal mine site is the nearest to the field trip route. Just north of Pekin, the Pennsylvanian shales and underclays were previously mined for making bricks and drainage tile.

Groundwater

Groundwater is a mineral resource frequently overlooked in assessments of an area's natural resource potential, yet this resource is essential for orderly economic and community development. More than 48% of the state's 11 million citizens and 97% of those who live in rural areas depend on groundwater for their water supply. Groundwater is derived from underground formations called aquifers. The water-yielding capacity of an aquifer can only be evaluated by constructing wells into it. After construction, the wells are pumped to determine the quality and quantity of groundwater available for use.

Because thick glacial deposits occur in the field trip area, sand and gravel deposits are common throughout most of the county. The Mahomet, Mackinaw, and other bedrock valleys contain thick deposits of unconsolidated materials that include thick basal sand and gravel and other intermediate sand and gravel. These sand and gravel deposits yield vast amounts of water for industrial and municipal water supplies.

NATURAL AREAS

Moraine View State Recreation Area

One of the largest of the glacial moraines in Illinois, the Bloomington Moraine, stretches across the state from Elgin to the Illinois River at Peoria east to Saybrook. In the middle of this sprawling feature, Moraine View State Recreation Area provides an ideal opportunity to enjoy both the tranquil natural beauty of midwestern woodland and refreshing outdoor activity. This 1,687-acre park includes facilities for picnicking, camping, hiking, swimming, fishing, boating, horseback riding, and hunting.

Mackinaw River State Fish and Wildlife Area

This 1,448-acre state park is located to the east-northeast of the town of Mackinaw in Tazewell County. It consists of more than two square miles of mostly wooded slope on the south side of the Mackinaw River. The park also contains upland meadows and floodplain bottomlands. To reach the park from Mackinaw, take Illinois Route 9 east 3 miles to Boston School Road (3500 E), turn left (north), and go 1.5 miles, following signs to the site office.

GUIDE TO THE ROUTE

We will start the field trip at the Dawson Lake marina parking lot within Moraine View State Recreation Area (NW¼, SE¼, NW¼, Sec. 35, T23N, R4E, Arrowsmith 7.5-minute Quadrangle, McLean County). Mileage will start as you leave the parking lot. Set your odometer to 0.0.

You must travel in the caravan. Please drive with 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. If the road crossing is protected by an Illinois State Geological Survey (ISGS) vehicle with flashing lights and flags, please obey the signals of the ISGS staff directing traffic. When we stop, park as close as possible to the car in front of you, and turn off your lights.

Some stops on the field trip are on private property. The owners have graciously given us permission to visit on the day of the field trip only. Please conduct yourselves as guests and obey all instructions from the trip leaders. So that we may be welcome to return on future field trips, follow these simple rules of courtesy:

- Do not litter the area.
- Do not climb on fences.
- Leave all gates as you found them.
- Treat public property as if you were the owner—which you are!
- Stay off all mining equipment.
- Parents must closely supervise their children at all times

When using this booklet for another field trip with your students, a youth group, or family, remember that you must get permission from property owners or their agents before entering private property. No trespassing, please.

Twelve USGS 7.5-minute quadrangle maps (Arrowsmith, Holder, Merna, Cooksville, Normal East, Normal West, Danvers, Secor, Mackinaw, Minier, Hopedale, and Morton) provide coverage for this field trip area.

START: Dawson Lake Marina Parking Lot, Moraine View State Recreation Area (NW, SE, NW, Sec. 35, T23N, R4E, 3rd P.M., Arrowsmith 7.5-minute Quadrangle, McLean County). Mileage will start at the exit of the parking lot.

Miles to next point	Miles from start	
0.0	0.0	Assemble at the parking lot at the Dawson Lake marina within Moraine View State Recreation Area. The starting point of the field trip lies within the Salt Creek watershed (Figure 14). The northernmost point of this watershed is about 1.25 miles north of Moraine View State Park. Salt Creek drains south-southwest and eventually joins the Sangamon River north of Springfield. EXIT the parking lot.
0.2	0.2	T-intersection (park road). TURN RIGHT.
0.1	0.3	T-intersection on the left (900 N). TURN LEFT onto 900 N.
0.75	1.05	T-intersection on the right (2725 E). Leave Moraine View State Park. CONTINUE AHEAD.
0.5	1.55	Crossroad intersection (2675 E). CONTINUE AHEAD.
0.05	1.6	STOP SIGN. CONTINUE STRAIGHT AHEAD on 900 E/County Road 36.

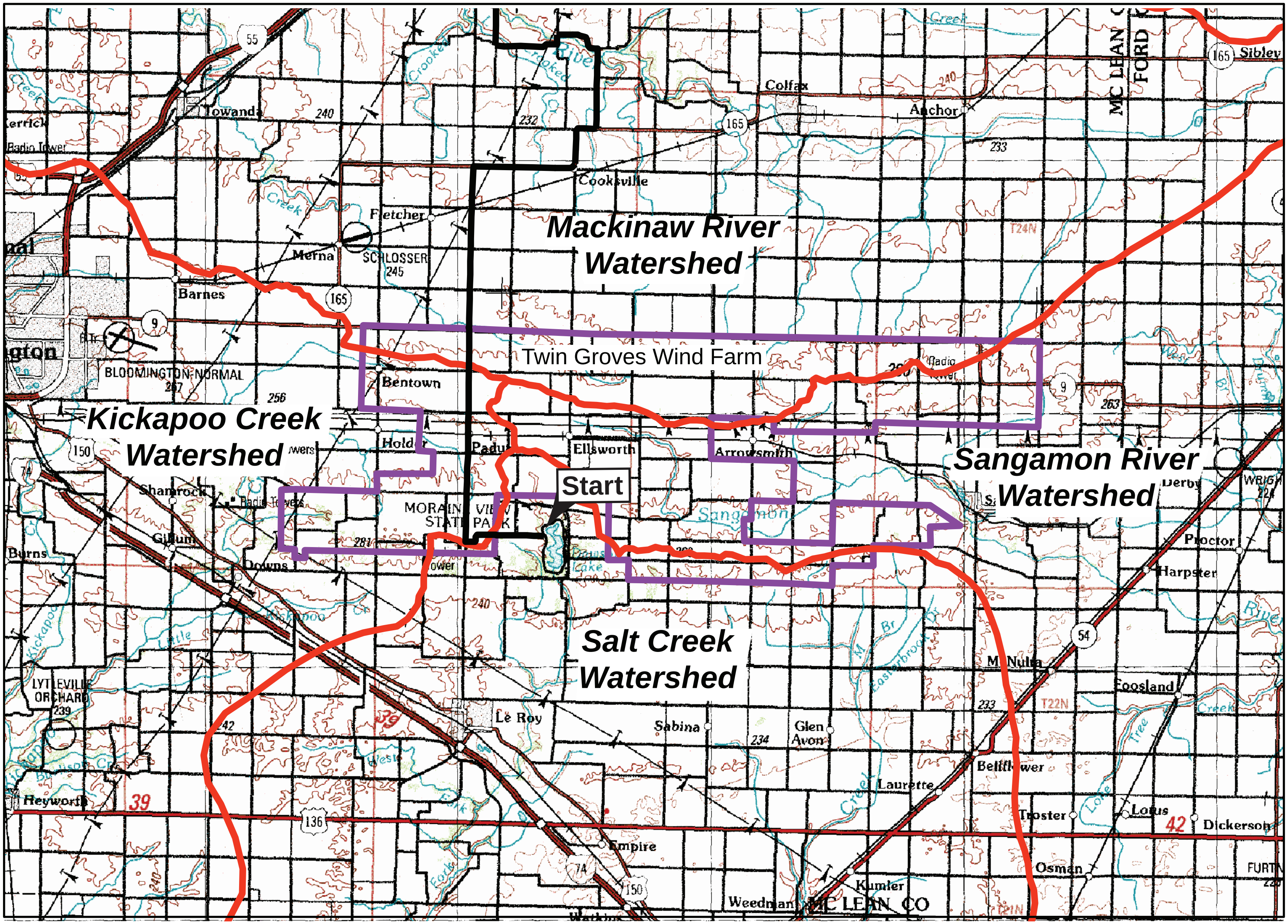


Figure 14 Map showing the Mackinaw River, Salt Creek, Kickapoo Creek, and Sangamon River watersheds, the area of the Twin Grove Wind Farm, and the first part of the field route. Scale originally 1:250,000.

0.15	1.75	This location is the divide between the Salt Creek and Kickapoo Creek watersheds (Figure 14). From here, the area to the north and west drains to Kickapoo Creek, which drains to the west and southwest and joins Salt Creek near the town of Lincoln.
0.25	2.0	Road TURNS LEFT.
0.2	2.2	Road TURNS RIGHT.
0.35	2.55	Crossroad intersection (County Road 36/2600 E/County Road 21). The road to the left rapidly descends 135 feet in elevation down the face of the Bloomington Moraine. The radio tower, located just west of the road, was sited to take advantage of this local high point. TURN RIGHT onto 2600 E/County Road 21.
1.2	3.75	Crossroad intersection (1000 N). CONTINUE AHEAD on 2600 E/County Road 21.
0.5	4.25	Cross an unnamed tributary to Kickapoo Creek, which drains to the west.
0.5	4.75	Crossroad intersection (1100 N). CONTINUE AHEAD on 2600 E/County Road 21.
0.5	5.25	Cross the Norfolk Southern Railroad. The few houses in the area just north of the railroad constitute unincorporated Padua. Begin the ascent of the Normal Moraine.
0.25	5.5	Cross under transmission lines.
0.25	5.75	Crossroad intersection (1200 N/County Road 28). CONTINUE AHEAD on 2600 E/County Road 21.
0.3	6.05	Crest of the Normal Moraine. The headwater area of the Sangamon River watershed is about ¾ mile to the east of the road (Figure 14). The headwaters of the Sangamon River watershed are adjacent to the headwaters of the Salt Creek watershed, separated only by the crest of the Normal Moraine. Remarkably, both of these watersheds originate next to each other, initially flow in opposite directions, and after flowing for more than 80 miles downstream, join north of Springfield.
0.35	6.4	Begin the ascent of the Eureka Moraine.
0.15	6.55	This area is within the eastern part of the Twin Groves Wind Farm. Material for this section is adapted from Horizon Wind (2009), Wind Farm (2009), and Vestas (2009). The wind farm covers more than 22,000 acres (over 34 square miles) in an east-west rectangular area in southeastern McLean County between State Route 9 and County Road 800 N and between County Roads 400 E and 2200 E (Figure 14). Construction of the Twin Groves Wind Farm began in 2006, although development started about 5 years earlier. The farm covers a large area, but only a couple hundred acres are actually used for the turbines, access roads, and associated structures. The farm contains 240 Vestas wind turbine generators, each rated with a capacity of 1.65 MW. The wind farm has the capacity to provide the annual energy need of about 115,000 homes. This energy has been purchased by Constellation Energy, one of the nation's largest suppliers of electricity. Horizon Wind Energy (Energias de Portugal, S. A.), the developer, owner, and operator of Twin Groves, has numerous wind farms throughout the United States. Modern wind turbines, such as those at Twin Groves, sit on towers that are from 200 to 330 feet tall. The blades can be longer than 100 feet. The main parts of a wind turbine consist of the tower, the blades, and the nacelle—a rounded box situated behind the blades. The nacelle contains the generator where blade motion is converted into electricity. A transmission within the nacelle

increases the blade rotation speed of about 18 revolutions per minute (rpm) up to about 1,800 rpm for the generator shaft. Vestas delivered its first three-bladed turbine in 1979 and is now a leading producer of wind turbines.

Wind-powered electrical generators can occur wherever there are sustainable winds. For practical reasons, however, wind generators are best suited for areas where the average wind speed is greater than 10 mph (16 km/h), where turbulent and gusty winds are uncommon, where there is access to local transmission lines, and where landowners are cooperative. The land on which the generators stand must either be purchased or leased. Within wind farms, the location of generators relative to each other (in both distance and pattern) has to be carefully planned. Each generator removes some of the wind energy, and this energy loss can impact neighboring generators if they are spaced too close together.

The height of the generator is also a critical factor. With increasing height above the ground surface, wind speeds are faster and less turbulent because of reduced frictional drag (strongest at the surface) and air viscosity. Rough surface topography and natural (e.g., trees) and man-made objects (e.g., buildings) on the surface increase frictional drag and turbulence. If the height of the generator is doubled, for example, the wind speed is expected to be at least 10% faster. Because of this relationship, wind farms in this part of Illinois have been situated on glacial moraines and, in other parts of Illinois, on glacial moraines or other natural ridges.

