Guide to the Geology of the La Rue–Pine Hills Area, Jackson and Union Counties, Illinois

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Field Trip Guidebook 1998D
Field Trip Guidebook 1999A

November 7, 1998
April 10, 1999

Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

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Cover photo *Inspiration Point (photo by W.T. Frankie)*

Geological Science Field Trips The Geoscience Education and Outreach unit of the Illinois State Geological Survey (ISGS) conducts four free 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 formed them. 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 preparing earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students.

A list of guidebooks of earlier field trips, useful for planning class tours and private outings, can be obtained by contacting the Geoscience Education and Outreach Unit, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820-6964. Telephone: (217) 244-2427 or 333-4747.

Eight U.S. Geological Survey 7.5-Minute Quadrangle maps (Altenburg, Gorham, Jonesboro, Murphysboro, Pomona, Neelys Landing, Ware, and Wolf Lake) cover this field trip area.

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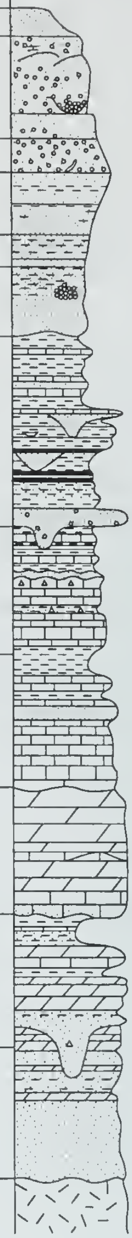
CONTENTS

Era		Period or System and Thickness	Epoch	Age (years ago)	General Types of Rocks
CENOZOIC "Recent Life"	Age of Mammals	Quatemary 0-500'	Holocene	10,000	Recent– alluvium in river valleys
			Pleistocene Glacial Age	1.6 m	Glacial till, glacial outwash, gravel, sand, silt, lake deposits of clay and silt, loess and sand dunes; covers nearly all of state except north-west corner and southem tip
		Tertiary 0-500'	Pliocene	5.3 m – 36.6 m	Chert gravel, present in northern, southem and western Illinois
			Eocene	57.8 m	Mostly micaceous sand with some silt and clay; presently only in southem Illinois
			Paleocene	66.4 m	Mostly clay, little sand; present only in southern Illinois
MESOZOIC "Middle Life"	Age of Reptiles	Cretaceous 0-300'		144 m – 286 m	Mostly sand, some thin beds of clay, and, locally, gravel, present only in southern Illinois
PALEOZOIC "Ancient Life"	Age of Amphibians and Early Plants	Pennsylvanian 0-3,000' ("Coal Measures")		320 m	Largely shale and sandstone with beds of coal, limestone, and clay
		Mississippian 0-3,500'		360 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'		408 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'		438 m	Principally dolomite and limestone
		Ordovician 500-2,000'		505 m	Largely dolomite and limestone but contains sandstone, shale, and siltstone formations
		Cambrian 1,500-3,000'		570 m	Chiefly sandstones with some dolomite and shale; exposed only in small areas in north-central Illinois
		Precambrian			Igneous and metamorhpic rocks; known in Illinois only from deep wells



Generalized geologic column showing succession of rocks in Illinois.

LA RUE–PINE HILLS AREA

The La Rue–Pine Hills Area geological science field trip will acquaint you with the *geology**, landscape, and mineral resources for parts of Jackson and Union Counties, Illinois. The field trip is located in southwestern Illinois in, and adjacent to, the broad Mississippi Valley. This scenic portion of Illinois embraces an area of diverse topography, relief, structure, and geologic history. The starting point for the field trip is the parking lot at the Murphysboro High School. The La Rue–Pine Hills area is approximately 310 miles southwest of Chicago, 150 miles southwest of Springfield, 75 miles south of East St. Louis, and 45 miles north of Cairo.

GEOLOGIC FRAMEWORK

Precambrian Era Through several billion years of geologic time, the area encompassing Jackson and Union Counties 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*. We know relatively little about these rocks from direct observations because they are not exposed at the surface anywhere in Illinois. Only about 35 drill holes have reached deep enough for geologists to collect samples from the Precambrian rocks of Illinois. From these samples, however, we know that these ancient rocks consist mostly of granitic and rhyolitic *igneous*, and possibly *metamorphic*, crystalline rocks formed about 1.5 to 1 billion years ago. From about 1 billion to about 0.6 billion years ago, these Precambrian rocks were exposed at the Earth's surface. During this long period, the rocks were deeply weathered and eroded, and formed a landscape that was probably quite similar to that of the present Missouri Ozarks. We have no rock record in Illinois for the long interval of *weathering* and erosion that lasted from the time the Precambrian rocks were formed until the first Cambrian-age *sediments* accumulated, but that interval 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, they must use other various techniques, such as measurements of Earth's gravitational and magnetic fields, and seismic exploration, to map out the regional characteristics of the basement complex. The evidence indicates that in southernmost Illinois, near what is now the historic Kentucky–Illinois Fluorspar Mining District, *rift* valleys like those in east Africa formed as the movements of crustal plates (plate *tectonics*) began to rip apart the Precambrian North American continent. These rift valleys in the midcontinent region are referred to as the Rough Creek Graben and the Reelfoot Rift (fig. 1).

Paleozoic Era After the beginning of the Paleozoic Era, about 520 million years ago in the late Cambrian Period, the 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. During the 280 million years of the Paleozoic Era, the area that is now called the Illinois Basin continued to accumulate sediments deposited in the shallow seas that repeatedly covered it. The region continued to sink until at least 15,000 feet of sedimentary strata were deposited. At various times during this era, the seas withdrew and the deposits were weathered and eroded. As a result, there are some gaps in the sedimentary record in Illinois.

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). Figure 2 shows the succession

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*Words in italics are defined in the glossary at the back of the guidebook. Also please note: although all present localities have only recently appeared within the geologic time frame, we use the present names of places and geologic features because they provide clear reference points for describing the ancient landscape.

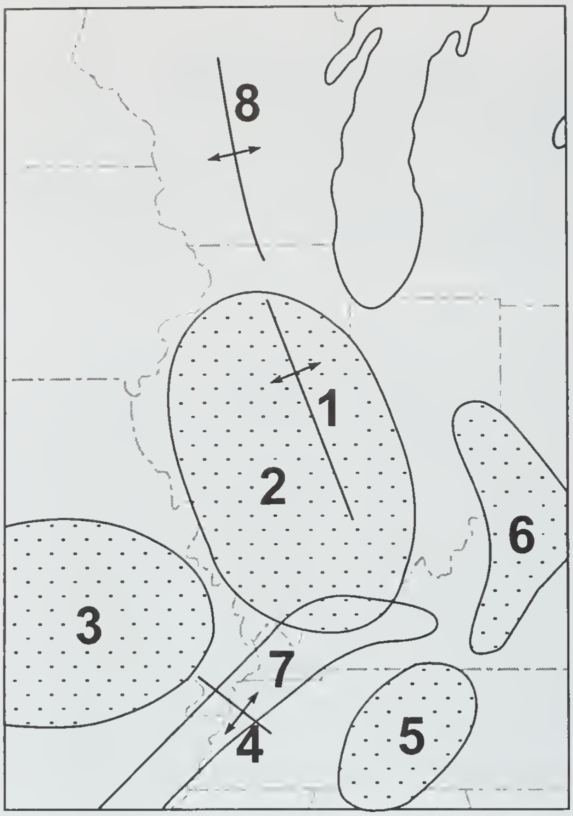


Figure 1 Location of some of the major structures in the Illinois region. (1) La Salle Anticlinorium, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, (7) Rough Creek Graben–Reelfoot Rift, and (8) Wisconsin Arch.

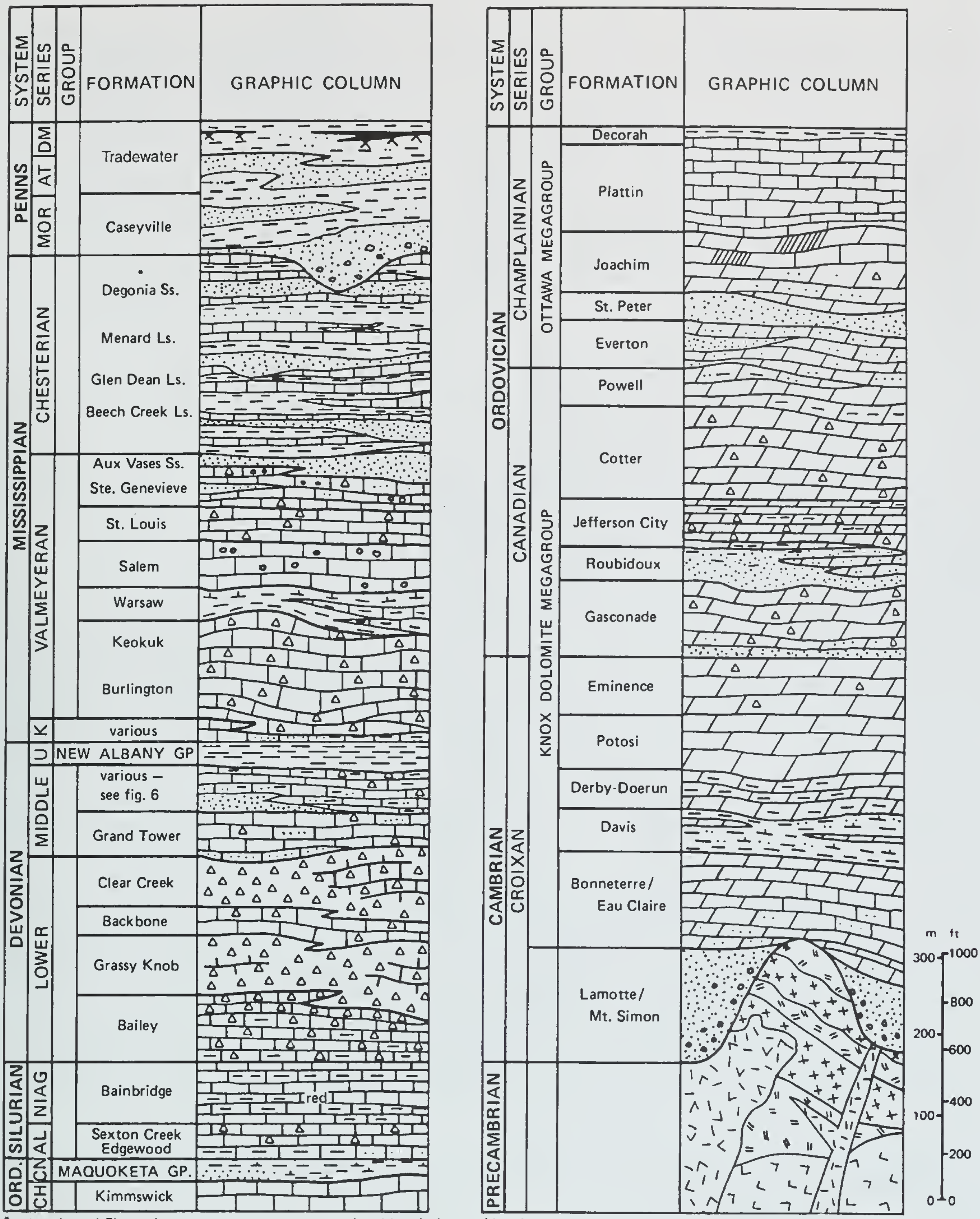
of Paleozoic rock strata a drill bit would penetrate in this area if the rock record were complete and all the *formations* were present. Only Paleozoic rocks of Devonian, Mississippian, and Pennsylvanian age are exposed in the field trip area.

The elevation of the top of the Precambrian basement rocks within the field trip area ranges from 7,000 feet below sea level in western Jackson County to 11,000 feet below sea level in eastern Union County. The thickness of the Paleozoic sedimentary strata deposited on top of the Precambrian basement ranges from about 8,600 feet in central Jackson County to more than 11,500 feet in eastern Union County.

STRUCTURAL AND DEPOSITIONAL HISTORY

As noted previously, the Rough Creek Graben and the Reelfoot Rift (figs. 1 and 3) were formed by tectonic activity that began in the latter part of the Precambrian Era and continued until the Late Cambrian. Toward the end of the Cambrian, rifting ended and the whole region began to subside, allowing shallow seas to cover the land.

Paleozoic Era From the Late Cambrian to the end of the Paleozoic Era, sediments continued to accumulate in the shallow seas that repeatedly covered Illinois and adjacent states. These inland seas connected with the open ocean to the south during much of the Paleozoic, and the area that is now southern Illinois was like an embayment. The southern part of Illinois and adjacent parts of Indiana and Kentucky sank more rapidly than the areas to the north, allowing a greater thickness of sediment to accumulate. During the Paleozoic and Mesozoic Eras, the Earth's thin crust was periodically flexed and warped in places as stresses built up in response to tectonic forces (plate movement and mountain building). These movements caused repeated invasions and withdrawals of the



*only selected Chesterian formations are identified

series abbreviations:

Al – Alexandrian	Cn – Cincinnatian	Mor – Morrowan
At – Atokan	Dm – Desmoinesian	Niag – Niagaran
Ch – Champlainian	K – Kinderhookian	U – Upper Devonian

Figure 2 Generalized stratigraphic column of the Paleozoic rocks in the field trip area. Unconformities are indicated by wavy lines.