Wind farm siting may be controversial. To some people, the large wind turbines are unsightly, but to others they are not, and some even attract tourists. Generally, wind farms should not be located where wildlife can be significantly impacted, such as along migratory bird routes. Additional concerns include turbine noise and light flicker (generally at sunrise and sunset).

0.0 6.55 PROCEED AHEAD on 2600 E/County Road 21.

0.2 6.75 Crossroad intersection (1300 N). CONTINUE AHEAD on 2600 E/County Road 21.

0.1 6.85 This point is the crest of the Eureka Moraine where we leave the Kickapoo Creek watershed and enter the Mackinaw River watershed (Figure 14); we will remain within this watershed for the rest of the trip. The Mackinaw River watershed covers about 1,140 square miles over six counties (Ford, Livingston, Mason, McLean, Tazewell, and Woodford). The Mackinaw River originates just to the east of the small village of Sibley in southwestern Ford County. From Sibley, the river generally flows west to southern Woodford County where it turns and flows southwestward into Tazewell County. Here, the river first turns to the west and then to the north where it joins with the Illinois River just west of Pekin. The length of the river from near Sibley to the Illinois River is about 130 miles.

0.4 7.25 Cross under transmission lines. These lines are the connector lines between wind turbines and the regional transmission grid. The highest point (just over 950 feet above mean sea level) in McLean County is about 11 miles to the east, on the crest of the Eureka Moraine in Section 6, T23N, R6E about 3 miles north and 1 mile west of Saybrook. A large radio tower, similar to the tower on the crest of the Bloomington Moraine, is situated on this high point.

0.5 7.75 STOP SIGN. Crossroad intersection (1400 N/Illinois 9). CONTINUE AHEAD on 2600 E/County Road 21.

0.15 7.9 Cross Money Creek, which flows between the Eureka Moraine to the south and the less prominent Fletchers Moraine to the north.

0.85 8.75 Crossroad intersection (1500 N). CONTINUE AHEAD on 2600 E/County Road 21.

0.75	9.5	“Blue Mound” is the isolated low hill to the west (left) with a farmstead on top. Natural Resource Conservation Service soil maps indicate that Blue Mound is underlain by a layer of sand and gravel. These sediments may have been deposited on or within the glacier by fluvial (stream) processes and, then, as the glacier stagnated and melted, were redeposited to form this mound, called a kame.
0.25	9.75	Crossroad intersection (1600 N). CONTINUE AHEAD on 2600 E/County Road 21.
1.0	10.75	Crossroad intersection (1700 N). CONTINUE AHEAD on 2600 E/County Road 21.
0.1	10.85	Cross under transmission lines.
0.9	11.75	STOP SIGN. Crossroad intersection (1800 N/Illinois 165). TURN RIGHT on 1800 N/Illinois 165.
0.45	12.2	Cross under transmission lines.
0.3	12.5	Cross an unnamed tributary to Little Crooked Creek.
0.25	12.75	Crossroad intersection (2700 E). CONTINUE AHEAD on 1800 N/Illinois 165.
0.6	13.35	Cross Little Crooked Creek.
0.7	14.05	Enter Cooksville.
0.1	14.15	Follow Illinois 165 as it TURNS TO THE LEFT.
0.25	14.4	Leave Cooksville. CONTINUE AHEAD on Illinois 165/2850 E.
0.7	15.1	Y-intersection (1900 N and Illinois 165/2850 E).
0.15	15.25	ROAD TURNS TO THE RIGHT onto Illinois 165/1900 N.
0.25	15.5	Cross an unnamed tributary to the Mackinaw River.
0.2	15.7	T-intersection on the left (2900 E). TURN LEFT onto 2900 E.
0.4	16.1	Cross an unnamed tributary to the Mackinaw River.
0.6	16.7	T-intersection on the left (2000 N). CONTINUE AHEAD on 2900 E.
0.25	16.95	T-intersection on the right (2025 N). CONTINUE AHEAD on 2900 E.
0.6	17.55	Cross bridge over Mackinaw River. Pull over and park on the right side of the road.

STOP 1: Upper Mackinaw River (southeast corner, NE¼, NE¼, NE¼, Sec. 35, T25N, R4E, Cooksville 7.5-minute Quadrangle, McLean County).

0.0	17.55	CONTINUE AHEAD on 2900 E.
0.15	17.7	T-intersection (2100 N). TURN LEFT on 2100 N.

0.2	17.9	ROAD TURNS TO THE RIGHT onto 2875 E.
0.3	18.2	ROAD TURNS TO THE LEFT onto 2150 N.
0.35	18.55	Cross an unnamed tributary to Mackinaw River.
0.35	18.9	T-intersection (2800 E). TURN LEFT on 2800 E.
0.1	19.0	Cross the bridge over the Mackinaw River.
0.2	19.2	T-intersection to the right (2100 N). TURN RIGHT onto 2100 N.
0.2	19.4	ROAD TURNS LEFT, followed by a RIGHT TURN.
0.1	19.5	Cross under transmission lines.
0.7	20.2	Crossroad intersection (2700 E). CONTINUE AHEAD on 2100 N.
0.2	20.4	Cross Little Crooked Creek.
0.3	20.7	Crossroad intersection (2650 E). TURN RIGHT onto 2650 E.
0.3	21.0	Cross Little Crooked Creek.
0.7	21.7	ROAD TURNS LEFT onto 2200 N. At the turn, you are on the edge of the Mackinaw River floodplain.
0.5	22.2	STOP SIGN. Crossroad intersection (2600 E/County Road 21). CONTINUE AHEAD on 2200 N.
0.3	22.5	Cross Crooked Creek.
0.85	23.35	Cross under transmission lines.
0.35	23.7	Crossroad intersection (2450 E). CONTINUE AHEAD on 2200 N.
0.2	23.9	The small mound on the right with the farmstead on top may have an origin similar to Blue Mound.
0.3	24.2	Crossroad intersection (2400 E). CONTINUE AHEAD on 2200 N.
1.0	25.2	T-intersection on the left (2300 E). CONTINUE AHEAD on 2200 N.
0.25	25.45	T-intersection on the right (2275 E/County Road 65). CONTINUE AHEAD on 2200 N/County Road 12.
0.1	25.55	ROAD TURNS TO THE LEFT and begins the ascent to the bridge.
0.4	25.95	Cross the bridge over Union Pacific Railroad, old Route 66, and Interstate 55.
0.2	26.15	Cross an unnamed tributary to the Mackinaw River.
0.8	26.95	T-intersection on the left (2125 E). CONTINUE AHEAD on 2200 N/County Road 12.
0.25	27.2	T-intersection on the right (2100 E). Note the natural gas wellhead on the right (northeast of intersection). CONTINUE AHEAD on 2200 N/County Road 12.

1.0	28.2	T-intersection on the right (2000 E). CONTINUE AHEAD on 2200 N/County Road 12.
0.25	28.45	T-intersection on the left (1975 E). CONTINUE AHEAD on 2200 N/County Road 12.
0.25	28.7	T-intersection on the right (1950 E/County Road 29). CONTINUE AHEAD on 2200 N/County Road 12.
0.25	28.95	Cross Money Creek. Note the U.S. Geological Survey (USGS) stream gauge on the east side, north (right) of the road.
0.25	29.2	T-intersection on the left (1900 E/County Road 29). CONTINUE AHEAD on 2200 N/County Road 12. To the right, trees demarcate the east-west path of the Mackinaw River valley.
0.75	29.95	T-intersection on the right (1850 E). CONTINUE AHEAD on 2200 N/County Road 12.
0.5	30.45	T-intersection on the left (1800 E). CONTINUE AHEAD on 2200 N/County Road 12.
0.65	31.1	Cross an unnamed tributary to Big Slough.
0.35	31.45	STOP SIGN. Crossroad intersection (1700 E/County Road 31). CONTINUE AHEAD on 2200 N/County Road 12.

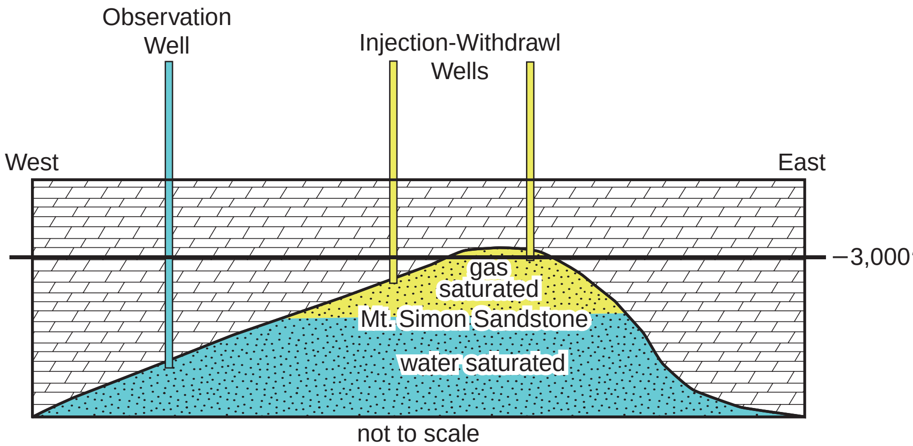
The NICOR Natural Gas compression station for the Hudson Gas Storage Field is located 1.5 miles to the south on 1700 E/County Road 31. We will not drive by the station, but we will discuss it at one of the other field trip stops.

Nicor, Inc. provides natural gas to over 2 million customers in Chicago and most of northern Illinois. The natural gas is produced mostly in the Gulf of Mexico region and is brought into Illinois by pipelines. Consumer demand for natural gas varies markedly from summer to winter because of fluctuating seasonal requirements, mainly for heating purposes. It is neither economically feasible nor efficient to construct enough pipelines to meet peak demand during the winter. Therefore, excess gas is moved from the Gulf gas fields during the summer and pumped into large underground gas storage facilities, such as this one, to be stored until the winter demand increase. During months of low demand, 4,000-horsepower compressors pump excess gas into the Cambrian age Mt. Simon Sandstone at a depth of about 3,800 feet (Figure 15). During high-demand months the gas is recovered, dewatered, odorized, and sent to consumers by distribution pipelines.

Nicor has seven underground gas storage fields in Illinois. Three are in McLean County (Hudson, Lake Bloomington, and Lexington) in small domes along the crest of the Downs Anticline, a natural fold in the bedrock strata. In the Hudson Gas Storage field (Figure 15), the porosity of the Mt. Simon reservoir rock ranges from 10 to 15% (considered to be fair porosity), and permeability ranges from 15 to 185 millidarcies (considered to be good permeability). Permeability is a measurement of how easily fluids (gas, oil or water) move through rocks. It is controlled by the size and connectedness of void spaces. The Cambrian age Eau Claire Formation, which consists of siltstones, dolomites, and some sandstones, forms the impermeable seal (or caprock) above the Mt. Simon Sandstone.

Since the gas was first injected in 1970, its “bubble” occupies an area of about two square miles and is about 60 feet thick at its maximum. The bubble contains about 8.5 trillion cubic feet of pressurized gas. On a typical heating day, about 125 million cubic feet of gas is withdrawn from the field, which increases to 175 million cubic feet of gas for peak heating days. The storage field has about 32 injection/withdrawal wells and 9 observation wells.

Figure 15 Cross section of the Downs Anticline at the Hudson Dome showing only the Cambrian bedrock strata. Note that this view is vertically exaggerated.



0.75	32.2	Cross Big Slough.
0.25	32.45	Crossroad intersection (1600 E). CONTINUE AHEAD on 2200 N/County Road 12.
0.95	33.4	Enter Hudson, named after Hudson, New York, the home of one of its early settlers. Hudson contains two houses that are listed on the National Register of Historic Places: Gildersleeve House, listed in 1977, and The Hubbard House, listed in 1979.
0.3	33.7	Crossroad intersection (Broadway Street/County Road 37).
0.25	33.95	Cross abandoned railroad grade.
0.1	34.05	Leave Hudson.
0.25	34.3	Cross under Interstate 39.
0.2	34.5	Cross Sixmile Creek.
0.05	34.55	T-intersection on the left (1400 E/Sweeney Lane). CONTINUE AHEAD on 2200 N/County Road 12.
1.0	35.55	T-intersection (1300 E) on the left. CONTINUE AHEAD on 2200 N/County Road 12. Over the next 0.5 mile, the route crosses the center of the Danvers Bedrock Valley (Figure 12), a prominent tributary of the buried, ancient Mackinaw Bedrock Valley. The Mackinaw and the Mahomet Bedrock Valleys are prominent features in the buried bedrock surface in this part of the state. The buried bedrock surface was formed largely during the early and middle Pleistocene when it was eroded by a regional river drainage system (Kempton et al. 1991) and subsequently buried by sedimentary material. Most of the material was deposited during the Pleistocene Epoch when the region was subjected to multiple advances and retreats of continental glaciers. The erosional material came from many sources, both from nearby rock outcrops at the time and from areas as far away as eastern Canada. The sand and gravel layers that are part of the infill of these bedrock valleys often form productive aquifers, such as the widespread Mahomet aquifer. In this area of this stop, the bottom of the Danvers Bedrock Valley is about 350 deep, although the relief of the ancient valley is closer to 150 feet.
1.1	36.65	T-intersection (1200 E/County Road 39). TURN RIGHT onto 1200 E/County Road 39.

0.5	37.15	T-intersection on the left (2250 N/County Road 12). TURN LEFT onto 2250 N/County Road 12.
0.25	37.4	Cross under transmission lines.
0.75	38.15	Crossroad intersection (1100 E). CONTINUE AHEAD on 2250 N/County Road 12.
1.0	39.15	T-intersection on the left (1000 E). CONTINUE AHEAD on 2250 N/County Road 12.
0.45	39.6	Cross Denman Creek.
0.1	39.7	T-intersection on the right (950 E). CONTINUE AHEAD on 2250 N/County Road 12.
0.1	39.8	Cross an unnamed tributary to Denman Creek.
0.45	40.25	Road overlaps the county boundary between Woodford and McLean Counties. For the next 1.45 miles, the route will slowly ascend the Eureka Moraine to near its crest.
0.7	40.95	Crossroad intersection (825 E). The site of Oak Grove village, which moved in 1888, is 1.1 miles to the south. CONTINUE AHEAD on 2250 N/County Road 12.
0.25	41.2	Cross an unnamed tributary to Denman Creek.
0.5	41.7	Crossroad intersection (750 E/County Road 9). TURN RIGHT onto 750 E/County Road 49.
0.2	41.9	Cross the boundary between Woodford County and McLean County. On the right (west) side of the road is the Lincoln 8th Judicial Circuit Monument. The highest point in Woodford County (just over 850 feet above mean sea level) is located a little more than 0.5 mile to the west.
0.3	42.2	Oak Grove Cemetery to the right. This cemetery, the preferred resting place of members of the Republican Party from Carlock, was established by Philip Benson, a member of the Whig party until the 1850s, when he joined the newly formed Republican Party (Huck 1996–2007). Benson was a rival to the prominent Democrat Abraham W. Carlock; apparently both were so committed that neither would permit members of the opposing party into their homes. However, since both politicians were very good friends of Abraham Lincoln, this commitment appears to have been exaggerated.
0.2	42.4	Y-intersection (Brown Road and Denman Road). White Oak Cemetery on the left, originally called Carlock Cemetery, was intended for members of the Democratic Party (Huck 1996–2007). The land for the plot was donated by Abraham W. Carlock in 1850. Carlock was a local prominent politician, and the town of White Oak was renamed Carlock in his honor in about 1875. He was a proud Democrat, and when he died in 1884, the words “Here sleeps the old Democrat” were placed on his monument. CONTINUE TO THE LEFT on Denman Road.
0.4	42.8	In the pasture on the left, just north of the wooded area, is the approximate site of the “Sulphur Spring Hotel.” Large boulders that have been placed along the right side of the road for the next 0.25 mile are glacial erratics.
0.5	43.3	Cross Vincent Run Creek.
0.1	43.4	Y-intersection (Denman Road and 2135 E). CONTINUE TO THE LEFT on Denman Road.
0.9	44.3	Pull over and park on the right side of the road. Walk to the Y-intersection (Winchester Lane and Denman Road) and bridge over Vincent Run Creek.

STOP 2: Parkland Foundation Boat Landing and Wyatt's Ford (NE¼, NE¼, SW¼, Sec. 7, T25N, R1E, Secor 7.5-minute Quadrangle, Woodford County).

0.0	44.3	Return to vehicles. ONE-BY-ONE, DRIVE TO THE Y-INTERSECTION, TURN AROUND, AND PROCEED BACK to the Y-intersection of Brown Road and Denman Road.
1.9	46.2	STOP SIGN. Y-intersection (Brown Road, Denman Road, and 750 E/County Road 49). CONTINUE AHEAD on 750 E/County Road 49.
0.7	46.9	STOP SIGN. Crossroad intersection (2250 N/County Road 12). About 0.3 miles to the west, just across the Woodford/McLean County line, is the site where Abraham Carlock lived and where Abe Lincoln would often visit and spend the night. CONTINUE AHEAD on 750 E.
0.1	47.0	Overview from the top of the Eureka Moraine toward the Bloomington Moraine, which is about 5 miles to the south and southwest. Park along the right side of the road.

STOP 3 (optional): View of the Bloomington Moraine (southeast corner, NE¼, SE¼, SW¼, Sec. 20, T25N, R1E, Danvers 7.5-minute Quadrangle, McLean County).

0.0	47.0	PROCEED AHEAD on 750 E. Between this point and Carlock, the route descends down the southwest face of the Eureka Moraine.
1.9	48.9	Enter Carlock (formerly Oak Grove). SLOW DOWN. 750 E becomes Church Street. Carlock was named after Abraham W. Carlock. The village moved to this location in 1888 after the railroad was laid out.
0.3	49.2	STOP SIGN. Crossroad intersection (Pyne Street). CONTINUE AHEAD on Church Street.
0.1	49.3	Cross Rock Creek.
0.05	49.35	STOP SIGN. Crossroad intersection (Douglas Street). CONTINUE AHEAD on Church Street.
0.1	49.45	STOP SIGN. Crossroad intersection (US 150/Washington Street). CONTINUE AHEAD on Church Street.
0.1	49.55	ROAD TURNS TO THE RIGHT onto Franklin Street.
0.1	49.65	Crossroad intersection (Jefferson Street). TURN LEFT onto Jefferson Street.
0.1	49.75	Enter Carlock City Park. Follow the lead car and staff directing traffic.

STOP 4: Carlock City Park (Lunch) (SE¼, NE¼, SW¼, Sec. 32, T25N, R1E, Danvers 7.5-minute Quadrangle, McLean County).

0.0	0.0	Reset odometer. Leave Carlock City Park. Follow the lead vehicle and staff directing traffic.
0.1	0.1	STOP SIGN. Crossroad intersection (Franklin Street). CONTINUE AHEAD on Jefferson Street.
0.1	0.2	STOP SIGN. Crossroad intersection (Washington Street/US 150). TURN LEFT onto Washington Street/US 150.
0.15	0.35	Y-intersection at the railroad crossing (Washington Street/County Road 53 and US 150). CAUTION. TURN SLIGHTLY TO THE LEFT on to Washington Street/County Road 53.
0.05	0.4	Cross Norfolk Southern Railroad.
0.2	0.6	Carlock School is on the right. Leave Carlock and CONTINUE AHEAD on 2050 N/County Road 53.
0.2	0.8	Cross bridge over Interstate 74.
0.4	1.2	Cross an unnamed tributary to Rock Creek.
0.3	1.5	Crossroad intersection (600 E). You have crossed the Third Prime Meridian. Prime meridians are lines of longitude that are the metaphorical “backbones” from which most of the continental United States was surveyed. The Land Ordinance of 1785 and the Northwest Ordinance of 1787 together provided the means for a systematic survey of public lands and established the rectangular survey system now known as the Public Land Survey System (PLSS). The 1785 ordinance grew from the idea that a true democracy would make it possible for the common man to own land. In order for this idea to be enacted, the land had to be divided into small parcels so that it could be sold at an affordable price. The “Point of Beginning” for the 1785 survey is on the north shore of the Ohio River near East Liverpool in southeastern Ohio. The PLSS eventually included all of the continental United States westward from Ohio to the Pacific Ocean with the exception of Kentucky, Tennessee, and Texas. The PLSS consists of 37 different separate surveys with 37 different prime meridians. These surveys began at an initial point, and townships were surveyed in all directions from that point. The north-south line through the initial point is the prime meridian, and the east-west line is called the baseline. The 1785 ordinance also established a method for funding public education by reserving Section 16 in each township for public schools. Sections 8, 11, 26, and 29 were supposed to be reserved to compensate Revolutionary War veterans; this practice, however, was not widely applied. The Third Prime Meridian supposedly began at the intersection of the Ohio River and the Mississippi River. Modern 7.5-minute USGS quadrangles show the meridian originating on the north shore of the Ohio River at Mound City, Illinois. If one extrapolates the meridian further south, however, it would align close to the intersection of the rivers. The meridian extends north to the Illinois-Wisconsin border. This meridian (near longitude 89° 10' 15" west), along with the baseline at latitude 38° 28' 20" (about 3 miles south of Centralia), was used to survey the east half of the state, except for a strip along the Indiana border and the area between this meridian and the Illinois River. CONTINUE AHEAD on 2250 N/County Road 53.

0.7	2.2	ROAD TURNS TO THE LEFT.
0.1	2.3	T-intersection on the right (unnamed). CONTINUE TO THE LEFT onto 500 E/ County Road 53.
0.2	2.5	Cross an unnamed tributary to Rock Creek.
0.1	2.6	T-intersection on the right (Congerville Road). CONTINUE AHEAD on 500 E/ County Road 53.
0.8	3.4	Crossroad intersection (1950 N). TURN RIGHT onto 1950 N.
1.5	4.9	Crossroad intersection (350 E/County Road 55). CONTINUE AHEAD on 1950 N.
0.1	5.0	Cross an unnamed tributary to Rock Creek.
0.9	5.9	Crossroad intersection (250 E). CONTINUE AHEAD on 1950 N.
1.0	6.9	Crossroad intersection (150 E). TURN RIGHT onto 150 E.
0.5	7.4	T-intersection on the left (2000 N). CONTINUE AHEAD on 150 E.
0.5	7.9	T-intersection (2050 N). TURN LEFT onto 2050 N and cross an unnamed tributary to Rock Creek.
0.25	8.15	ROAD TURNS TO RIGHT onto 125 E.
0.15	8.3	Cross an unnamed tributary to Rock Creek.
0.3	8.6	Cross Rock Creek.
0.1	8.7	Pull over and park on the right side of road.

STOP 5: Rock Creek Exposure (S½, NW¼, NE¼, NW¼, Sec. 32, T25N, R1W, Danvers 7.5-minute Quadrangle, McLean County).

0.0	8.7	Return to vehicles. CONTINUE AHEAD on 125 E.
0.5	9.2	T-intersection (2150 N/County Road 50). The right side of the road is the boundary between Woodford and McLean Counties. TURN LEFT onto 2150 N/County Road 50.
1.0	10.2	Crossroad intersection (25 E/1425 E). CONTINUE AHEAD on 2150 N/County Road 50.
0.25	10.45	ROAD TURNS TO THE LEFT onto 1400 E. Note the sand and gravel pit (inactive?) to the right. The right side of the road is the boundary between Tazewell and Woodford Counties.
0.3	10.75	ROAD TURNS TO THE RIGHT onto River Road. Begin the descent down the surface of an alluvial fan to the floodplain of the Mackinaw River.
0.4	11.15	Enter the Mackinaw River floodplain. For the next mile, the road parallels the Mackinaw River.

0.2	11.35	T-intersection on the right (Ragar Road/King Road/River Road). CONTINUE STRAIGHT AHEAD on King Road. The bridge across the Mackinaw is the Rocky Ford Bridge. According to the 1873 plat map of Tazewell County, the site of the “Rocky” ford is about 0.3 miles upstream from the bridge.
0.4	11.75	ROAD TURNS TO THE LEFT AND THEN BACK TO THE RIGHT.
0.15	11.9	Cross Rock Creek.
0.3	12.2	Cross Hollands Creek and begin the ascent up the surface of an alluvial fan.
0.2	12.4	T-intersection on the left (Brown Road). CONTINUE AHEAD on King Road.
0.2	12.6	Pull over and park on the right side of road.

STOP 6 (optional): Overview of the Mackinaw River Valley (NW¼, SE¼, NW¼, Sec. 1, T24N, R2W, Mackinaw 7.5-minute Quadrangle, Tazewell County).