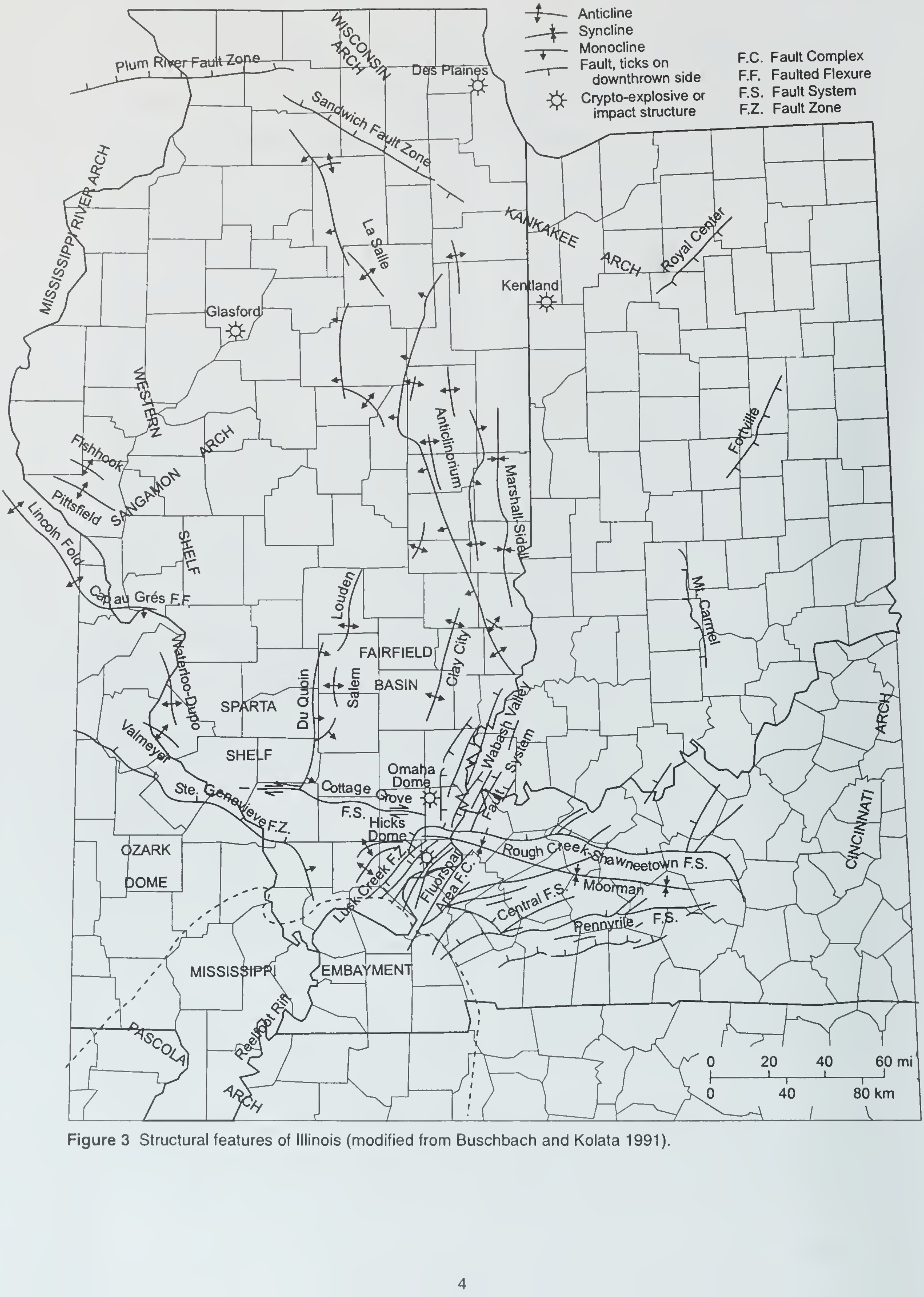


Figure 3 Structural features of Illinois (modified from Buschbach and Kolata 1991).

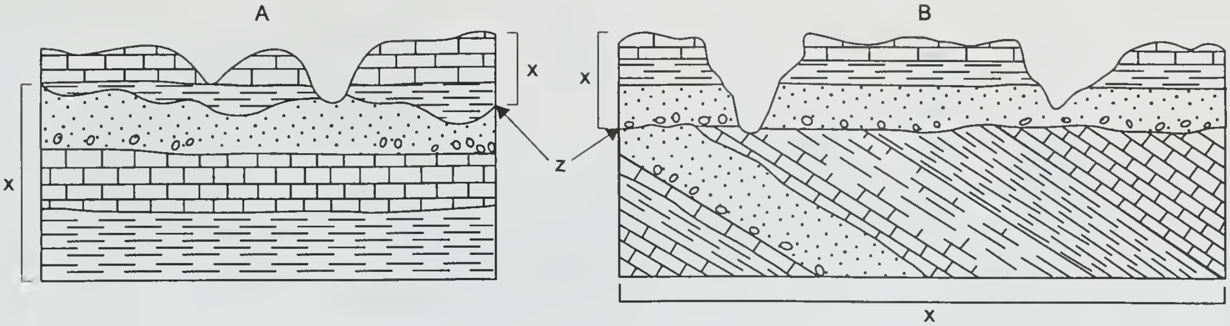


Figure 4 Schematic drawings of (A) a disconformity and (B) an angular unconformity (x represents the conformable rock sequence and z is the plane of unconformity).

seas across the region. The former sea floors were thus periodically exposed to erosion, which removed some sediments from the rock record.

Many of the sedimentary units, called *formations*, have *conformable* contacts—that is, no significant interruption in deposition occurred as one formation was succeeded by another (figs. 2 and 4). 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 however, in some places, the top of the lower formation was at least partially eroded before deposition of the next formation began. In these instances, fossils and other evidence in the two formations indicate that there is a significant age difference between the lower unit and the overlying unit. This type of contact is called an *unconformity* (fig. 4). If the *beds* above and below an unconformity are parallel, the unconformity is called a *disconformity*. However, if the lower beds were tilted and eroded prior to deposition of overlying beds, the contact is called an angular unconformity.

Unconformities occur throughout the Paleozoic rock record and are shown in the generalized stratigraphic column (fig. 2) as wavy lines. Each unconformity represents an extended interval of time for which there is no rock record in this area.

Near the close of the Mississippian Period, gentle arching of the rocks in eastern Illinois initiated the development of the La Salle Anticlinorium (figs. 1 and 3). This is a complex structure having smaller structures such as domes, *anticlines*, and *synclines* superimposed on the broad upwarp of the anticlinorium. Further gradual arching continued through the Pennsylvanian Period. Because the youngest Pennsylvanian strata are absent from the area of the anticlinorium (either because they were not deposited or because they were later eroded away), 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.

Mesozoic Era During the Mesozoic Era, the rise of the Pascola Arch (figs. 1 and 3) in southeastern Missouri and western Tennessee produced a structural barrier that helped form the current shape of the Illinois *Basin* by closing off the embayment and separating it from the open sea to the south. The Illinois Basin is a broad, subsided region covering much of Illinois, southwestern Indiana, and western Kentucky (fig. 1). Development of the Pascola Arch, in conjunction with the earlier sinking of the deeper portion of the basin to the north, gave the basin its present asymmetrical, spoon-shaped configuration (fig. 5). The tectonic uplifting of the Pascola Arch is responsible for the regional northward-dipping nature of the Paleozoic rocks along the southern portion of the Illinois Basin (see fig. 5). This uplifting of the Paleozoic rocks and subsequent erosion created the east–west escarpment of

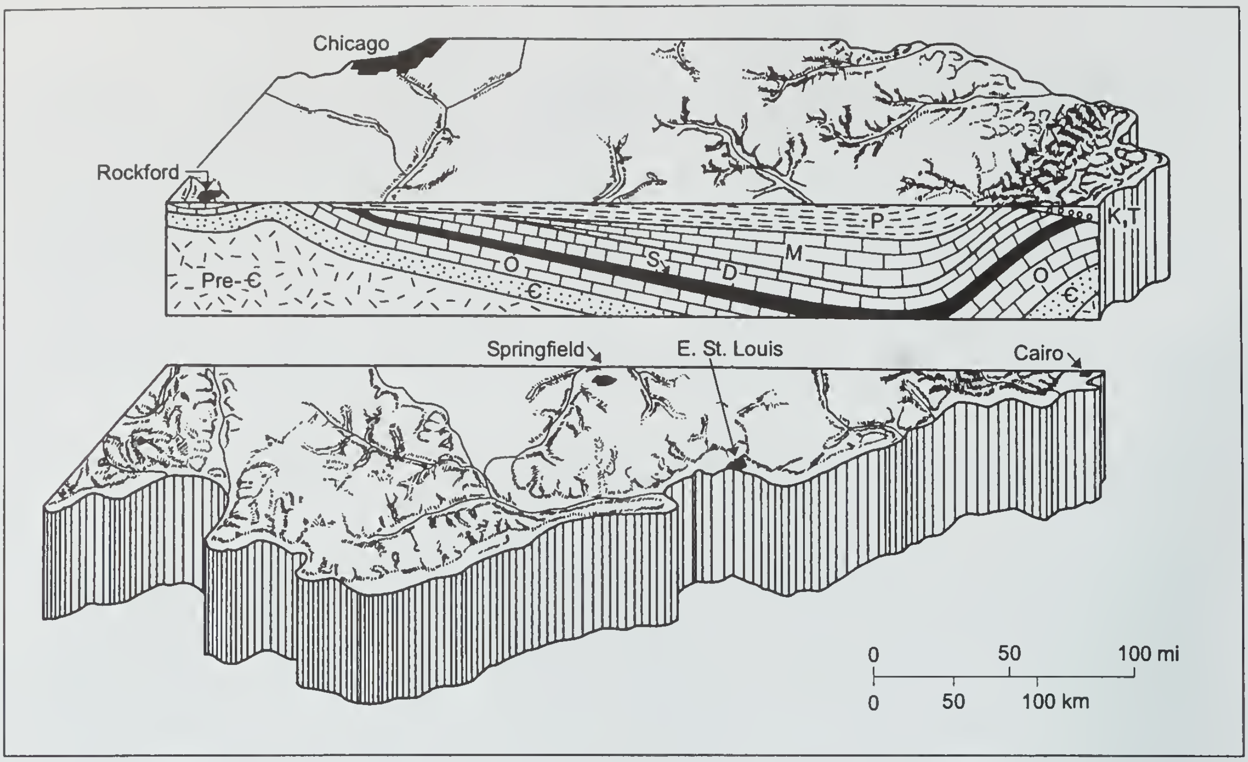


Figure 5 Stylized north–south cross section shows the structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks has been greatly exaggerated and younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-Є) granites. They form a 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.

Mississippian- and Pennsylvanian-age strata in southern Illinois. This escarpment forms the southern edge of the Illinois Basin. South of this escarpment, the deeply eroded Paleozoic rocks are overlain by Cretaceous- and Tertiary-age sediments (fig. 6), which were deposited in an area called the Mississippian Embayment (fig. 3). The geologic map (fig. 6) shows the distribution of the rock *systems* of the various geologic time periods as they would appear if all the glacial, windblown, and surface materials were removed.

Younger rocks of the latest Pennsylvanian Period, and perhaps the Permian (the youngest rock systems of the Paleozoic), may at one time have covered the Devonian strata that are exposed in the southern part of the field trip area. There is a possibility that even younger rocks from the Mesozoic and Cenozoic Eras, which are deposited south of the Mississippian Escarpment (see fig. 6 and generalized geologic column), may have been deposited here. Indirect evidence, based on the stage of development (rank) of coal deposits and the generation and maturation of petroleum from source rocks (Damberger 1971), indicates that perhaps as much as 1.5 miles of additional sedimentary rocks of latest Pennsylvanian age and younger once covered southern Illinois. During the more than 240 million years since the end of the Paleozoic Era (and before the onset of *glaciation* 1 to 2 million years ago), however, 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 north of the Mississippian Embayment were removed.