0.0	12.6	Return to vehicles. CONTINUE AHEAD. Within the next mile, the route ascends onto the Bloomington Moraine, but, because the route also is ascending up and out of the Mackinaw River valley, it is difficult to see where the route crosses onto the moraine.
1.7	14.3	ROAD TURNS TO THE RIGHT.
0.1	14.4	ROAD TURNS TO THE LEFT.
0.4	14.8	Cross under the transmission line and abandoned railroad grade. STOP SIGN. Crossroad intersection (Runyon Road). CONTINUE AHEAD on King Road. This is the crest of the Bloomington Moraine.
0.4	15.2	ROAD TURNS TO THE LEFT.
0.5	15.7	T-intersection (Illinois 9) TURN RIGHT onto Illinois 9.
0.8	16.5	Crossroad intersection (Zimmerly Road/Lilly Road). CONTINUE AHEAD on Illinois 9.
0.5	17.0	Crossroad intersection (Boston School Road/County Road 24). TURN LEFT onto Boston School Road/County Road 24. Over the next mile, the route descends down the southern face of the Bloomington Moraine.
1.4	18.4	Cross Little Mackinaw River.
0.1	18.5	T-intersection on the right (Morgan Road). CONTINUE AHEAD on Boston School Road/County Road 24.
1.5	20.0	Crossroad intersection (Townline Road/County Road 7). TURN RIGHT onto Townline Road/Country Road 7.
1.1	21.1	Cross the Little Mackinaw River. Glenwood Cemetery is on the left.

0.05	21.15	Note the granite boulder with the plaque on the left. The area behind the boulder is the homestead site of George Washington Minier (1813–1902). In a centennial history of Minier, Illinois, Graber (1967) reports that Minier was born in Pennsylvania, moved to Illinois in 1837, and settled in Bureau County, where he resided for ten years. While there, he became a surveyor and surveyed the state road from Peru to Knoxville and taught school. In 1839, he surveyed a part of the Illinois River bottom and ascertained the altitude of Starved Rock. In 1847, he moved to Bloomington and opened a high school for boys and girls, and the following year he opened a female college. In 1850, he purchased 160 acres of land at a cost of $0.83 per acre. In connection with farming, he served as president of the State Horticultural Society, as vice president of the State Agricultural Society, and as president of the North American Forestry Association. Minier was conscientiously opposed to slavery, and during the time of soldier enlistment for the Civil War, he made many eloquent speeches in favor of volunteering. He was also a member of the Peace Congress of the United States and an earnest advocate of all temperance work. He joined the Prohibition Party, and he was the first man ever nominated for Congress on the Prohibition ticket. In October 1867, he platted the village that bears his name (located about 3.5 miles south). His acquaintances included Abraham Lincoln and Stephen Douglas.
0.15	21.3	T-intersection on the right (Keyser Road), followed by a T-intersection on the left (Minier Road). CONTINUE AHEAD on Townline Road/County Road 7.
0.55	21.85	T-intersection on the left (Tazewell Road). CONTINUE AHEAD on Townline Road/County Road 7.
0.2	22.05	Enter and leave unincorporated Tazewell. The Illinois Terminal Railroad formerly crossed the road within Tazewell, but there is little evidence of the railroad grade. Note the grain tower to the right that has been modified for a new use.
1.0	23.05	Crossroad intersection (Mackinaw Road/Country Road 6). CONTINUE AHEAD on Townline Road/County Road 7.
0.9	23.95	T-intersection on the left (Railsback Road). CONTINUE AHEAD on Townline Road/County Road 7.
0.05	24.0	Cross Sargent Slough.
0.05	24.05	Enter and leave unincorporated Walnut and cross an abandoned railroad grade.
0.6	24.65	T-intersection on the right (Weishaupt Road). CONTINUE AHEAD on Townline Road/County Road 7.
0.7	25.35	Cross an unnamed tributary to Sargent Slough.
0.55	25.9	Crossroad intersection (Concord Road). CONTINUE AHEAD on Townline Road/County Road 7. In the distance to the left is the Railsplitter Wind Farm, which is being developed on the Shelbyville Moraine in Tazewell (38 wind turbines) and Logan (29 wind turbines) Counties.
0.5	26.4	Descend down the slope to the floodplain of the Mackinaw River.
0.2	26.6	T-intersection on the left (Hopedale Road/County Road 9). CONTINUE AHEAD on Townline Road/County Road 7.

0.4	27.0	T-intersection on the right (Benson Road). CONTINUE AHEAD on Townline Road/County Road 7. Note the levee on the left. Levees in this part of the Mackinaw River valley are primarily constructed to prevent the flooding of farmland.
0.2	27.2	Cross the bridge over the Mackinaw River.
0.3	27.5	TURN LEFT onto the road to the quarry, and follow lead vehicle and staff directing traffic.

STOP 7: Lowery Sand and Gravel Pit, Townline Road (NW¼, NE¼, NW¼, Sec. 3, T23N, R3W, Hopedale 7.5-minute Quadrangle, Tazewell County).

0.0	27.5	Return to vehicles. PROCEED BACK to Quarry entrance road. TURN RIGHT on Townline Road/County Road 7.
0.3	27.8	Cross the bridge over the Mackinaw River.
0.2	28.0	T-intersection on the left (Benson Road). TURN LEFT onto Benson Road. Note the levee on the right.
0.4	28.4	Begin ascent upslope from the floodplain to the uplands.
0.6	29.0	T-intersection on the right (Hinman Road). CONTINUE AHEAD on Benson Road.
0.35	29.35	Drop down onto the floodplain and cross the bridge over the Mackinaw River. Note the levees on both sides of the road.
0.4	29.75	ROAD TURNS TO THE LEFT onto Sauder Road.
0.25	30.0	T-intersection on the right (White Oak Grove Road). TURN RIGHT onto White Oak Grove Road.
0.55	30.55	T-intersection (Illinois 9). TURN RIGHT onto Illinois 9. An abandoned railroad grade parallels Illinois 9 on the left.
0.8	31.35	Cross Mud Creek.
0.2	31.55	Crossroad intersection (Schmidgall Road). CONTINUE AHEAD on Illinois 9. Ponds to the right are abandoned sand and gravel pits.
0.8	32.35	Cross the bridge over the Mackinaw River. Note the levees on both sides of the river.
0.75	33.1	T-intersection on the right (Weishaupt Road). CONTINUE AHEAD on Illinois 9.
0.4	33.5	Crossroad intersection (Hoffman Avenue). TURN LEFT onto Hoffman Avenue and cross the abandoned railroad grade.
0.1	33.6	Cross an unnamed tributary to the Mackinaw River. Note the levee on the south side only.
0.2	33.8	ROAD TURNS TO LEFT.
0.3	34.1	ROAD TURNS RIGHT onto Fast Avenue. The Mackinaw municipal water well and treatment plant is on the left.

0.1	34.2	Cross abandoned railroad grade.
0.25	34.45	Note the “Leaving Water Supply Protection Area” sign on the right. This sign is intended to help protect the area around the Mackinaw municipal water well.
0.1	34.55	Enter Mackinaw. Mackinaw is situated on the Bloomington Moraine adjacent to a major breach through which the Mackinaw River flows. The village of Mackinaw, named after the river, was plotted in 1828 and was the first county seat until 1831, when the county seat was moved to Pekin. The county seat has moved several more times after starting in Mackinaw (1827–1831), Pekin (1831–1836), Tremont (1836–1849), and Pekin (1850–present).
0.15	34.7	STOP SIGN at crossroad intersection (Main Street). TURN LEFT onto Main Street.
0.2	34.9	Cross abandoned railroad grade. Note the railroad depot on the right.
0.1	35.0	Leave Mackinaw. Main Street becomes Dee-Mack Road/County Road 6.
0.1	35.1	Cross under the transmission line and descend to the Mackinaw River floodplain.
0.2	35.3	T-intersection on the right (Hild Road). TURN RIGHT onto Hild Road.
0.3	35.6	ROAD TURNS LEFT.
0.5	36.1	ROAD TURNS RIGHT. Directly west (to the left before the turn) is a view of a failed segment of the levee along the Mackinaw River. The levee appears to have been undercut and eroded by the lateral movement of the river.
0.3	36.4	Leave floodplain and begin the ascent up the hill. The levee to the left is for flood prevention and also serves as noise and view barrier of the sand and gravel operation on the other side.
0.3	36.7	T-intersection (Kenton St. and Hild Road). TURN LEFT and CONTINUE on Hild Road.
0.15	36.85	T-intersection (Quarry entrance to left; Hild Road turns to the right). TURN LEFT onto the quarry entrance road. Follow lead vehicle and staff directing traffic.

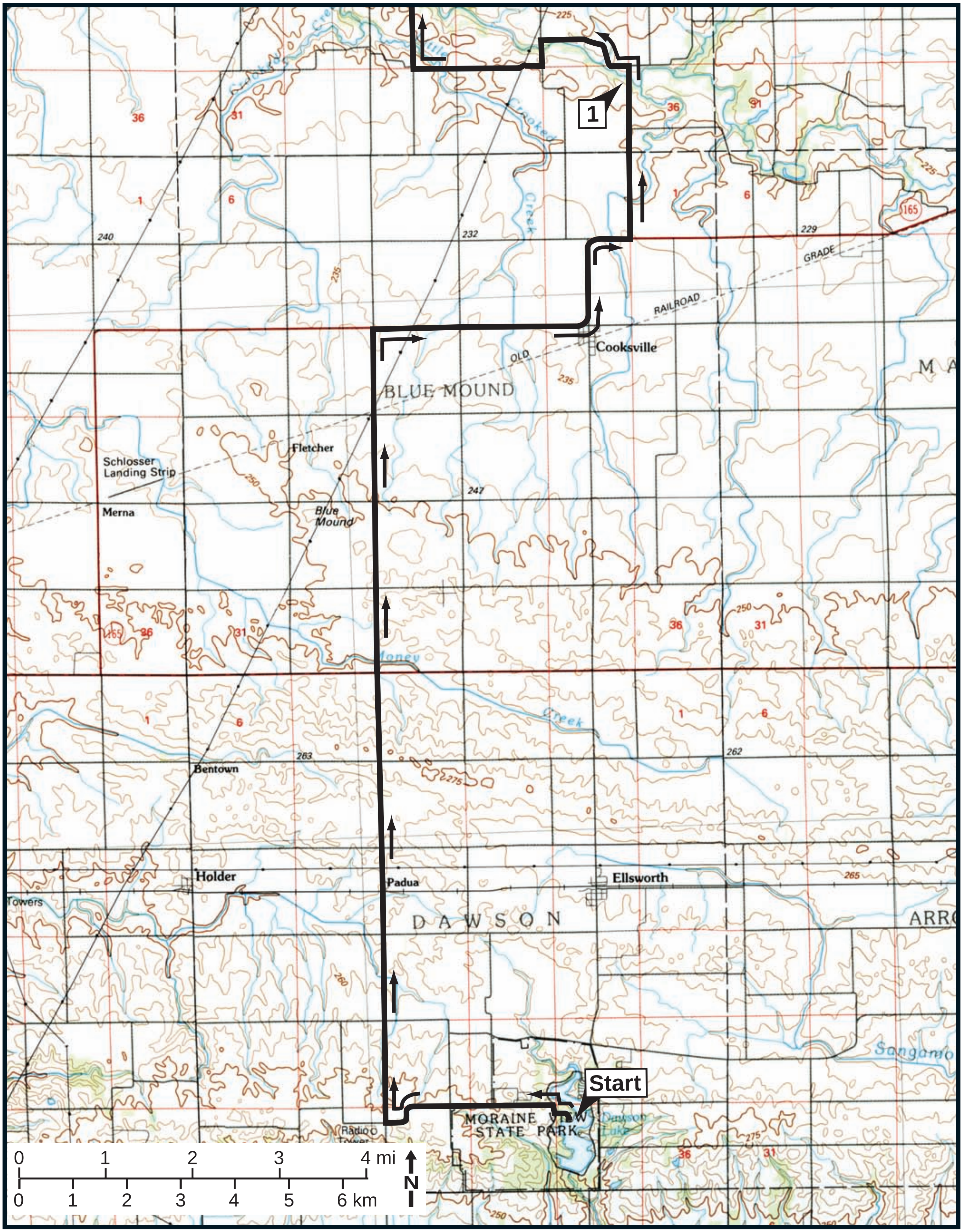
STOP 8: Lowery Sand and Gravel Pit, Hild Road (SW¼, NW¼, NW¼, Sec. 9, T24N, R2W, Mackinaw 7.5-minute Quadrangle, Tazewell County).

End of field trip. **Have a safe journey home**.

Retrace the route back to Dee-Mack Road/County Road 6.

If you plan to travel north or east, turn right and drive until you reach the intersection with US 150. Turn right onto US 150 and follow it through Deer Creek and onto Goodfield (about 10 to 11 miles). At Goodfield, turn right (south) to the second entrance to Interstate 74, which takes you to Bloomington-Normal.

If you plan to travel south or west, turn left and drive through Mackinaw to Illinois 9. Turn right (west) and continue until you reach Interstate 55 (about 7 to 8 miles). Take the first entrance to travel toward Peoria. Take the second entrance to travel toward Springfield.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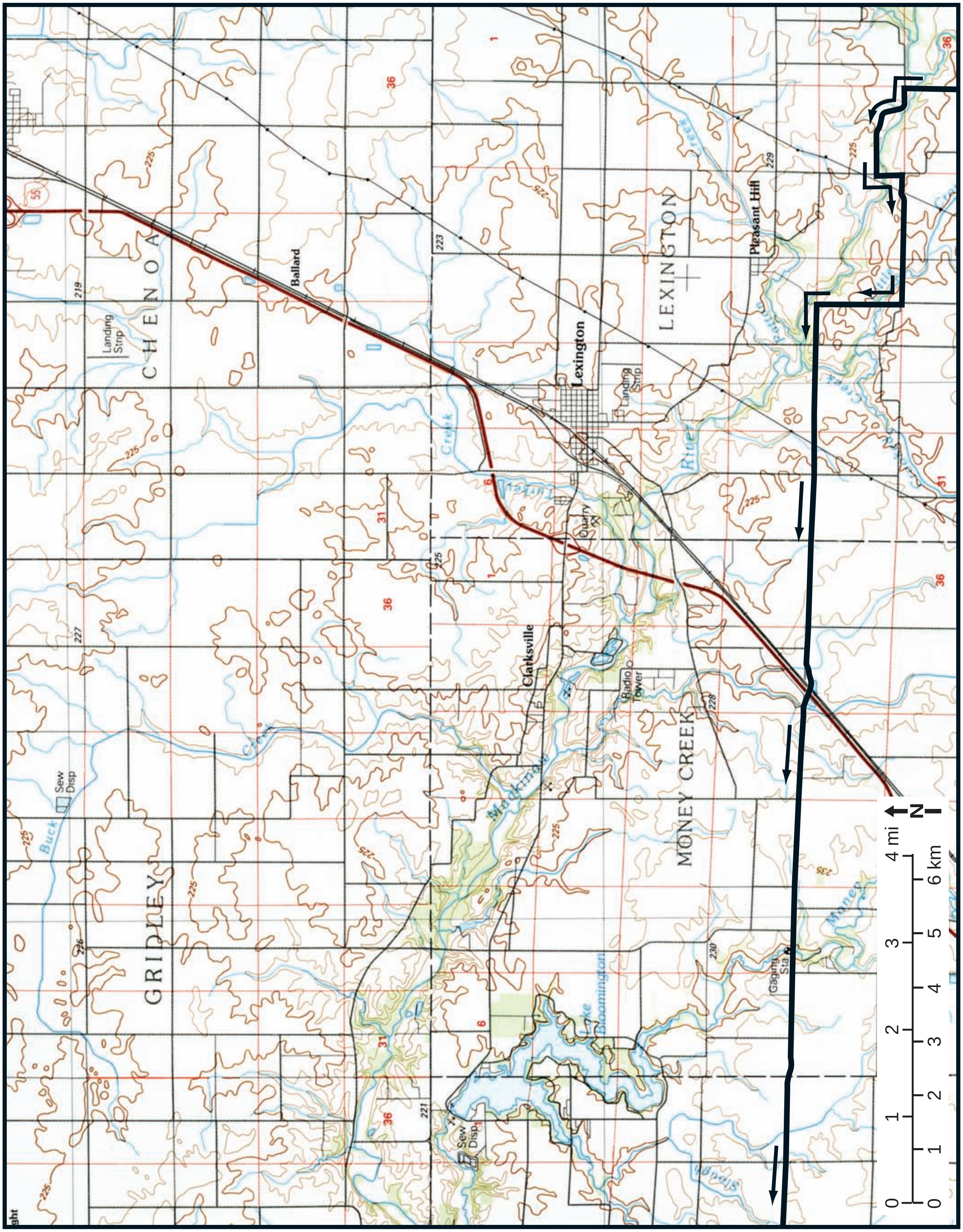
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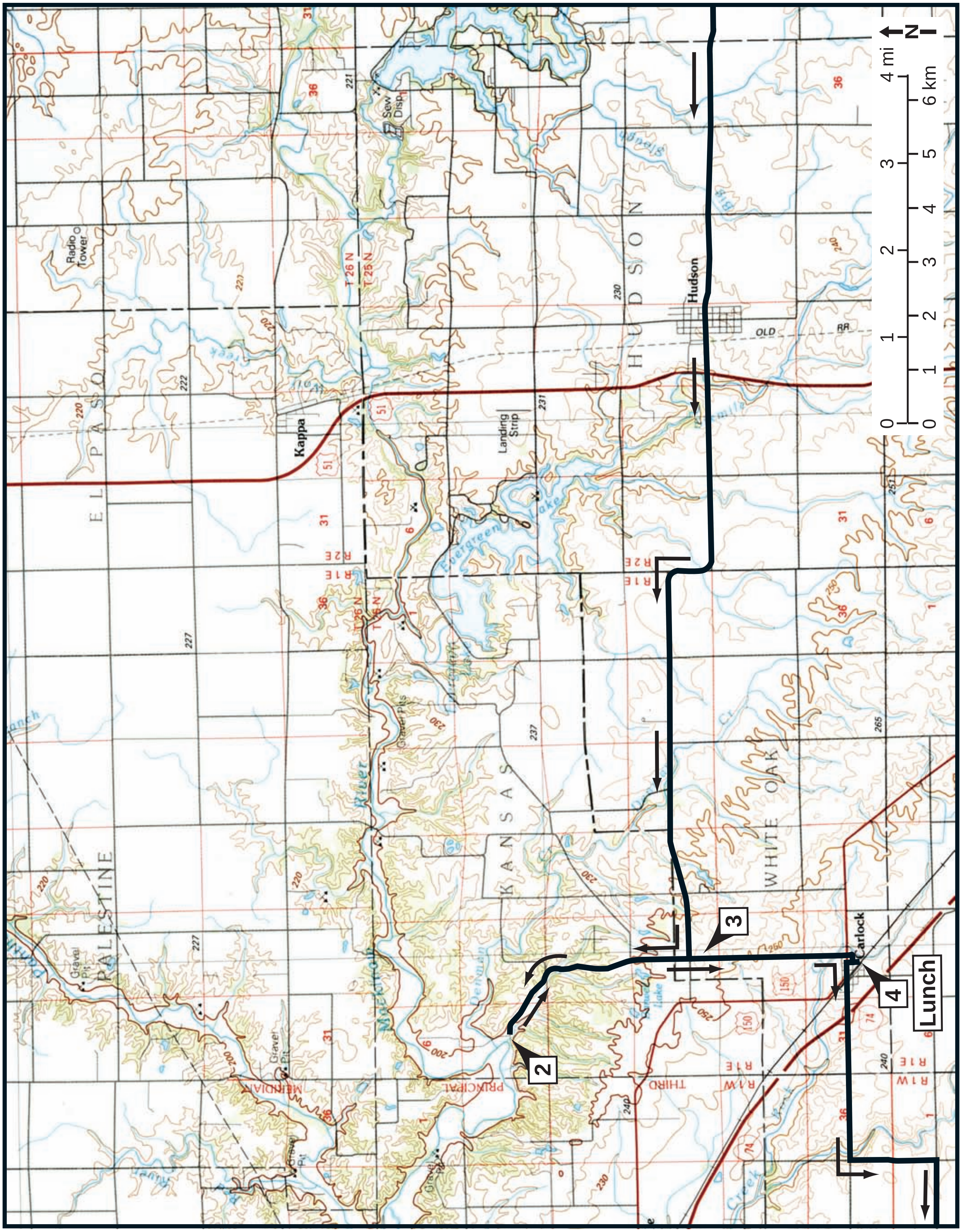

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Hudson
Carlock
Radio Tower
Landing Strip
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Evergreen Lake
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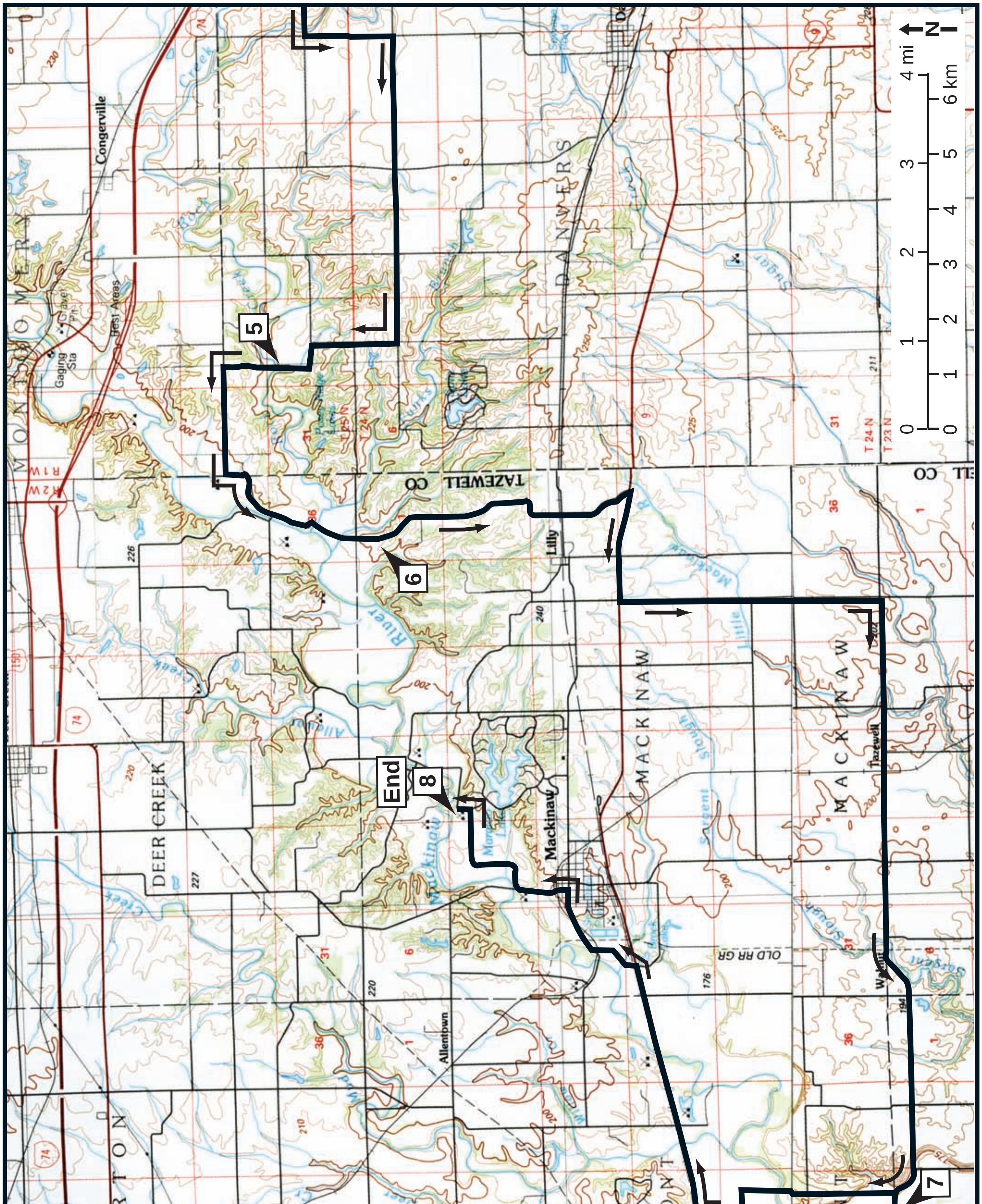
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Congerville
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Lilly
MACKINAW
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DEER CREEK
Allentown
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OLD RR GR
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STOP DESCRIPTIONS

START: Dawson Lake Marina Parking Lot, Moraine View State Recreation Area (NW¼, SE¼, NW¼, Sec. 35, T23N, R4E, Arrowsmith 7.5-minute Quadrangle, McLean County).

The landscape of northeastern Illinois generally is composed of many subtle hills, long uphill slopes, and elongate ridges. Aerial photography and remote sensing imagery show about 50 of these large, broad arcuate ridges covering much of the northeastern quadrant of Illinois (Figure 11). These elongate ridges—end moraines—were formed by glacial movement across the area between about 25,000 and 14,000 years ago during the Wisconsin Episode of glaciation. As ice accumulated, the Wisconsin glacier advanced into Illinois from its source area in Canada; as it advanced, the glacier incorporated materials into the ice, dragging and reshaping those materials. As the glacier "retreated" from the area, that is, when melting exceeded ice accumulation, it deposited debris. During the Wisconsin Episode, the glacier advanced and retreated many times.