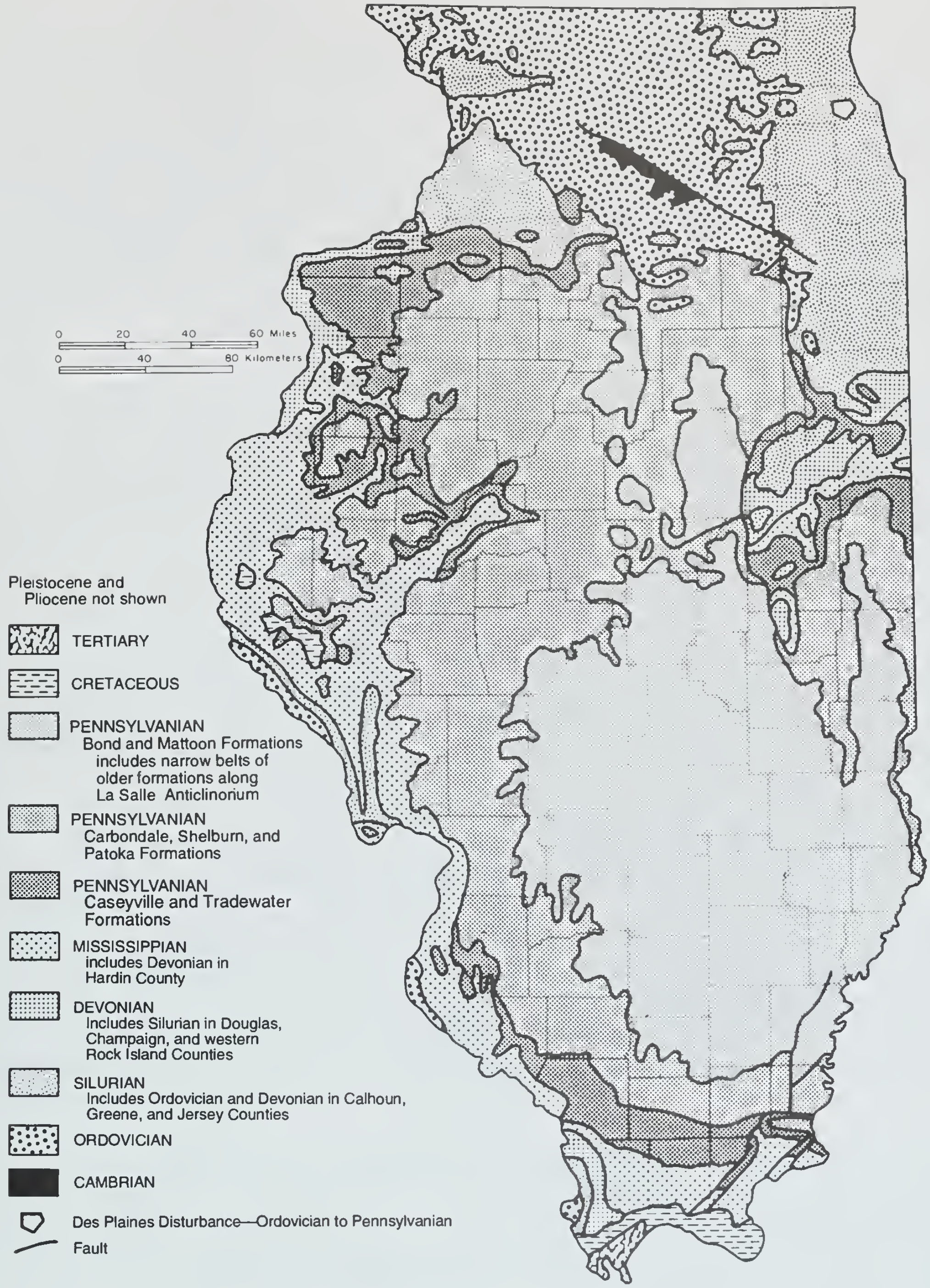


Figure 6 Bedrock geology beneath surficial deposits in Illinois.

During this extended period of erosion, deep valleys were carved into the gently tilted bedrock formations. These valleys are referred to as bedrock valleys (fig. 7). Later, the topographic *relief* was reduced by repeated advances and melting back of continental *glaciers* that scoured and scraped the bedrock surface. This glacial erosion affected all the formations exposed at the bedrock surface in Illinois. The final melting of the glaciers left behind the nonlithified deposits in which our Modern Soil has developed.

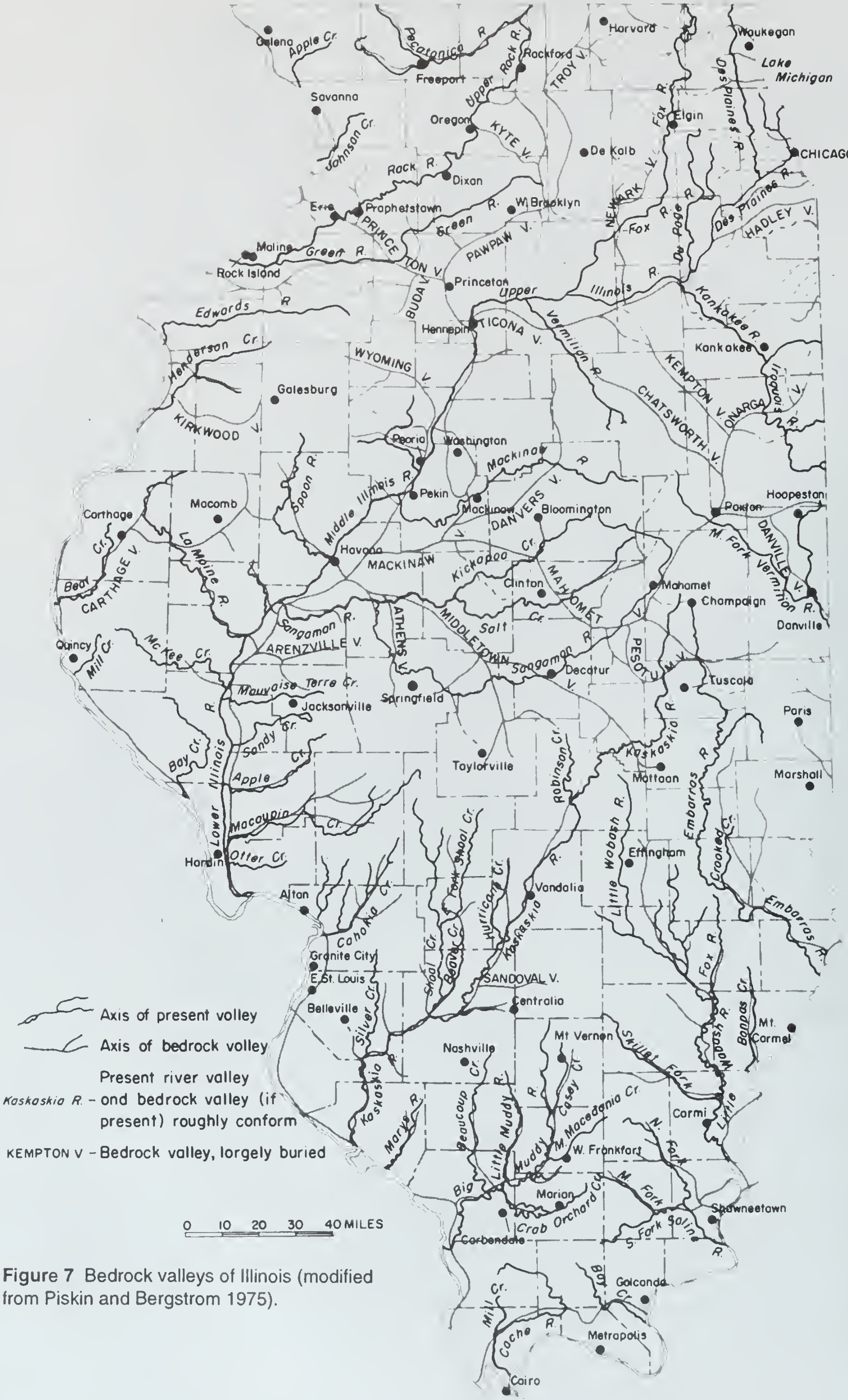


Figure 7 Bedrock valleys of Illinois (modified from Piskin and Bergstrom 1975).

The field trip area is located in one of the parts of southern Illinois where faulting of Paleozoic strata has been extensive (fig. 3) and, as a consequence, stratigraphic relationships of the various rock units are complicated. The major structural feature in the region is the Ste. Genevieve Fault Zone, which begins in Franklin County, Missouri, about 50 miles southwest of St. Louis, and extends southeastward across the northeastern flank of the Ozark Dome (fig. 3) into Illinois where it dies out in Union County, a distance of about 120 miles. The Ste. Genevieve Fault Zone marks in part the boundary between the Ozark Dome and the Illinois Basin. Nelson and Lumm (1985) report as much as 3,000 feet of downward displacement to the northeast along a sharp monoclinal flexure or fold (strata dip or flex from the horizontal in one direction only). This flexure is cut by one or more high-angle reverse faults (fig. 8). Smaller high-angle normal and reverse faults are found on both sides of the main zone. At both ends, the Ste. Genevieve Fault Zone dies out into a monocline.

The main fault of the Ste. Genevieve Fault Zone in Illinois is the Rattlesnake Ferry Fault, which actually is a faulted flexure or monocline. Vertical displacement along this structure locally exceeds 3,000 feet, with a maximum of 1,200 to 1,400 due to faulting; the remainder is the result of monoclinal flexure. Strata are down thrown to the northeast side. Exposures along this fault show Lower Devonian Clear Creek Chert thrust up against Lower Mississippian Ste. Genevieve Limestone. The Rattlesnake Ferry Fault is not a single fault, but consists of a disturbed zone ranging from about 100 feet to nearly 1.5 miles wide. Although the fault plane is not actually exposed, its approximate position can be found in various exposures near the Big Muddy River and by looking at the linear alignment of drainage patterns on the Wolf Lake 7.5-Minute Quadrangle map (see route maps). A striking difference exists between the topography developed on the Mississippian and Pennsylvanian rocks northeast of the fault and that developed on the Devonian Clear Creek Chert on the southwest side where a more closely-spaced stream pattern has developed.

Nelson and Lumm (1985) have noted two periods of faulting along the Ste. Genevieve Fault Zone. The first was in late Middle Devonian time, and the second ran from latest Mississippian through early Pennsylvanian time, with possible minor post-Pennsylvanian movement.

Cenozoic Era: Glacial History As stated above, erosion that took place long before the glaciers advanced across the state left a network of deep valleys carved into the bedrock surface. As glaciation began, the streams probably stopped eroding and began to aggrade. That is, their channels began to build up and fill in because the streams did not have sufficient volumes of water to carry and move the increased volumes of sediment. These ancient stream valleys were completely filled by the outwash from later glaciations.

During the Pleistocene *Epoch*, beginning about 1.6 million years ago, massive sheets of ice (called continental glaciers) built up to thousands of feet thick and flowed slowly southward from Canada. During the Illinois Episode, which began around 300,000 years before the present (B.P.), North American continental glaciers reached their southernmost position, approximately 30 miles east of the field trip area, in the northern part of Johnson County (fig. 9). The glaciers advanced to within less than 6 miles north of Grand Tower in Jackson County. The last of these glaciers retreated (melted) from northeastern Illinois about 13,500 years B.P. The maximum thickness of these later Wisconsin Episode glaciers in Illinois was about 2,000 feet in the Lake Michigan Basin, but the ice was only about 700 feet thick over most of Illinois' land surface (Clark et al. 1988).

The *topography* of the bedrock surface throughout much of Illinois is largely hidden by glacial deposits, except along the major streams. In many areas, the glacial drift is thick enough to completely mask the underlying bedrock surface. Studies of mine shafts, water-well logs, and other drill-hole

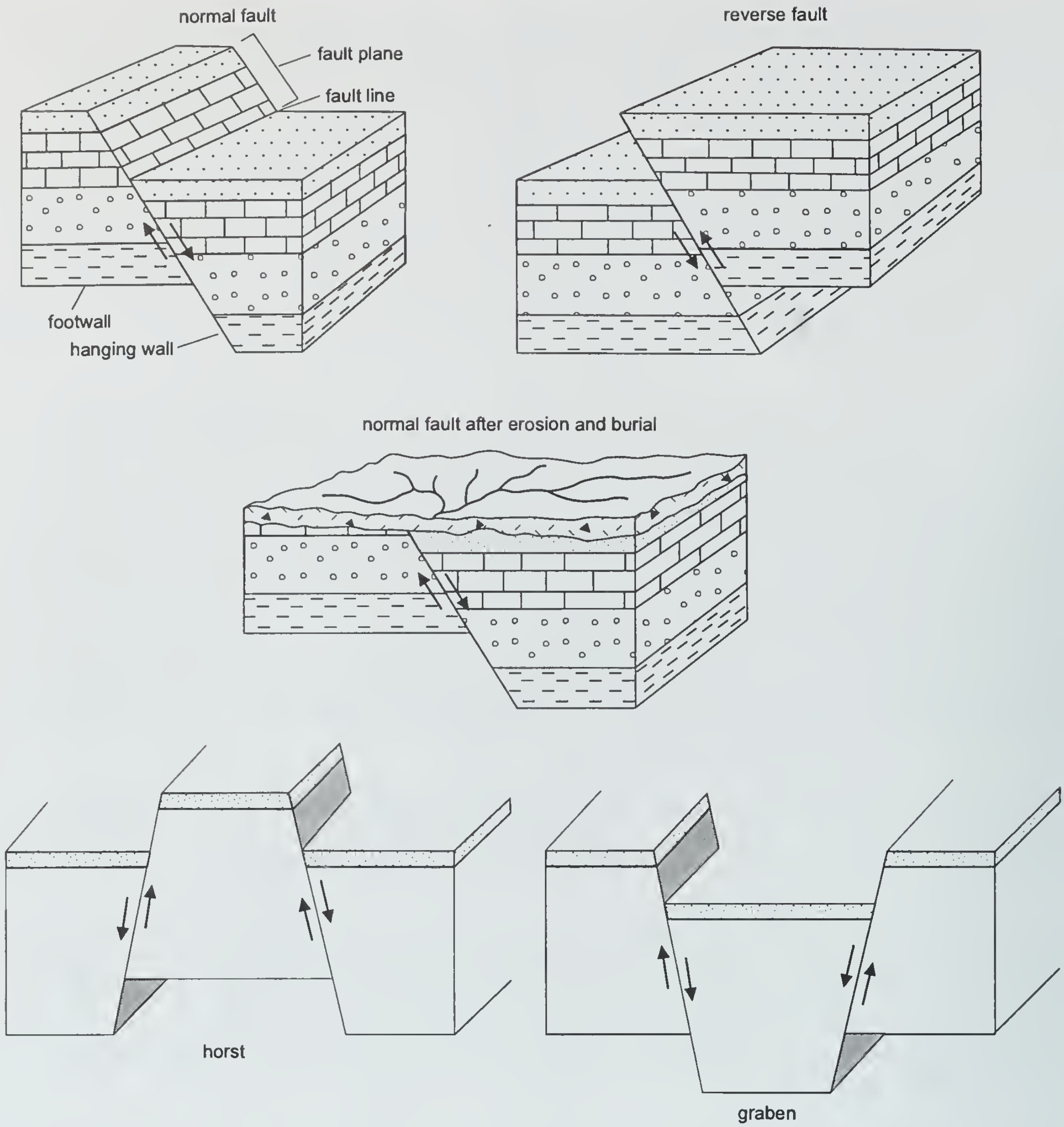


Figure 8 Diagrammatic illustrations of fault types that may be present in the field trip area (arrows indicate relative directions of movement on each side of the fault).

information, in addition to the scattered bedrock exposures in some stream valleys and roadcuts, show that the present land surface in the areas of Illinois where the glacial deposits are thickest does not reflect the underlying bedrock surface. The topography of the preglacial surface has been significantly modified by glacial erosion and subdued by glacial deposits.