End moraines were formed by the accumulation of unsorted sediments (known as glacial drift) during times when the rate of ice advance and the rate of melting were essentially in balance. During these times, the margins of the glacier remained in the same place for a relatively long time, perhaps tens to hundreds of years. As more and more material was carried forward (transported) to the edge of the glacier, the rock debris melted out and piled up to form a ridge: the end moraine. Most end moraines are composed of till, the unsorted mixture of debris, ranging in size from clay to boulders, deposited by the glacier. The melting glacier also formed ground moraines as it deposited a thinner till layer on the relatively flat, glaciated landscape behind and between moraines. Glacial meltwater washed through accumulated debris, transporting and depositing sediment out ahead of the decaying glacier as stratified drift. The coarsest of this water-transported material, sand and gravel (outwash), was deposited near the ice front. Outwash plains are often associated with end moraines.

On this field trip, we will traverse several end moraines, some of them multiple times. The trip starts in Moraine View State Park, which is situated on the Bloomington Moraine (Figure 16). As the route heads north, we will cross over the Shirley, Bloomington, Normal, Eureka, and Fletchers Moraines, in succession. The subtle ridges of the Shirley and Fletchers Moraines are not easily recognizable on this route. Moraine View State Park is situated near the crest of the Bloomington Moraine. In the vicinity of Stop 2 and the lunch stop, we will cross the Eureka Moraine in the Carlock area. Later, near the end of the trip, we will traverse the Bloomington Moraine near Mackinaw.

STOP 1: Upper Mackinaw River (southeast corner of NE¼, NE¼, NE¼, Sec. 35, T25N, R4E, Cooksville 7.5-minute Quadrangle, McLean County).

The origin of the Mackinaw River is a ditched channel near Sibley in northwestern Ford County, about 17 miles east of Stop 1. In this segment of the river, the stream channel is straight, the water is relatively slow moving, and there are few trees along its banks. At Colfax, about 5 miles to the east, the river begins to meander, and a thin band of trees generally is found along the banks. West of Interstate 55, about 6 miles north-northwest of this location, the tree band substantially widens, and, in some places, the floodplain is forested. Man-made levees are absent.

From Sibley to just upstream from Stop 2, the Mackinaw River flows parallel to the front of the El Paso Moraine (just to the north of this site) or across the area between the El Paso and Eureka Moraines. From Stop 1 to Stop 2, the channel size and the low flows are large enough to provide significant year-round aquatic habitats that are generally shaded by the tree bands along the banks. At this stop, floodplains are not well defined and are relatively narrow. The river channel has been generally very stable laterally and not significantly affected by channelization. Clayey silt alluvium is the dominant bank material and is often strengthened by riparian tree roots. The streambed materials are generally finer grained (sandy), but there are a few lag deposits (streambed gravel and cobble deposits) and gravel-cobble riffles (lag deposit in very shallow water).

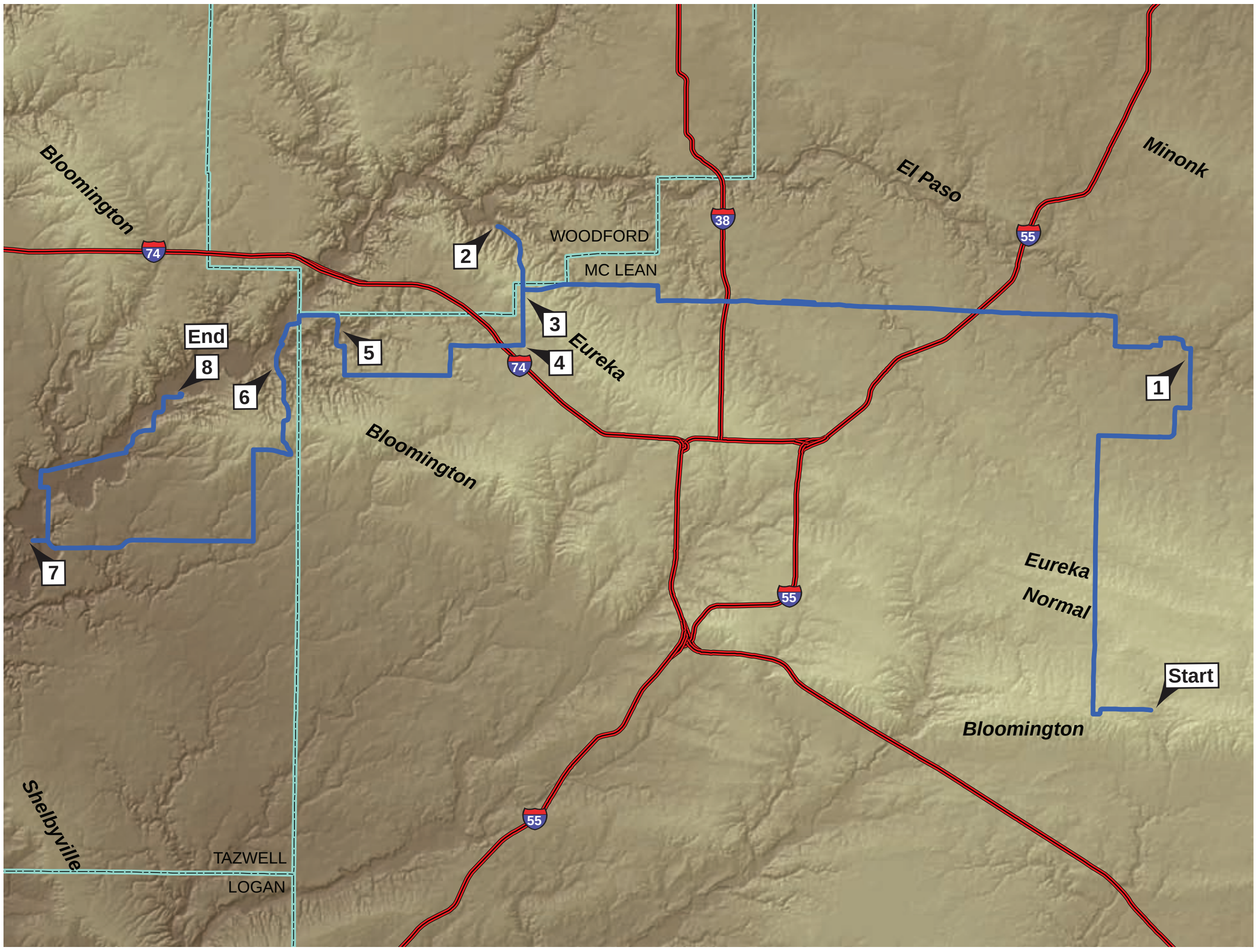

Figure 16 Shaded relief map showing the field trip route and the labeled major glacial moraines. Map by C.C. Abert, Illinois State Geological Survey.

STOP 2: Parkland Foundation Boat Landing and Wyatt's Ford (NE¼, NE¼, SW¼, Sec. 7, T25N, R1E, Secor 7.5-minute Quadrangle, Woodford County).

Middle Mackinaw River

The middle portion of the Mackinaw River flows perpendicular to and erodes through successive glacial moraines (Figure 17). Stop 2 is very close to where the Mackinaw River begins to traverse the Eureka Moraine.

The valley relief nearly doubles as the river valley cuts through the moraine, and steep, high valley walls are common in this segment. The river is quite sinuous, and the floodplains are significantly wider (generally ranging from about 650 to 1,000 feet), particularly in the stretches between moraines (over 3,000 feet wide). Although the bank alluvium is sandier than upstream, the river channel is still relatively stable laterally. The stream bank is dominated by silt and clay, but sand and gravel pockets are present, particularly where the river erodes through a moraine. The streambed is dominated by sand, but gravel and cobble riffles are common.

Eighth Judicial District

Between about 1839 and 1859, Abraham Lincoln worked intermittently as a lawyer on the Judicial Circuit (formally named the 8th Judicial Circuit after the 1848 Illinois Constitution). The circuit (Figure 18) consisted of counties that did not have standing courts. In 1839, the circuit was nine counties; in 1850, it was 14; later it was reduced to eight. A court assemblage, consisting of judge, prosecutor, and defense attorney, traveled to various county seats for trials. Lincoln's role was almost always the defense attorney. He and

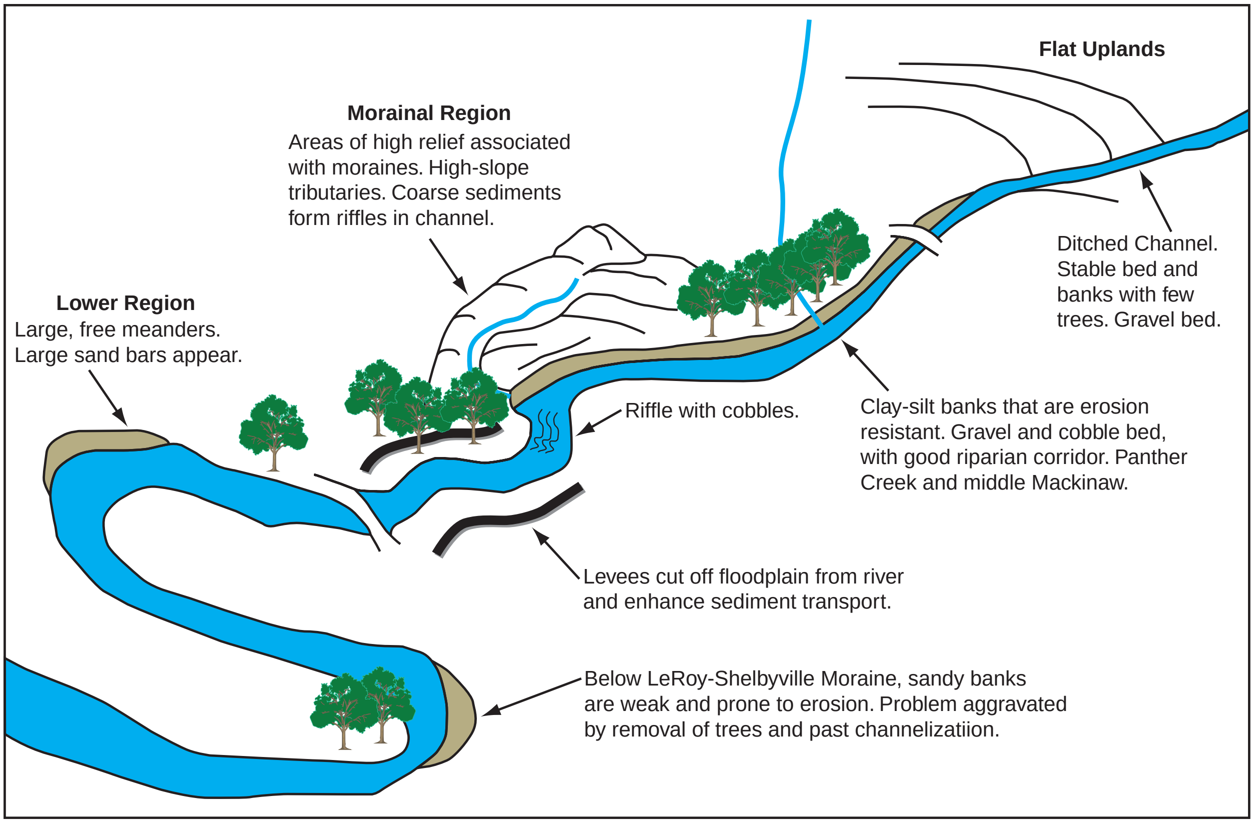

Figure 17 Stylized profile of the Mackinaw River from northeastern McLean County to northern Tazewell County (from Jeffords in Post 1997, modified after Gough 1997).