Although the Illinois Episode glaciers probably built morainic ridges similar to those formed by the later Wisconsin Episode glaciers, the Illinois Episode *moraines* apparently were not as numerous and have been exposed to weathering and erosion for approximately 280,000 years longer than

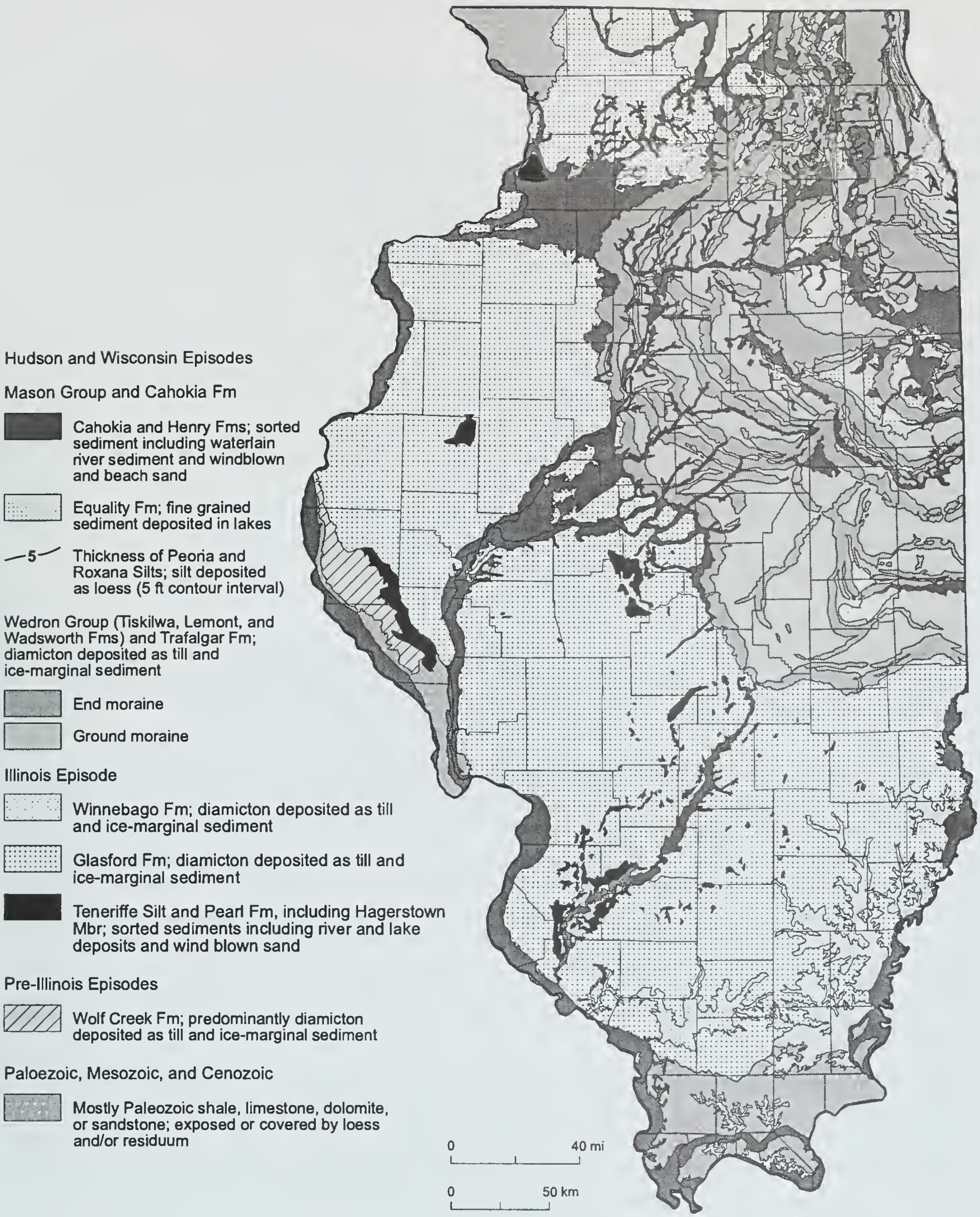


Figure 9 Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

their younger counterparts. For these reasons, Illinoian glacial features generally are not as conspicuous as the younger Wisconsinan features.

Overlying the glacial deposits is a thin cover of windblown silt called *loess* (pronounced "luss"). These sediments were deposited by the wind during all of the glacial episodes, from the earliest pre-Illinois Glacial Episode (approximately 1.6 million years ago) to the last glacial episode, the Wisconsin Episode (which occurred approximately 25,000 to 12,500 years ago). These loess deposits mantle the bedrock throughout the field trip area. Although thicknesses as great as 50 feet are known along the Mississippi Valley, in this area the loess is locally somewhat more than 15 feet thick. Loess deposits of both Illinoian and Wisconsinan ages are present in the area.

Although glacial till deposited directly by the ice is not found within the La Rue–Pine Hills area, other materials called "outwash" (composed of silt, sand, and gravel) were deposited by sediment-laden meltwater streams pouring away from the ice fronts during both advance and waning of the thick masses of ice. Major river valleys, such as the Mississippi Valley and the Big Muddy Valley, were the main channels for the escaping meltwaters and thus were greatly widened and deepened during times of greatest flood. During times of decreased meltwater flow, the valleys became filled and choked with outwash called "valley trains" far beyond the ice margins. Outwash deposits in the Mississippi Valley here are well in excess of 200 feet thick. About 13,000 years ago, near the end of the last glacial episode in Illinois (the Wisconsin), a great meltwater flood poured down the major river valleys and caused major changes in their channels.

GEOMORPHOLOGY

Physiography The field trip area is located along the boundary between two prominent physiographic provinces (fig. 10). These include the Shawnee Hills Section of the Interior Low Plateaus Province and the Salem Plateau Section of the Ozark Plateaus Province (fig.10).

The Shawnee Hills, also known as the "Illinois Ozarks," encompasses a region extending northward from the overlapping Coastal Plain sediments in extreme southern Illinois to slightly north of the southern limit of Illinoian glaciation and westward to the Salem Plateau Section. This region, which is situated along the southern rim of the Illinois Basin (figs. 1 and 3), is a complex dissected upland that is underlain by Pennsylvanian and Mississippian bedrock strata of varied geology (fig. 6). The northern part of the section is comprised of the Pennsylvanian escarpment, a steep, south-facing, asymmetric ridge or cuesta ("kwesta") composed largely of resistant sandstones. This ridge extends southeastward for more than 70 miles from the Big Muddy River to the confluence of the Saline and Ohio Rivers. The southern part of the section is a dissected plateau largely underlain by Chesterian (Mississippian) strata.

The Salem Plateau Section forms the eastern edge of the Ozark Dome, an extensive upland in southern Missouri and northern Arkansas (fig. 3). The Illinois part of the Salem Plateau Section is composed of maturely dissected, partially truncated cuestas that dip to the east and northeast. The whole of the Salem Plateau in the field trip area is mainly underlain by a thick succession of deeply weathered Devonian chert and siliceous limestone formations. Uplands are well dissected with steep slopes and numerous narrow, deep ravines that have steep gradients. The topography is much more rugged than in the Shawnee Hills Section. The Ste. Genevieve Fault Zone marks the boundary in Illinois between the Ozark Plateaus Province and the Interior Low Plateaus Provide (figs. 3 and 10).

Figure 10 Physiographic divisions of Illinois.

As noted previously, the land surface had been extensively eroded prior to glaciation. Within the field trip area, erosion into the relatively weak rocks of Pennsylvanian age formed the Ancient Big Muddy Bedrock Valley. As glaciation began, streams probably changed from erosion to aggradation; that is, their channels began to build up and fill in because the streams did not have sufficient volumes of water to carry and move the increased volumes of sediment (a process called alluviation). To date, no evidence indicates the early fills in these preglacial valleys were ever completely flushed out of their channels by succeeding glacial meltwater torrents.

Drainage Within the field trip area, drainage is controlled by the Big Muddy River and the Mississippi River and their tributaries. Some of the drainage patterns exhibited by the smaller tributaries are structurally controlled by faulting.

Relief The highest land surface along the field trip route is located at Government Rock in Pine Hills near Stop 2, where the surface elevation is 831 feet above mean sea level (msl). The lowest elevation encountered on the field trip is located at Grand Tower along the Mississippi River at Stop 5, where the elevation is 340 feet above msl. The surface relief of the field trip area, calculated as the difference between the highest and lowest points, is 491 feet. *Local relief* is most pronounced adjacent to Fountain Bluff and along the Pine Hill bluffs adjacent to the La Rue Swamp, where the Ancient Mississippi River has cut down (eroded) through the bedrock forming the large Mississippi Valley.

NATURAL RESOURCES

Mineral production Of the 102 counties in Illinois, 98 reported *mineral* production during 1995, the last year for which complete records are available. The total value of all minerals extracted, processed, and manufactured in Illinois during 1995 was $2,202,300,000, which is 10.9% lower than the 1994 total. Minerals extracted accounted for 87.6% of this total; processed crude minerals and manufactured minerals accounted for the remaining 12.4%. Coal continued to be the leading commodity, accounting for 64% of the total. Illinois is the fifth largest producer of coal in the nation, and is ranked 13th among the 31 oil-producing states and 16th among the 50 states in total production of nonfuel minerals, but it leads all other states in the production of sand and gravel, industrial sand, and tripoli (microcrystalline silica).

Jackson County ranked 59th and Union County ranked 53rd among all Illinois counties in 1992 on the basis of the value of all minerals extracted, processed, and manufactured. Economic minerals currently mined in Jackson County include sand and gravel, stone, and crude oil, and those in Union County include stone.

Oil production in Jackson County in 1992 totaled 2,000 barrels, and cumulative oil production equaled 115,000 barrels. Although no coal is currently being mined in Jackson County, cumulative coal production equals 60,531,911 tons.

Groundwater Groundwater is a mineral resource frequently overlooked in assessments of an area's natural resource potential. The availability of this mineral resource is essential for orderly economic and community development. More than 35% of the state's 11.5 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 glacial outwash valley train deposits occur in this area along the Big Muddy River and the Mississippi River, the sand and gravel deposits are a significant source of groundwater.

GUIDE TO THE ROUTE

We'll start the trip at the Murphysboro High School (home of the Red Devils). The high school is located in the southeast quarter of Sec. 32, T8S, R2W, 3rd PM, Jackson County, Murphysboro 7.5-Minute Quadrangle. Mileage will start at the east end of the parking lot.

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.

Private property 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!

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.

Eight USGS 7.5-Minute Quadrangle maps (Altenburg, Gorham, Jonesboro, Murphysboro, Pomona, Neelys Landing, Ware, and Wolf Lake) provide coverage for this field trip area.

Miles from last point	Miles from start	
0.0	0.0	Exit parking lot of Murphysboro High School, heading east.
0.45	0.45	Stop (1-way). T-intersection (Blackwood Drive and North 14th Street). TURN RIGHT onto North 14th Street, heading south.
0.15	0.6	T-intersection from the right. Entrance to Jackson County Nursing Home. T-intersection from the left, Suburban Drive. CONTINUE AHEAD.
0.1	0.7	T-intersection from the right. Entrance to Junior High School. CONTINUE AHEAD.
0.1	0.8	T-intersection from the right (Fair Drive). CONTINUE AHEAD.
0.1	0.9	T-intersection from the left (Bost Lane). CONTINUE AHEAD.

0.05	0.95	T-intersection from the left (Roberta Drive) and T-intersection from the right (Keogh Drive). CONTINUE AHEAD.
0.2	1.15	Crossroad intersection (Illinois Avenue). CONTINUE AHEAD.
0.05	1.2	T-intersection from the left (Olive Drive). CONTINUE AHEAD.
0.05	1.25	T-intersection from the right (Grace Street). CONTINUE AHEAD.
0.05	1.3	T-intersection from the left (Maple Street). CONTINUE AHEAD. Prepare to turn right.
0.05	1.35	Crossroad intersection (North 14th Street and Gartside Street). TURN RIGHT (heading west on Gartside Street).
0.05	1.4	Crossroad intersection (15th Street). CONTINUE AHEAD.
0.05	1.45	Crossroad intersection (16th Street). CONTINUE AHEAD.
0.05	1.5	Crossroad intersection (17th Street). CONTINUE AHEAD.
0.05	1.55	T-intersection from the left (Meadow Lane). CONTINUE AHEAD.
0.1	1.65	Crossroad intersection (19th Street). CONTINUE AHEAD. Prepare to turn left.
0.1	1.75	Stop (4-way). Intersection of (20th Street and Gartside Street). TURN LEFT (on 20th street).
0.1	1.85	Crossroad intersection (Herbert Street). CONTINUE AHEAD.
0.1	1.95	Crossroad intersection (Clark Street). CONTINUE AHEAD.
0.05	2.0	Crossroad intersection (Wall Street). CONTINUE AHEAD. The playground to the right marks the former location of Longfellow School.
0.05	2.05	Crossroad intersection (Logan Street). CONTINUE AHEAD.
0.05	2.1	Crossroad intersection (Elm Street). CONTINUE AHEAD.
0.05	2.15	Crossroad intersection (Pine Street). CONTINUE AHEAD.
0.05	2.2	Stoplight. Intersection of 20th Street and Walnut Street/Highway 13. CONTINUE AHEAD. Note: Hucks Gas Station on the southeast corner of the intersection.
0.05	2.25	Stop (4-way). Intersection of Spruce Street and 20th Street. CONTINUE AHEAD.
0.15	2.4	Crossroad intersection (Division Street). CONTINUE AHEAD.

0.05	2.45	T-intersection from the right (Dewey Street). CONTINUE AHEAD. Lincoln School located on the right.
0.05	2.5	T-intersection from the right (Clay Street). CONTINUE AHEAD.
0.1	2.6	T-intersection from the right (McCord Street). CONTINUE AHEAD.
0.05	2.65	T-intersection from the right (Alexander Street). CONTINUE AHEAD.
0.05	2.7	T-intersection from the left (Apple Lane). CONTINUE AHEAD.
0.05	2.75	Crossroad intersection (Commercial Avenue). CONTINUE AHEAD.
0.05	2.8	T-intersection from the right (Lake Street). CONTINUE AHEAD.
0.15	2.95	T-intersection from the right (Lindell Avenue). CONTINUE AHEAD.
0.05	3.0	T-intersection from the right (Jackson Street). CONTINUE AHEAD.
0.1	3.1	Cross Big Muddy River.
0.45	3.55	T-intersection from the left (Hannah Road). CONTINUE AHEAD. Note: The road makes a large 90° turn to the right and 20th Street becomes Town Creek Road as you exit Murphysboro.
0.5	4.05	T-intersection from the left (Hickory Ridge Road). CONTINUE AHEAD. Note: Hickory Ridge Road will take you to the Little Grand Canyon Recreation Area, located 7 miles to the southwest of this intersection.
0.15	4.2	Cross East Branch of Jones Quarry Creek.
0.4	4.6	Cross Jones Quarry Creek. T-intersection from the left (Maple Spring Road) just past the creek. CONTINUE AHEAD.
0.5	5.1	T-intersection from the right (Worthen Cemetery Road). CONTINUE AHEAD.
0.1	5.2	T-intersection from the left ("old" Town Creek Road). CONTINUE AHEAD.
0.5	5.7	Road starts descent into the valley eroded by Town Creek.
0.3	6.0	T-intersection from the left ("old" Town Creek Road). CONTINUE AHEAD.
0.1	6.1	T-intersection from the left (Pond Ridge Road). CONTINUE AHEAD.
0.2	6.3	Road follows valley cut by Town Creek. The creek is to the left at the base of the small hills.
0.25	6.55	Road makes a gentle curve to the left.
1.05	7.6	T-intersection from the left (Pierson Road). CONTINUE AHEAD.

0.05	7.65	Outcrop of Pennsylvanian Caseyville Sandstone to the right. Approximately 7 feet of well defined cross-bedded sandstone occurs at road level. Note: Just past the outcrop, you enter the floodplain of the modern Big Muddy River. Historically, this vast floodplain was deposited by the Mississippi River.
0.05	7.7	T-intersection from the right (Walnut Hill Road). CONTINUE AHEAD.
0.4	8.1	Cross the Big Muddy River. Note the fine-grained silt (reworked loess) deposits along the banks of the Big Muddy River.
0.45	8.55	T-intersection from the left (Big Muddy Levee Road). CONTINUE AHEAD.
0.3	8.85	T-intersection from the right (unmarked levee road). CONTINUE AHEAD.
0.15	9.0	Enter community of Sand Ridge. CONTINUE AHEAD.
0.1	9.1	Crossroad intersection (Grimsey Road to the right and Sand Ridge Road to the left). CONTINUE AHEAD. The community of Sand Ridge is built on top of a large sand dune within the floodplain of the Mississippi River (see route maps). This sand ridge was formed by the prevailing westerly winds that transported and redeposited the coarse-grained sands from within the floodplain. The finer-grained windblown silt-sized particles were deposited as loess on top of, and along the eastern bluffs.
0.5	9.6	Good view of Fountain Bluff straight ahead. The highest elevation on top of Fountain Bluff is 760 feet above sea level. This large bluff protrudes 360 feet above the floodplain. To the left of us is the La Rue–Pine Hills area.
0.3	9.9	Cross Worthen Bayou. This channelized ditch flows into the Big Muddy River, and is used to control drainage within the floodplain.
0.7	10.6	Stop (1-way). T-intersection (Town Creek Road and Route 3). TURN LEFT. Johnson Creek is 7 miles to the right, Oakwood Bottoms is 4 miles to the left, and Turkey Bayou is 8 miles to the left. After making a turn, directly ahead to your right is Fountain Bluff. Route 3 passes along the east side of Fountain Bluff. We're following the south route of the Great River Road, and the southern branch of the Lincoln Heritage Trail
1.5	12.1	Enter overpass for the Union Pacific Railroad. Note the fish rearing ponds to the left.
0.25	12.35	T-intersection from the right (Gorham Road). CONTINUE AHEAD.
1.20	13.55	T-intersection from the right (Happy Hollow Road). CONTINUE AHEAD.
0.25	13.8	Spring coming out of Fountain Bluff on the right-hand side of the road. There is a small plastic PVC pipe next to the road with water flowing out of it. The spring is approximately 50 feet from the road.
0.4	14.2	T-intersection from the left (Oakwood Bottoms Road). CONTINUE AHEAD. The Oakwood Bottoms Greentree Reservoir interpretive site is ½ mile to the left,

		and Turkey Bayou is 4 miles to the left. La Rue–Pine Hills is located 9 miles straight ahead.
0.8	15.0	T-intersection from the right (Meyers Road). CONTINUE AHEAD.
0.85	15.85	T-intersection from the right (Power Plant Road). CONTINUE AHEAD. This road marks the south end of Fountain Bluff. River Access Park and historic site is to the left.
0.75	16.6	Immediately to your right is Walker Hill, a fault-controlled block within the Mississippi floodplain, part of the St. Genevieve Fault zone. Walker Hill rises 120 feet above the surrounding floodplain.
0.7	17.3	T-intersection from the left (Howardton Road). CONTINUE AHEAD. The road to the left takes you to Rattlesnake Ferry.
0.15	17.45	Entering Grand Tower, population 800.
0.05	17.5	T-intersection from the right (Grand Tower Road). CONTINUE AHEAD. Abandoned Veach Oil service station is just south of the intersection.
0.8	18.3	Crossroad intersection (Upper Chute Road to the right and Elliott Road to the left) CONTINUE AHEAD. The large bluffs to the left of the road are part of the La Rue–Pine Hills area.
0.5	18.8	This is a good place to stop and examine the diversity of the Mississippi River floodplain. The trees on the right-hand side of the road outline Tower Chute, an abandoned meander of the Mississippi River. Grand Tower Island (see route maps) is located between Tower Chute and the Mississippi River. This island is an example of a portion of Missouri that lies east of the Mississippi River. The trees to the left outline the Big Muddy River. The Mississippi River is currently flowing along the base of the bluffs located to the west.
0.6	19.4	T-intersection from the left (Kings Ferry Road). CONTINUE AHEAD.
1.05	20.45	Crossroad intersection (Lower Chute Road to the right and East Cemetery Road to the left). CONTINUE AHEAD. Directly ahead on the east and west side of the road, you can see the levee along the Big Muddy River.
1.05	21.5	T-intersection from the right (Muntz Road). CONTINUE AHEAD.
0.5	22.0	T-intersection from the left (Levee Road). North side of the Big Muddy River. CONTINUE AHEAD.
0.1	22.1	Cross Big Muddy River, leaving Jackson County and entering Union County.
0.1	22.2	T-intersection from the left. Just past the bridge (Muddy Levee Road/15.25N and State Route 3/305E). TURN LEFT. A portion of the River to River Trail follows along the levee of the Big Muddy River.

1.45	23.65	CAUTION: Cross Union Pacific Railroad tracks. Unguarded: no lights, no guard gates, single track. CONTINUE AHEAD.
0.85	24.5	View directly ahead of the Pine Hills, the most westerly protruding rock pedestal is Inspiration Point, which will be Stop 2 on this field trip. Inspiration Point is 265 feet above the Levee Road. The top of the bluffs is about 640 feet above sea level. The bluffs consist of the Devonian-age Bailey Limestone.
0.5	25.0	T-intersection (Muddy Levee Road/1700N and La Rue Road/470E). TURN RIGHT. Sign directly ahead "La Rue/Pine Hills Research Natural Area Shawnee National Forest, collections prohibited."
0.1	25.1	Entrance to Winter's Pond picnic ground to the right. TURN RIGHT. Straight ahead is the road that traverses the base of the bluffs.

STOP 1 Winter's Pond (center NW NE, Sec. 9, T11S, R3W, 3rd PM, Wolf Lake 7.5-Minute Quadrangle, Union County). Note: When exploring this area, be aware that all three of Illinois' poisonous snakes reside in this area. So you need to watch your step!

0.0	25.1	Leave Stop 1. Turn left out of the parking lot and head back toward the Muddy Levee Road.
0.15	25.25	T-intersection (Muddy Levee Road/1700N and La Rue Road/470E). CONTINUE AHEAD on the La Rue Road. As you're driving along the base of Pine Hills, notice the large number of slump blocks that have slid down or cascaded off of the bluffs.
0.35	25.6	T-intersection from the right (Pine Hills Road/1740N). TURN RIGHT.
0.1	25.7	Entrance to McCann Springs Picnic area on the right. A lower trail leading up to Inspiration Point starts from this picnic area.
0.3	26.0	Road makes a tight "switchback" to the right. A sign in the middle of the curve states "Clear Springs Wilderness Area."
0.15	26.15	Switchback to the left. Just past the switch back on the right-hand side of the road is a parking lot for Inspiration Point. Pull over to the right side of the road as far as you can safely go.

STOP 2 Inspiration Point (SE SE SE, Sec. 4, T11S, R3W, 3rd PM, Wolf Lake 7.5-Minute Quadrangle, Union County). From the parking lot follow the trail to Inspiration Point. The length of the trail is approximately ¼ mile. The overlook is located in the NE NE NW NE of Section 9.