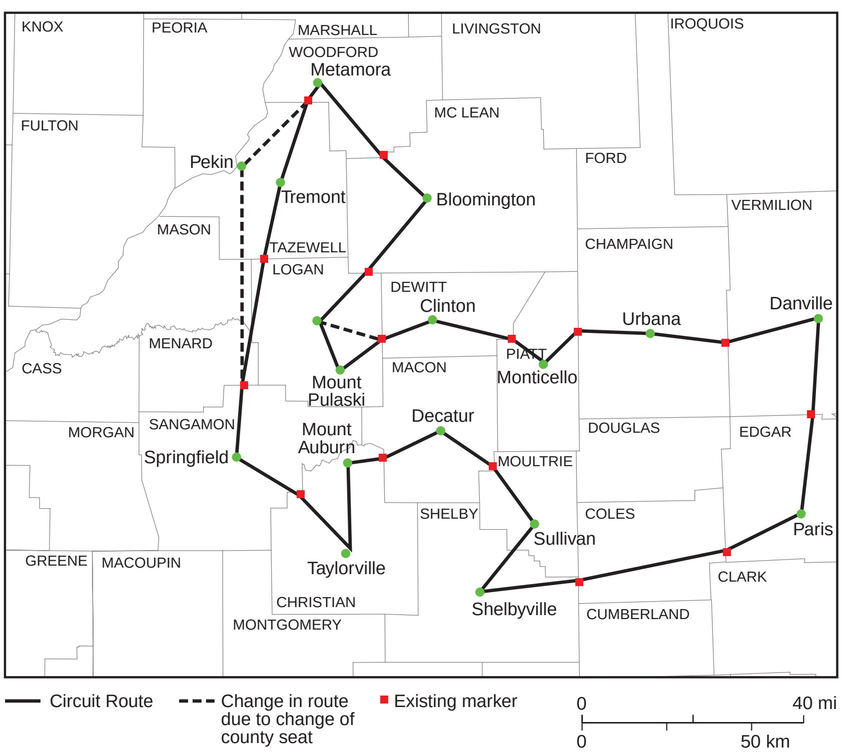

Figure 18 Map of the 8th Judicial Circuit during the1850s showing the general route(s) that Abraham Lincoln traveled to various county courthouses for trials (modified after Fraker 2004).

his companions traversed the circuit by carriage or horseback every fall and spring. Each circuit was a trip of about 400 miles and lasted about three months. Between circuit trips, Lincoln would be in private practice in Springfield. Here, at Wyatt's Ford, Lincoln crossed the Mackinaw River on the way to Bloomington from Metamora, the county seat of Woodford County at that time. Metamora contains one of only two courthouses on the 8th Judicial Circuit that are still standing in its original location.

Wyatt's Ford

A ford is a passage over a natural shallow area in a river or stream, usually at a site where the bed has a firm substrate, such as bedrock or a sand, gravel, or cobble deposit. Wyatt's Ford consists of a series of sand and gravel channel bars that occur at this large, nearly 120-degree bend in the Mackinaw River. For many years, vehicles could regularly cross from one side of the river to the other, except during high water events. During the last decade or so, someone excavated a large portion of the ford on the north side of the river to prevent vehicles from crossing the river. There is, however, enough of the ford remaining that one can readily walk across the river using the channel bars that are just downstream of the excavated area.

This is an unusual site for a ford composed of channel bars. In most streams, the flow around bends is strongest on the outside of the curve (south side at this stop) and weakest on the inside (north side). Because the maximum velocity occurs on the outer side, the outer bank is generally the site of erosion. Conversely, the inner side of the curve is often the site of deposition, usually in the form of a point bar. At this site, however, the point bars extend all the way across the channel, in part because the gradient of the Mackinaw River is so low that the flow velocities are rarely strong enough to move (by erosion and re-deposition) the sand and gravel channel bars, including the bars on the outside of the curve. The source of the sediment can be seen by looking just upstream from the ford to the intersection with Vincent Run. The channel slope for the tributaries that flow into Vincent Run is about 0.01 (100 vertical feet per 10,000 horizontal feet); the Mackinaw channel slope is about 0.001 (10 vertical feet per 10,000 horizontal feet), one-tenth of the former. Thus, seasonal flooding and summer flash floods in the Vincent Run watershed, and perhaps in the Denman Creek watershed (which joins the Mackinaw about one-fifth of a mile upstream), have flow velocities that are strong enough to erode and transport sand and gravel from the streambeds down to the Mackinaw River. Once these sediments reach the Mackinaw River streambed, velocities are no longer strong enough to transport them, and the sediments are deposited as channel bars. Over time, the excavated area of the ford will likely be reoccupied by newly deposited channel bars as this process slowly continues.

STOP 3 (optional): View of the Bloomington Moraine (SE corner, NE¼, SE¼, SW¼, Sec. 20, T25N, R1E, Danvers 7.5-minute Quadrangle, McLean County).

Stop 3 is at the crest of the Eureka Moraine at a surface elevation of just over 850 feet above mean sea level. The moraine is named for the town of Eureka, located about 10 miles to the northwest. The highest part of the moraine in the field trip area (higher than 880 feet) is about 3 to 7 miles to the southeast. The crest generally has a relief of 50 to 60 feet above the face (front) of the Eureka Moraine. To the northwest of this stop, relief ranges from slightly more than 60 feet to nearly 100 feet, because the Eureka Moraine has overridden the underlying Normal Moraine. The Eureka Moraine is about 100 miles long and ranges from 1 to 3 miles wide (Figures 11 and 16).

About 6 miles to the south and southwest is the crest of the slightly older Bloomington Moraine, named for the city of Bloomington. The crest elevation is slightly more than 880 feet, about the same as that of the Eureka Moraine. Like many early settlements, the village of Danvers is located on a local ridge—the crest of the Bloomington Moraine, about 5.5 miles to the southwest. The Bloomington Moraine is one of the state's most conspicuous moraines, about 188 miles long and about 1 to 12 miles wide.

The crest of the Eureka Moraine is also a drainage divide between adjacent smaller watersheds or drainage basins. To the northeast, the streams flow directly into the Mackinaw River. To the southwest, the streams drain off the front of the moraine into tributaries of Rock Creek, which in turn flows into the Mackinaw to the west.

STOP 4: Carlock Park (Lunch) (SE¼, NE¼, SW¼, Sec. 32, T25N, R1E, Danvers 7.5-minute Quadrangle, McLean County).

STOP 5: Rock Creek Exposure (S½, NW¼, NE¼, NW¼, Sec. 32, T25N, R1W, Danvers 7.5-minute Quadrangle, McLean County).

The Danvers section is an excellent exposure of strata deposited during the Illinois and Wisconsin Episodes. At the bottom of the exposure and just above the creek is the Radnor Till Member of the Glasford Formation (Illinois Episode). The till is oxidized (tan) and partially leached of calcite (slow reaction with dilute hydrochloric acid). The dark-colored pendants and columns are organic materials washed down into cracks in the till from the overlying Berry Clay Member of the Glasford. The Radnor Till was deposited under the glacial ice of a lobe that extended as far south as Springfield and as far west as Farmington about 135,000 years ago during the Illinois Episode glaciation. Sometime after the glacier melted back, slope wash derived from the till and windblown silt (loess) accumulated in low marshy areas as the Berry Clay. Subsequently the Sangamon Geosol was developed on and through the Berry Clay and Radnor Till. A geosol is a laterally traceable geologic weathering profile that generally is indicative of an ancient soil horizon. Because the Berry Clay environment was swampy, the iron in this clay-rich B soil horizon was reduced, resulting in the unit's blue and green hues. The Sangamon Geosol is overlain by wetland deposits of the Robein Silt and the wind-transported and deposited silts and clays of the Roxana Silt and Morton Silt.

During the Wisconsin Episode, the glacier again advanced into the area and deposited the Delavan Till Member and the overlying "pinkish" undifferentiated Tiskilwa Formation of the Wedron Group. These tills are separated by a sand and gravel unit deposited from meltwater streams. The Wedron Group is thin here because almost 80 feet of the Tiskilwa Till was removed during the early development of Rock Creek. This early valley was about 1,000 feet wide. During a slight glacial readvance that formed the Eureka Moraine, the Mackinaw River formed an ice marginal stream along the moraine and cut down through the tills of the Bloomington Moraine. The Mackinaw River set a new and lower base level for the area, and Rock Creek rapidly downcut about 40 feet and cut back 3 miles to the east-northeast. During the downcutting, Rock Creek eventually encountered and captured a northwesterly flowing stream trapped between the Bloomington Moraine and Normal Moraine (both end moraines). The capture point was at the south edge of Congerville, prior to the construction of Interstate 74. When the interstate was built, Rock Creek was diverted through an artificial channel just south of the highway.

This section at Rock Creek provides information that is used to interpret the glacial stratigraphy and buried landscape. Most of the water wells (Figure 19) drilled in the area encountered drift, peat, wood, and green clay that marks the short interval between the top of the Radnor Till of the Glasford Formation and the Tiskilwa Formation of the Wedron Group.

STOP 6 (optional): Overview of the Mackinaw River Valley (NW¼, SE¼, NW¼, Sec. 1, T24N, R2W, Mackinaw 7.5-minute Quadrangle, Tazewell County).

The present-day Mackinaw River valley is an underfit stream, meaning that the modern river is too small to have eroded such a wide valley. The valley was instead formed by the massive amounts of sediment-rich, glacial meltwater that were present as the glacier receded from the area. During this time, it was likely that the entire valley was a braided stream complex.

Braided streams are characteristic of fluvial systems where water flow is episodic and the sediment load is very high. The name originates from the fact that the stream flows in several small channels, resembling the strands of a braid. The channel locations are almost constantly changing because of obstructions caused by the stream-deposited sediment. Because of the channel

Page 1 **ILLINOIS STATE GEOLOGICAL SURVEY**

Water Well		Top	Bottom
brown clay		0	1
yellow clay	Tiskilwa Formation Wedron Group	1	18
blue clay		18	40
blue clay-very soft & sandy		40	47
blue clay		47	58
blue clay--very sandy		58	61
blue clay--some sand		61	83
brown clay--very soft		83	92
green clay--very soft		92	102
blue clay--hard sandy	Radnor Till Member Glasford Formation	102	119
gray water sand--very fine & silty		119	121
fine/coarse sand--some fine gravel		121	124
blue clay--very sandy		124	144
gray sand--very fine & silty		144	147
blue clay--very silty		147	151
fine/coarse silty sand w/some gravel		151	152
f/crs sty s-some f gravel & clay balls		152	155
fine/coarse sand & gravel		155	157
medium/coarse sand-some gravel		157	164
very tight water sand at		164	164
Total Depth			164

Casing: 4" STANDARD BLACK from 4' to 161'
Screen: 3' of 3.75" diameter 35 slot
Water from sand & gravel at 161' to 164'.
Static level 100' below casing top which is 1' above GL

Permit Date: January 1, 1969 **Permit #:** NF 5515

COMPANY Ebert, Robert H
FARM Preller, R.
DATE DRILLED March 6, 1969 **NO.** 1
ELEVATION 720GL **COUNTY NO.** 00625
LOCATION SE NW SE
LATITUDE 40.592199 **LONGITUDE** -89.237163
COUNTY McLean **API 121130062500** **29 - 25N - 1W**

Figure 19 Strata that are exposed at the Rock Creek section are correlated with the described samples from a nearby water well. The water well is about 0.7 miles to the northeast from the Rock Creek exposure.

movement, water depth tends to be shallow except during maximum flooding events. After the glacier left the area and the climate warmed to conditions similar to the modern climate, the Mackinaw River, with precipitation as the primary water source and with a much smaller sediment load, re-established itself as a meandering river that soon was entrenched into the valley floor.

In this lower part of the middle segment, natural levees (measured in inches) are common; constructed levees (measured in feet) begin to appear near the junction with Rock Creek (between Stops 5 and 6). Where man-made levees occur, the river is usually hydraulically disconnected from the floodplain. These floodplains typically have large fields of row crops. Riparian trees thus tend to occur only as a thin band along the river banks. The banks are composed of silty alluvium, but the clay fraction is less than it was upstream. Short sections of the stream indicate some lateral channel movement. The streambed is dominated by sand and gravel, and gravel and cobble deposits are common. However, the river slope is shallow, and materials larger than coarse gravel do not move very far. These gravel deposits are generally in the form of well-developed point and midchannel bars. Near the lower end of the middle segment, near Interstate 55, the first major channelization of the river occurs.

STOP 7: Lowery Sand and Gravel Pit, Townline Road (NW¼, NE¼, NW¼, Sec. 3, T23N, R3W, Hopedale 7.5-minute Quadrangle, Tazewell County).

At Stop 7, we will examine the sedimentary structures that are revealed in the walls of the pit. These structures formed either contemporaneously with deposition (primary) or by sedimentary processes after deposition (secondary).

At this site we will examine a primary sedimentary structure, the layering within a Pleistocene outwash deposit (Figure 20). These structures and other sediment characteristics are used to interpret the environment of deposition for these strata. The layering (or stratification) is caused by changes in the size of the sediments; some layers contain gravel and cobbles, and other layers are dominated by sand-sized grains. This pattern indicates that the sediments were deposited in an environment in which the water flow rate fluctuated greatly or was seasonally episodic. The sediment in many of the layers is poorly sorted (Figure 21) and consists of many grain sizes. This variation also indicates that the water flow rate varied and tended to be very episodic (i.e., very rapid flow followed by very low flow). Closer examination of the coarser sediments (sand, gravel, pebbles, and cobbles) reveals that they are fragments of various rock types (lithologies), such as granite and quartzite, which are not known to occur in Illinois near or at the surface but are common in outcrops in Wisconsin, Michigan, or central Canada. The shapes of these rocks ranges from subangular to well-rounded. The study of modern rivers indicates that sediments (fluvial) that have traveled hundreds of miles tend to be dominated by well-rounded, sand-size grains; thus, at least the coarser sediments at this location were not transported long distances by fluvial processes.