0.0	26.15	Leave Stop 2 and CONTINUE AHEAD.
0.45	26.6	Trail entrance on the left side of the road is Godwin Trail, part of the River to River Trail.
0.35	26.95	Pull-off to the right. Old Trail Point Observation. CONTINUE AHEAD.
0.25	27.2	Small pull-off on the left-hand side of the road. The trail on the right-hand side of the road leads to Government Rock, which has an elevation of 831 feet above mean sea level.
0.1	27.3	Pine Ridge observation pull-off on the right-hand side of the road. Sign at Pine Ridge Observation: Saving the short-leaf pine. These hills were named for the unusual short-leaf pine, *Pinus echinata*, found growing here by surveyors in 1810. The Pine Hills is one of two original locations for short-leaf pine in the state. The short-leaf pine evolved with fire and needs fire to thrive. The fires which used to burn across these slopes have been suppressed since the area was settled. The US Forest Service now uses and prescribe burns to manage this area to keep the pines in the pine hills. The seeds of the short-leaf pine will not sprout without the fire's help. These seeds must be in direct contact with the soil. Fire burns off old needles and old duff "leave litter" from the ground and releases nutrients into the soil which help the short-leaf pine seeds to sprout. Thick bark protects mature trees from fires, younger trees if burned can resprout from the base. Follow the short trail from here to walk along the pines.
0.75	28.05	Saddle Hill Observation pull-off. This observation point has a picnic table and a fire pit.
0.35	28.4	T-intersection from the left (South Hutchins Creek Road/490E and Pine Hills Road/1550N). CONTINUE AHEAD.
0.1	28.5	Crooked Tree Trail pull-off on the right-hand side of the road. Sign reads: You can see for miles. At the end of this short steep trail, you'll find a bench with a view. From the secluded perch, you can see the Missouri Ridge line six miles away. To the north, the red towers are the pipeline suspension bridge at Grand Tower just visible. This pipeline carries natural gas across the Mississippi River. Your view may include glimpses of the mighty river itself. You may have to look hard depending on the season. Traffic moving along Route 3 is just two miles from the base of the Pine Hills. Just below you stretching out from the Hills is La Rue Swamp, a wonderful wetland full of life. Take a hike and see for yourself.
1.25	29.75	Pull-off on the right side of the road is the McGee Hill Observation Point. View directly below from this pull-off is a well-developed abandoned ox bow on the Mississippi River floodplain. The three large limestone blocks just in front of the wood fence were brought to this point and are not native to the Pine Hills area. The community of La Rue located on the floodplain consists of a few houses

		where the railroad tracks and the gravel road cross (see route maps). Good view of the bluffs on the Missouri side too. The Mississippi River is flowing near the base of the hills on the Missouri side of valley. McGee Hills is to the left of the pull-off.
0.1	29.85	Entrance to McGee Hill picnic ground, left-hand side of the road.
0.25	30.1	Entrance to Allen's Flat picnic ground on the left-hand side of the road. There is an outhouse at Allen's Flat.
0.3	30.4	Switchback. Start our descent down La Rue Pine Hills. White Pine Trail head is on the left-hand side of the road in the middle of the switchback curve.
0.8	31.2	Cross ford of small creek. The creek bed is loaded with highly weathered chert with some fossil casts.
0.1	31.3	Cross second small ford.
0.2	31.5	Cross another small ford.
0.5	32.0	Mixed hardwood plantation on the left side of the road was planted in 1938.
0.1	32.1	Cross small ford. A pull-off parking area is on the right-hand side of the road just past the ford.
0.45	32.55	Pine Hills camp ground is visible to your left through the trees.
0.15	32.7	T-intersection from the left (1230N and Pine Hills Road/565E). Entrance to Pine Hills Camp Ground. CONTINUE AHEAD.
0.75	33.45	Stop (1-way). T-intersection (Pine Hills Road/555E and State Forest Road/1160N). TURN LEFT. A small abandoned quarry is on the left.
0.05	33.5	To the left and behind the barns, notice the westward dipping beds of the Bailey Limestone. The cherty texture of the limestone can be seen in the hillside.
0.3	33.8	On the left is an entrance to a small abandoned quarry. This quarry was mining the lower Devonian Grassy Knob chert.
0.7	34.5	T-intersection from the left (Hoot Owl Lane/670E and State Forest Road/1105N). CONTINUE AHEAD.
0.7	35.2	View to the right of the Mississippi River floodplain. The Mississippi River is about 3.5–4 miles to the southwest and flows at the base of the bluffs seen in the distance to the right. These bluffs are part of the Trail of Tears State Park in Missouri. We are approaching the Trail of Tears State park in Illinois.
0.9	36.1	T-intersection from the left (Beech Grove Road/775E and State Forest Road/1025N). CONTINUE AHEAD.

0.15	36.25	T-intersection from the right (Clear Creek Levee Road/800E and State Forest Road/1020N). CONTINUE AHEAD. To the left is an exposures of loess in the small rounded hills located on the far side of the field.
0.25	36.5	T-intersection from the left (Walnut Tree Road/820E and State Forest Road/1015N). Walnut Tree Road is a levee road along Clear Creek. CONTINUE AHEAD. Just past the levee road, cross Clear Creek, and to the right is a stand of trees planted by the Union State Nursery.
0.3	36.8	The road is following the valley cut by a small tributary to Clear Creek. The creek is located to the right. This valley contains up to 60 feet of alluvial deposits formed from the weathering and erosion of the Clear Creek chert. Exposures of reworked loess deposits which are underlain and overlain by cherty gravel bars are visible along the banks of the creek. Fossil collecting is good just about anywhere along the creek. Fossils include brachiopods (*Amphigenia curta, Eodevonaria melonicus*, *Strophomena*, and *Spirifer*), the trilobite *Dalmanities pratteni*, rare crinoid fragments, rare graptolites, and lots of crinoid stems.
0.3	37.1	T-intersection from the left (North Forest Road/875E and State Forest Road/1025N). CONTINUE AHEAD. This is the entrance to the Union State Nursery.
0.05	37.15	T-intersection from the left (second entrance to the Nursery). CONTINUE AHEAD.
0.40	37.55	T-intersection from the right (Fire Tower Road/920E). CONTINUE AHEAD. This is the entrance to Trail of Tears State Park. The Fire Tower is still at the top of the bluffs; however, a chain link fence surrounds the tower, and the lower stairs have been removed. Pass white barn on the left-hand side of the road just past that intersection.
0.2	37.75	T-intersection from the left. TURN LEFT. Entrance to Trail of Tears State Forest Shelter No. 1. On the day of the field trip, enter the parking lot and make a wide circle and head back toward the road.

STOP 3 Lunch: Trail of Tears State Forest Shelter No. 1 (NW SE SW, Sec. 8, T12S, R2W, 3rd PM, Jonesboro 7.5-Minute Quadrangle, Union County). Are you hungry?

0.2	37.95	Leave Stop 3 and TURN RIGHT. Head back toward the offices of the State Nursery.
0.15	38.1	T-intersection from the left (Fire Tower Road/920E). CONTINUE AHEAD.
0.4	38.5	T-intersection from the right. TURN RIGHT. Entrance to offices of the State Nursery. Follow the road and TURN LEFT where it crosses the creek and CIRCLE BACK towards the main road. We'll park along the service road and cross the main road to look at the outcrop and collect fossils in the rubble in the creek.

STOP 4 Clear Creek (NW SE SW, Sec. 7, T12S, R2W, 3rd PM, Jonesboro 7.5-Minute Quadrangle, Union County).

0.3	38.8	Leave Stop 4. At the T-intersection of State Forest Road/1025N and North Forest Road/875E, TURN RIGHT.
0.6	39.4	Cross Clear Creek.
0.4	39.8	T-intersection from the right (Beech Grove Road/775E and State Forest Road/1025N). CONTINUE AHEAD.
1.6	41.4	T-intersection from right (Hoot Owl Lane/670E and State Forest Road/1105N). CONTINUE AHEAD.
1.1	42.5	T-intersection from right (Pine Hills Road/555E and State Forest Road/1160N). CONTINUE AHEAD.
0.5	43.0	CAUTION: Cross Union Pacific Railroad, dual tracks. Signal lights and guard gates. CONTINUE AHEAD.
0.1	43.1	STOP (1-way). T-intersection (State Route 3/500E and State Forest Road/1135N). TURN RIGHT heading north. After crossing the tracks, you enter the community of Wolf Lake
0.35	43.45	T-intersection from the left (Wolf Lake Road). CONTINUE AHEAD.
0.85	44.3	T-intersection from the right (Enson Bickford Road/1250N). CONTINUE AHEAD. This is the entrance to the Enson Bickford Company, which manufactures Trojan products. Established in 1836 in Sainsbury, Connecticut, they produce and test explosive products here.
0.6	44.9	T-intersection from the left (McMahan Lane/1280N). CONTINUE AHEAD.
0.4	45.3	Center-pivot irrigation system on the left-hand side of the road. Notice the large cypress trees to the left.
0.4	45.7	Cross Running Lake Ditch.
0.8	46.5	Crossroad intersection (La Rue Road to the right and Gaillee Road to the left). CONTINUE AHEAD. Entrance to the La Rue Ecological area is to the right. This road is the southern entrance to the road that runs along the base of the bluffs and through the La Rue Swamp.
1.2	47.7	T-intersection from the right (Muddy Levee Road/1525N). CONTINUE AHEAD.
0.05	47.75	Cross Big Muddy River. Leaving Union County and entering Jackson County. Notice the big muddy banks along the Big Muddy River!!

0.25	48.0	T-intersection from the right (levee road on the north side of the Big Muddy River). CONTINUE AHEAD.
0.5	48.5	T-intersection from the left (Muntz Road). CONTINUE AHEAD.
0.9	49.4	Good view of the bluffs of the Pine Hills to the right.
0.1	49.5	Crossroad intersection (Lower Chute Road to the left and East Cemetery Road to the right). You can see Inspiration Point to your right in the bluffs.
0.3	49.8	To the left, the tree-lined area is Tower Island Chute, an abandoned meander of the Mississippi River.
0.7	50.5	T-intersection from the right (Kings Ferry Road). CONTINUE AHEAD.
1.1	51.6	Crossroad intersection (Upper Shoot Road to the left and Elliott Road to the right). CONTINUE AHEAD.
0.5	52.1	Entering Grand Tower, population 800.
0.3	52.4	T-intersection from the left (Grand Tower Road). TURN LEFT.
0.3	52.7	View to the right; notice the power plant in the distance. To the right of the power plant is Fountain Bluff and to the left is Walker Hill.
0.5	53.2	T-intersection from the right (Fifth Street). CONTINUE AHEAD. Pass intersections of Fourth Street, Railroad Street, Third Street, and Second Street.
0.25	53.45	T-intersection from the right (Main Street). CONTINUE AHEAD.
0.05	53.5	Road makes 90° turn to the right and becomes Front Street. CONTINUE AHEAD. The levee is to the left.
0.2	53.7	T-intersection from the right (Walnut Street). CONTINUE AHEAD.
0.05	53.75	T-intersection from the right (Walker Street). CONTINUE AHEAD.
0.1	53.85	Grand Tower Public Library to the right is constructed of native limestone.
0.05	53.9	T-intersection from the right (Maple Street) and public boat launch on the left. CONTINUE AHEAD.
0.1	54.0	Intersection of Market Street to the right, and entrance to Devil's Backbone on the left. TURN LEFT. Take the road leading up to the levee and follow signs leading to Devil's Backbone Park. Once on top of the levee, to the left you can see Tower Rock and the Missouri side of the Mississippi River.
0.2	54.2	Y-intersection. Take the right-hand fork, which follows along the east side of the Devil's Backbone.

0.3	54.5	Walker Hill is to the right. We're following along the eastern base of the Backbone.
0.1	54.6	Outcrop of bedrock on the northern end of the Backbone, just before the stop sign.
0.1	54.7	STOP (1-way). T-intersection (Brunk Horst Avenue to the right and entrance to Devil's Backbone Park to the left). TURN LEFT and immediately TURN RIGHT and follow road on the western edge of the Backbone Camp Ground. Obscured from our view is an old steam locomotive in the campground just to the left of the entrance. Great view of the Mississippi River to the left and outcrop of bedrock on the right.

0.2	54.9	**STOP 5 Devil's Bake Oven** (NW SW SE NE, Sec. 23, T10S, R4W, 3rd PM, Altenburg 7.5-Minute Quadrangle, Jackson County). The Devil's Bake oven is located just north and under the natural gas pipeline suspension bridge. Pull over to the right side of the road.

0.0	54.9	Leave Stop 5. CONTINUE AHEAD to the top of the levee.
0.05	54.95	Y-intersection at the top of the levee toad. Follow the road to the right toward the base of the suspension bridge. The gas pipeline is operated by the Natural Gas Pipeline Company of America (phone: 1-800-733-2490). As you pass by the large anchoring structure for the suspension bridge, notice the mass of concrete and cables.
0.15	55.1	Cross abandoned Illinois Central Railroad grade. STOP (1-Way). Crossroad intersection (Brunk Horst Avenue to the left and Fifth Avenue to the right). CONTINUE AHEAD and pass T-intersections of Fifth Street and Fourth Street.
0.25	55.35	STOP (1-Way). T-intersection (Third Avenue and 20th Street). TURN LEFT onto Third Avenue. Walker Hill is immediately in front and to the right of the intersection.
0.05	55.4	T-intersection from the left (21st Street). CONTINUE AHEAD. Dead-end road to the right.
0.2	55.6	View of Fountain Bluff to the right. The outcrop is the Caseyville Sandstone. The upper portion of the bluff consists of very massively bedded sandstone, whose fresh surfaces have a whitish tint which weathers gray. The lower beds consist of thin-to medium-bedded tabular units.
0.7	56.3	STOP (1-Way). T-intersection (Third Avenue and Power Plant Road). Turn right.
0.2	56.5	Large outcrop of Caseyville Sandstone, with well-defined crossbeds in the lower portion, to the left.

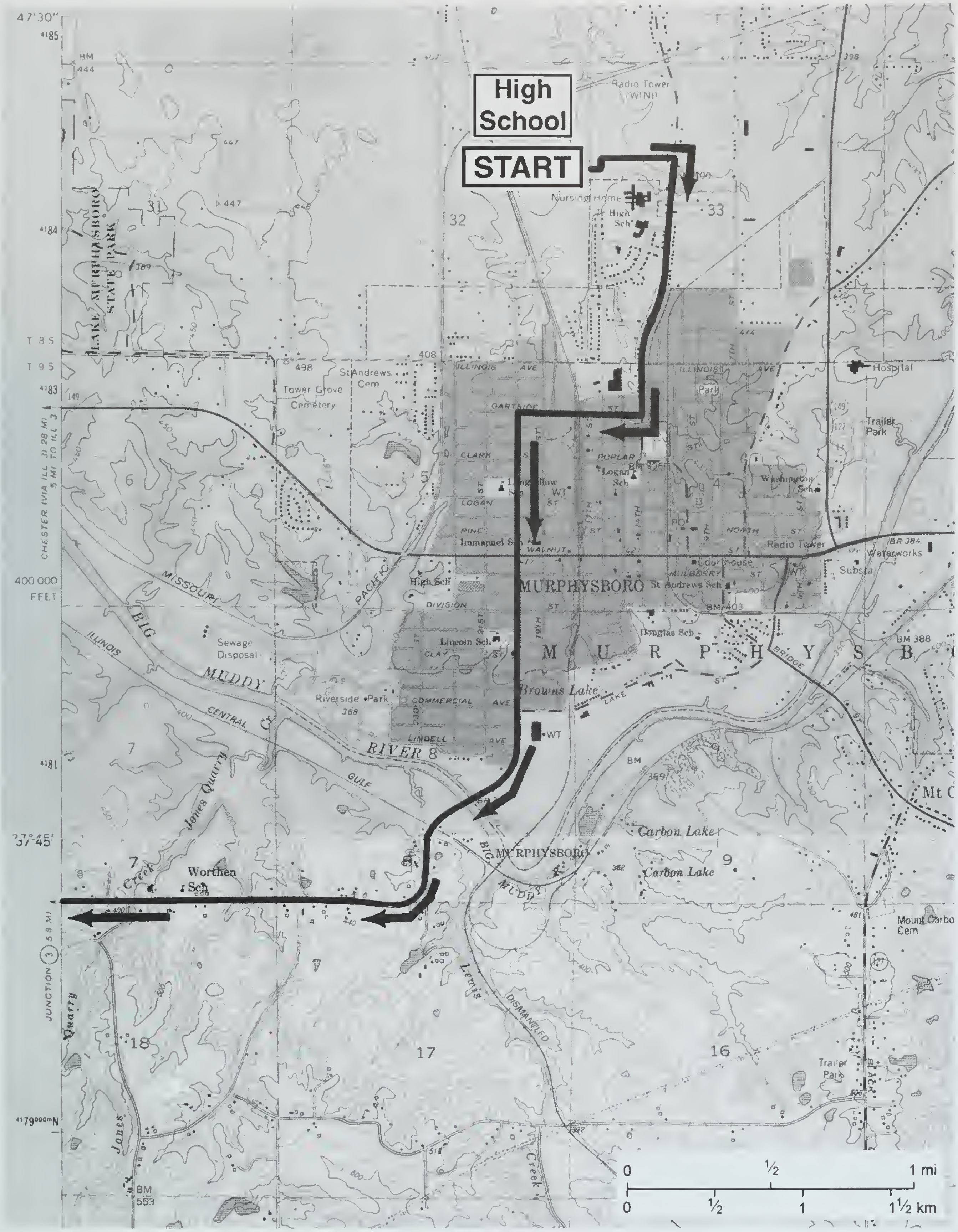
1.1	57.6	STOP (1-Way). T-intersection (Power Plant Road and Illinois Route 3). TURN LEFT. Once again we're following the North National Route of the Great River Road.
0.8	58.4	T-intersection from the left (Myers Road). CONTINUE AHEAD.
0.8	59.2	T-intersection from the right (Oakwood Bottoms Road). CONTINUE AHEAD. Oakwood Bottoms is ½ mile, and Turkey Bayou is 4 miles, to the right.
0.45	59.65	Fountain Bluff Spring on the left.
0.25	59.9	T-intersection from the left (Happy Hollow Road). CONTINUE AHEAD.
0.9	60.8	Prepare to turn left onto Gorham Road.
0.3	61.1	T-intersection from the left (Gorham Road). TURN LEFT onto Gorham Road just before the overpass.
1.0	62.1	Entering the community of Gorham, population 400.
0.1	62.2	T-intersection from the left (First Street). CONTINUE AHEAD and pass by intersection of Second Street. We are on Main Street.
0.35	62.55	Gorham's U.S. Post Office is on the left-hand side of the road. CONTINUE AHEAD.
0.05	62.6	T-intersection from the right. CONTINUE AHEAD. Road makes a large gentle 90° turn to the left and becomes Neunert Road.
0.3	62.9	Fish rearing ponds are located to the right and left.
0.2	63.1	View of Fountain Bluff and the massive Caseyville Formation sandstone to your left. Highest elevation of Fountain Bluff is 779 feet above mean sea level. Elevation of the road we're on averages 360 feet above mean sea level. Local relief is 419 feet. Ahead and to your right are the bluffs along the Mississippi River on the Missouri side.
0.8	63.9	T-intersection from the left (Fountain Bluff Road). TURN LEFT. Pass between the grain elevator on the right and the large metal farm buildings on the left and right.
0.6	64.5	Road passes through the middle of a small farmstead and curves to the left.
0.3	64.8	Fountain Road curves to the left.
0.1	64.9	Small opening in the understory on the right-hand side of the road. The road that we're following parallels an old Illinois Central Railroad bed that is immediately to the right between the road and the bluff.
0.15	65.05	Red barn on the left-hand side of the road. To the right is an opening in the under story. This the location of the Illinois Central Railroads Fountain Bluff station, and it is

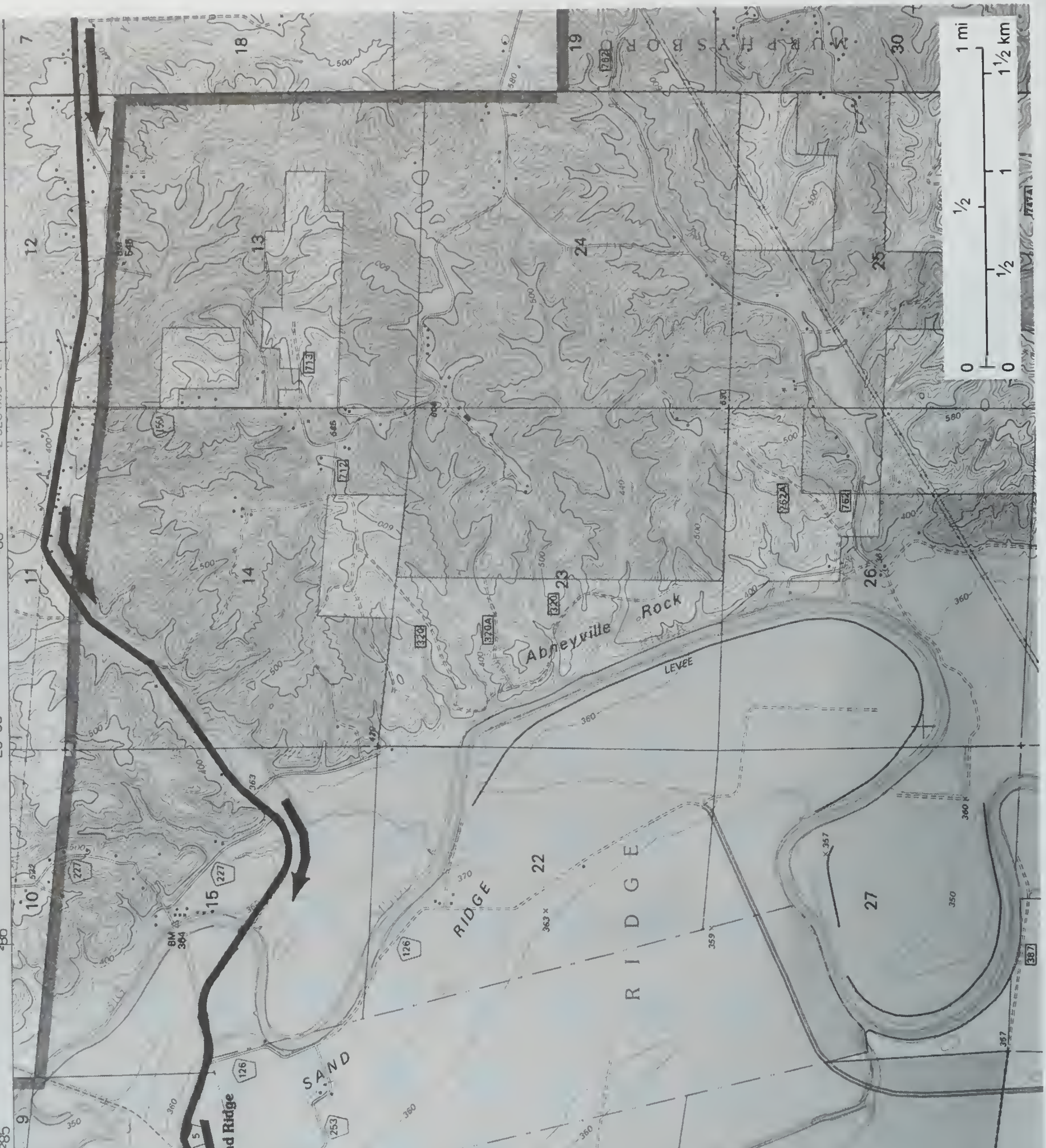
		also the location of Foundation Bluff Springs. A small waterfall usually flows over the sandstone bluffs.
0.15	65.2	Vegetation on both the right- and left-hand sides of the road. Use this to mark the entrance to the pictographs.

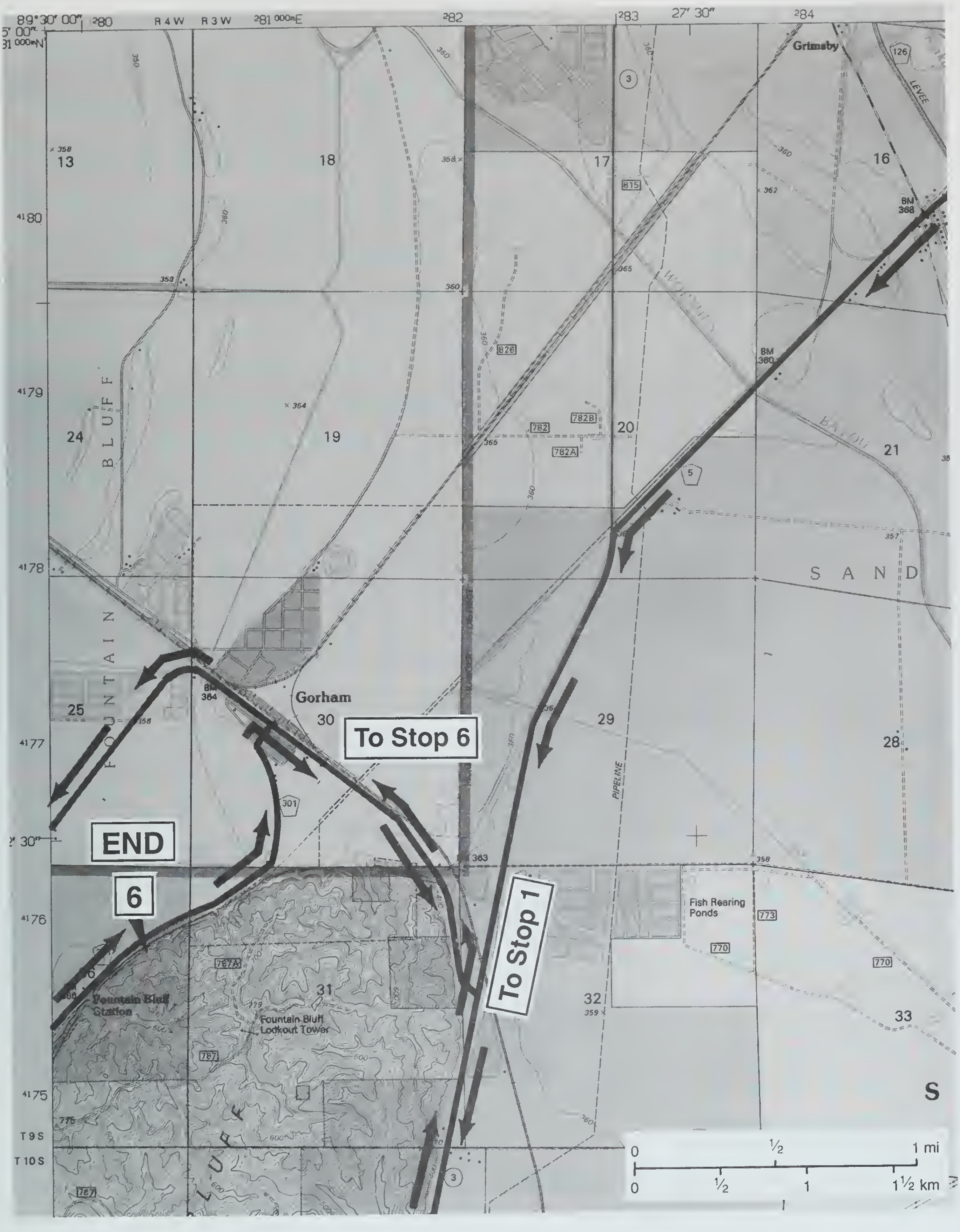
0.05	65.25	**STOP 6 Fountain Bluff** (NW SE NE, Sec. 36, T9S, R4W, 3rd PM, Gorham 7.5-Minute Quadrangle, Jackson County). Pull over to the right-hand side of the road as far as you can. The small opening in the understory is the trail leading to the pictographs.