Figure 20 View of the wall at Lowery Sand and Gravel Pit on Townline Road. The layers in the strata are interpreted to be caused by variations in the rate of the water flow. Note that boundaries between the layers are not well defined. (Photograph by W.T. Frankie.)

How were they deposited? The lithologies indicate that the sediments were transported for hundreds of miles, but the sorting and grain size indicate that they were not transported by water over this distance. Note that some of the larger cobbles have faceted or beveled faces, indicating they were shaped as they were transported by the glacier. As the glacier moved, the rocks were rubbed against each other or were dragged against the underlying bedrock, which rounded corners and beveled the sides into smooth surfaces. Some of the cobbles are striated, which is another characteristic of transportation by glaciers. A logical answer to the question of deposition is that these sediments first were transported by glacial ice from the northeast to Tazewell County or a nearby site. As the glacier receded and melted, the meltwater eroded and retransported the glacial sediments (mostly glacial till). At times, large amounts of water and glacial sediment would have flowed from the glacier southward and through breaches in the moraines. This type of deposit is known as glacial outwash. At times, the flow was fast enough to move gravel and cobbles, while at other times the meltwater flow was just fast enough to transport the finest sediments (clay) from the area. The fluctuation in flow was probably caused by seasonal changes in the melting rate of the glacier. At the front of modern glacier, outwash is deposited by braided stream systems. Braided streams consist of anastomosing (branching and rejoining) channels that are separated by numerous, ephemeral (short-lived) bars. The flow rate is characteristically episodic, the water depth is often shallow, and the stream channel is relatively wide. Thus, it is likely that these sediments at this stop were transported by glacial meltwater in a very wide channel (the entire river valley) in which large amounts of materials were moved seasonally during episodic floods.

Figure 21 Close-up view of a coarser-grained layer at Lowery Sand and Gravel Pit on Townline Road. The deposit is very poorly sorted (grain sizes are extremely variable) and consists of various lithologies, indicating that this material was deposited during very episodic water flow. (Photograph by W.T. Frankie.)

We will not visit a site within the lowermost segment of the Mackinaw River valley, but Stop 7 in the lower portion of the middle segment has many similarities to the lower segment. In the lower segment, the Mackinaw River has large meanders (greater sinuosity) and very sandy banks. The main reason the banks are sandy is that the river is flowing through unconsolidated floodplain and glacial outwash deposits which contain a high percentage of erodible sand. Because the bank materials are dominated by erodible sand, the lateral stability of the channels has decreased. Most of this section has been channelized, and man-made levees are present almost everywhere. The river bed is dominated by sand, with gravel and cobbles, and the river typically contains large sand bars. Riparian forests tend to occur where the channel migration has caused the land to be unfarmable.

STOP 8: Lowery Sand and Gravel Pit, Hild Road (SW¼, NW¼, NW¼, Sec. 9, T24N, R2W, Mackinaw 7.5-minute Quadrangle, Tazewell County).

Stop 8 affords us an opportunity to examine and collect a large number of different types of rocks that were deposited in the outwash deposits being mined at this pit. There are many different types of igneous and metamorphic rocks that were undoubtedly brought to the area from the north by Wisconsin Episode glaciation and that were eventually deposited as outwash sediments as the glacier melted. Additionally, some rocks were picked up by the glacier in northern Illinois and transported here, including Pennsylvanian limestone, coal, and black shale and Silurian dolomite. Rocks found in the sand and gravel deposits along the Illinois River to the west (Hunter 1966) include dolomite, limestone, chert, shale, sandstone, siltstone, ironstone concretions, gabbro, granite, rhyolite, quartzite, gneiss, schist, graywacke, and coal.

We can also examine the equipment utilized in this sand and gravel operation. There are a number of pieces of equipment that allow the company to sort the sediments into the precise sizes they need in order to meet product specifications of their customers. You may have never thought about how that gravel in your driveway was actually mined and segregated or what the sand in your children's sandbox went through before you purchased it at your local hardware store.

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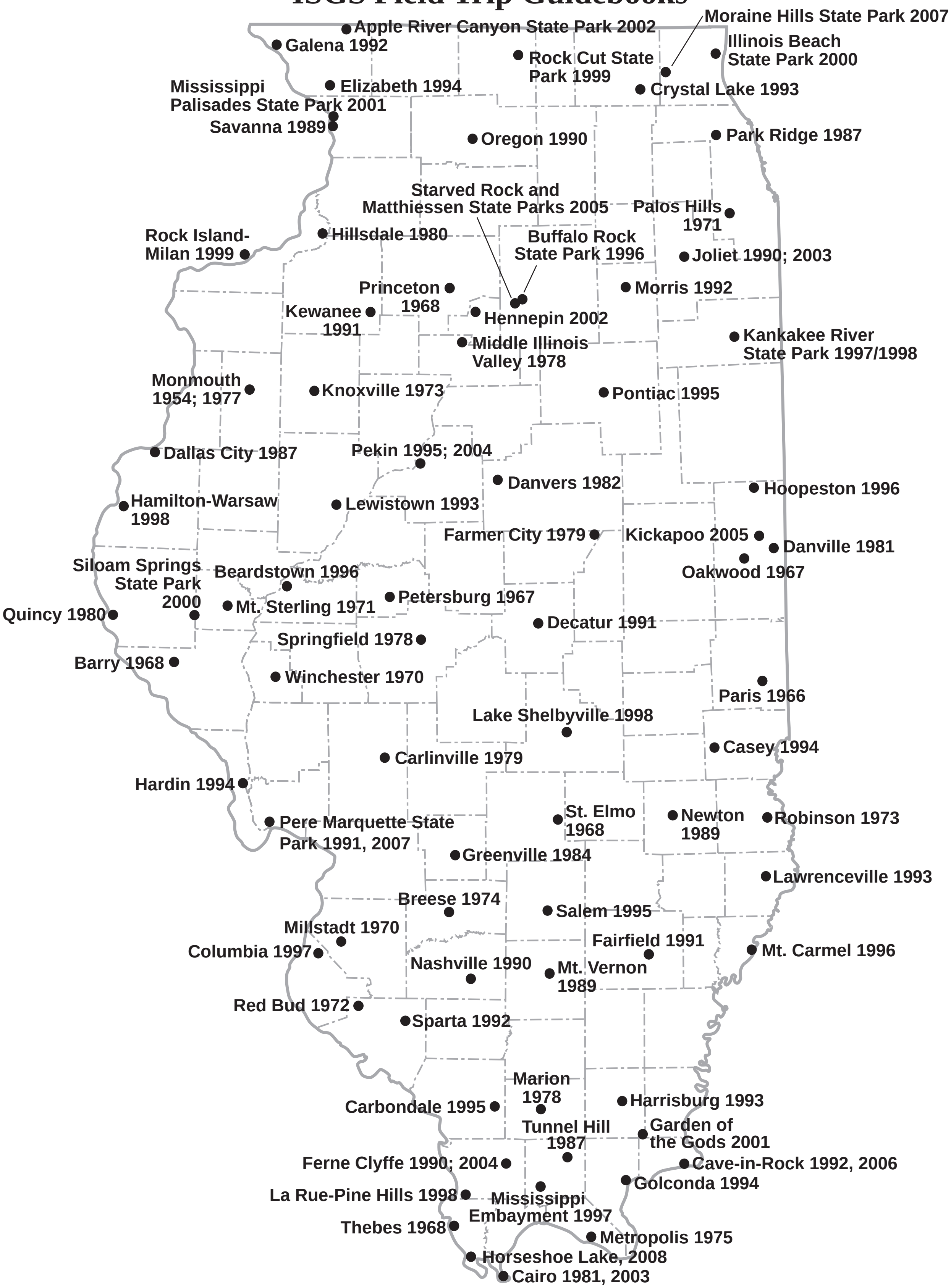

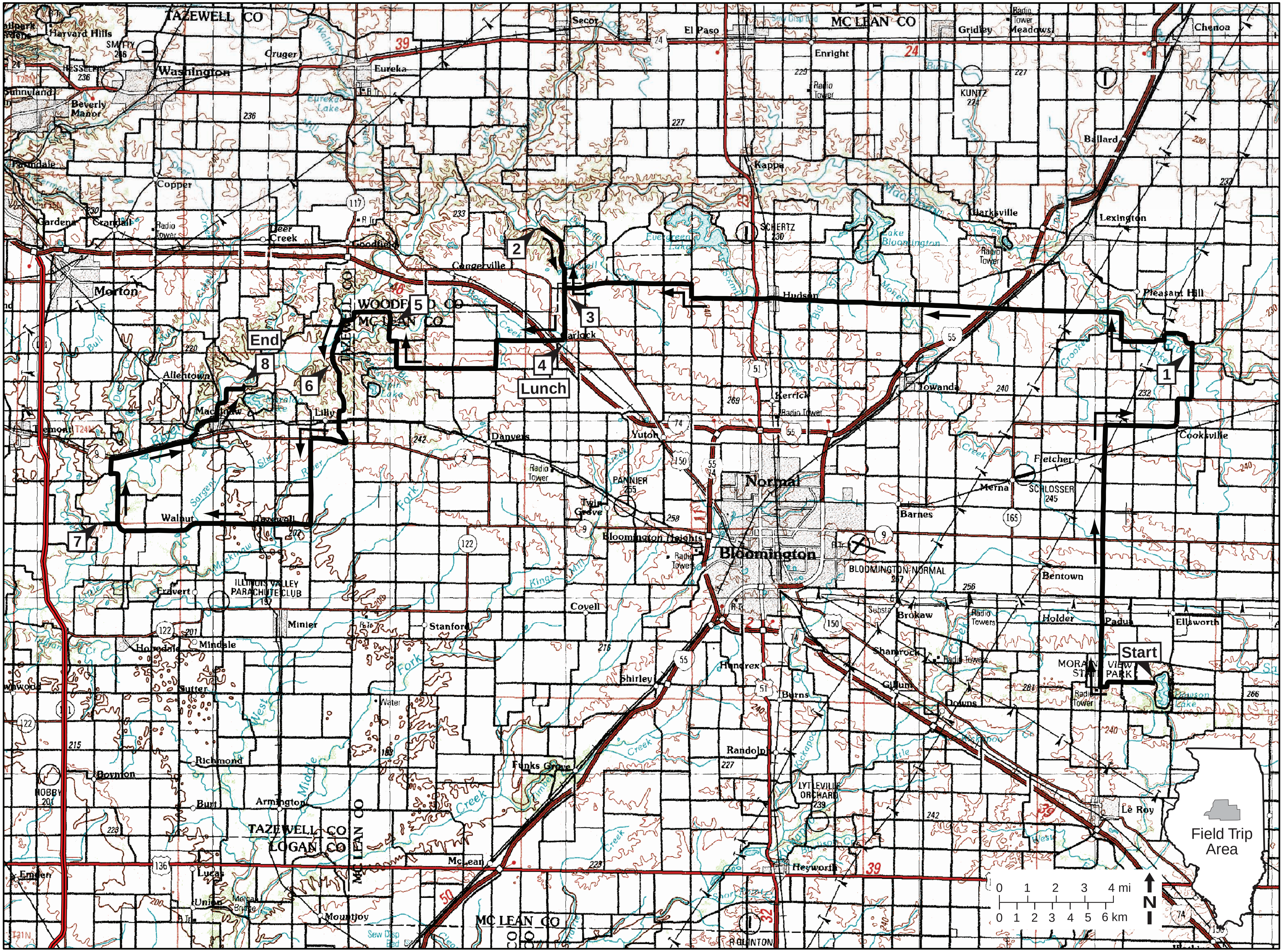

Start
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4
Lunch
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End
Field Trip Area
0 1 2 3 4 mi
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N
TAZEWELL CO
MC LEAN CO
WOODFORD CO
LOGAN CO
Bloomington
Normal
Washington
Morton
Eureka
El Paso
Lexington
Hudson
Towanda
Le Roy
Heyworth
Danvers
Mackinaw
Carlock
Congerville
Chenoa
Gridley
Secor
Minier
Stanford
McLean
Shirley
Downs
Ellsworth
Cooksville
Walnut
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