0.0	65.25	Leave Stop 6. CONTINUE AHEAD on the gravel road to reach civilization.
0.25	65.5	Excellent view of Liesegang iron staining of the Caseyville Sandstone in the upper part of the bluff.
0.75	66.25	Road curves to the right. Entering Gorham; you are now on Second Street.
0.05	66.3	STOP (2-Way). Crossroad intersection (Second Street and Clark Street). CONTINUE AHEAD.
0.15	66.45	Stop (1-Way). T-intersection (Second Street and Main Street). TURN RIGHT onto Main Street; you are heading toward Illinois State Route 3.
1.15	67.6	STOP (1-Way). T-intersection (Gorham Road and Illinois State Route 3). If you turn left, you will head toward Route 16, which will take you into Murphysboro. If you turn right, you'll head south towards Ware and Illinois Route 146.

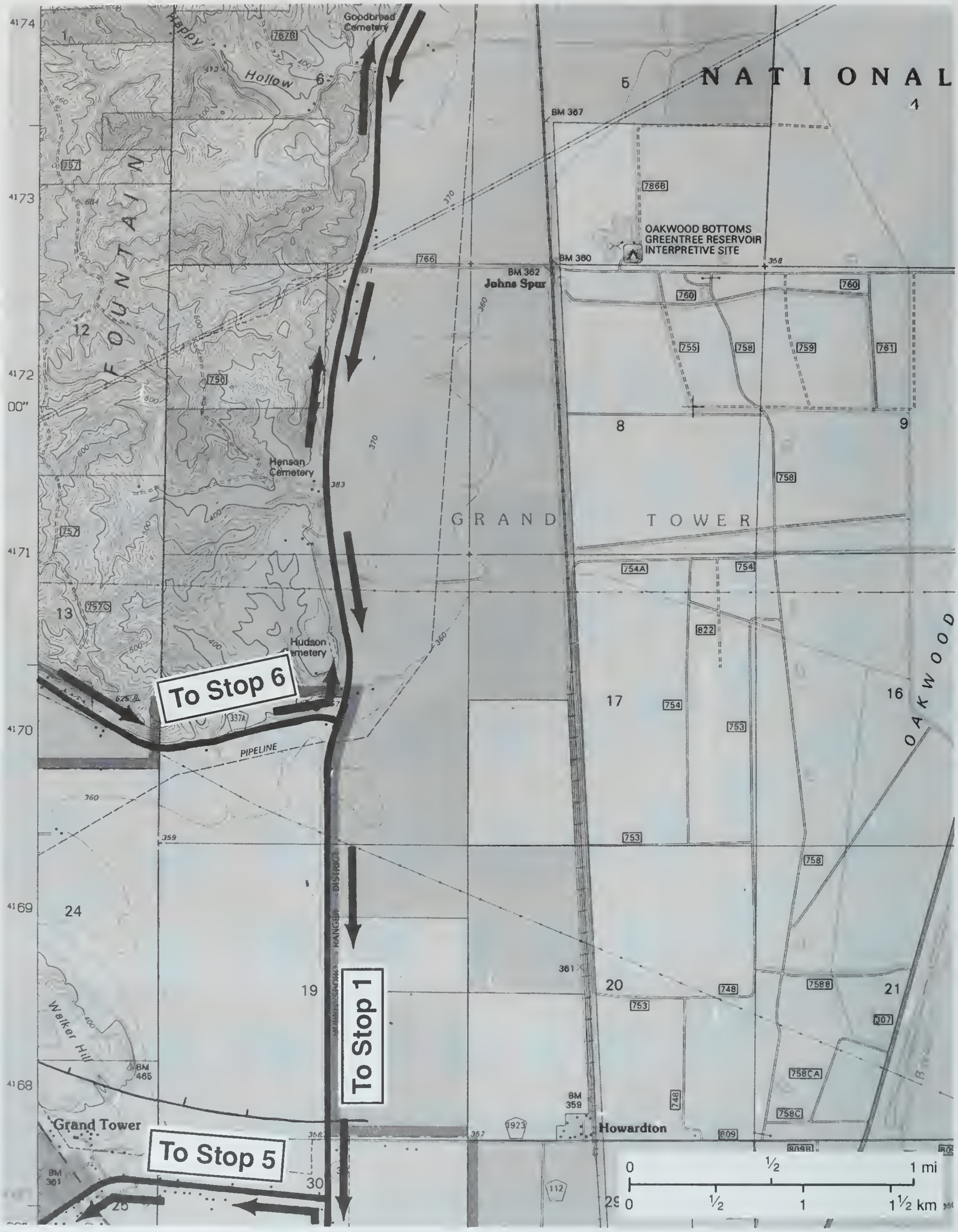
END OF TRIP Have a safe trip home! We hope to see you on April 10 for the Spring Field Trip to the La Rue–Pine Hills Area or on May 22 for the Rock Island–Moline area.


High School
START
MURPHYSBORO
Nursing Home
Jr High Sch
Radio Tower (WINI)
Hospital
Trailer Park
Washington Sch
Logan Sch
Longfellow Sch
Immanuel Sch
High Sch
Lincoln Sch
Courthouse
St Andrews Sch
Douglas Sch
Radio Tower
Waterworks
Substa
St Andrews Cem
Tower Grove Cemetery
Sewage Disposal
Riverside Park
Browns Lake
Carbon Lake
Worthen Sch
Mount Carbon Cem
LAKE MURPHYSBORO STATE PARK
BIG MUDDY RIVER
MISSOURI PACIFIC
ILLINOIS CENTRAL GULF
Jones Quarry Creek
Lewis Creek
DISMANTLED
CHESTER IVIA ILL 3) 28 MI 5 MI TO ILL 3
JUNCTION 3 5.8 MI
0 ½ 1 mi
0 ½ 1 1½ km

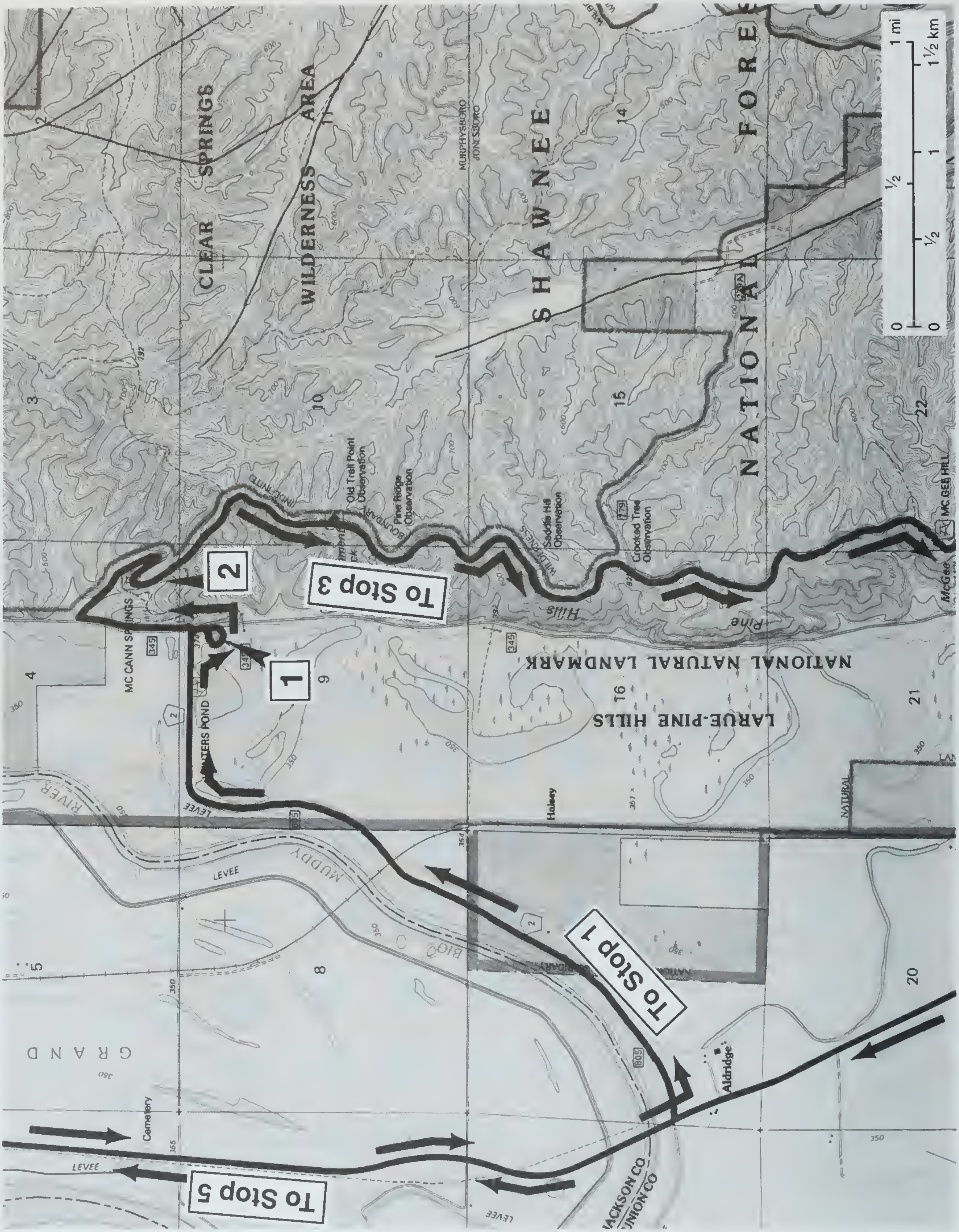

R3W R2W 89°2
2 520 000 FEET
25' 00"
Grimsby
Sand Ridge
SAND RIDGE
SAND RIDGE
Abneyville Rock
LEVEE
LEVEE
MURPHYSBORO
0
1/2
1 mi
0
1/2
1
1 1/2 km

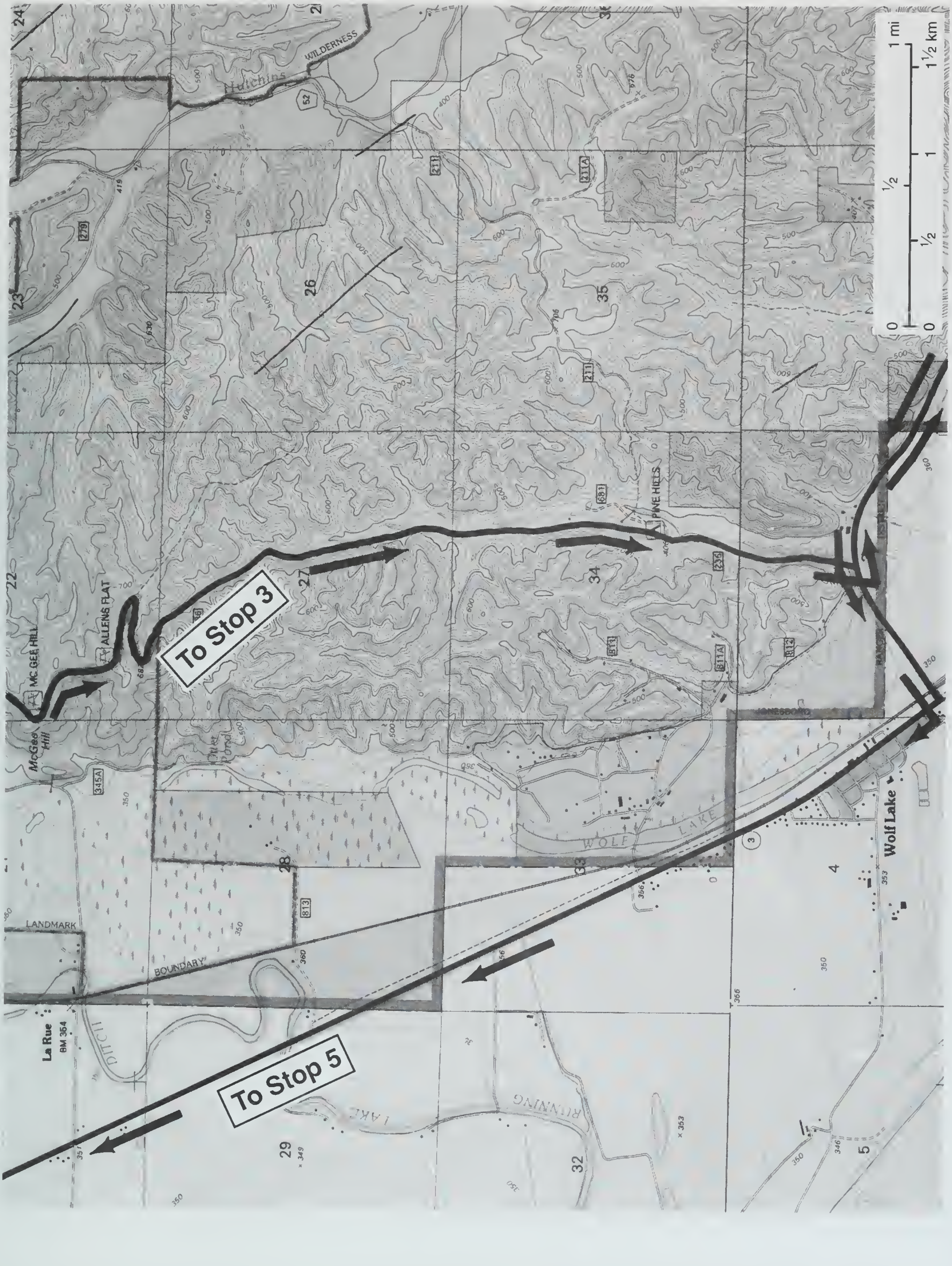


Grimsby
Gorham
To Stop 6
To Stop 1
END
6
Fountain Bluff Station
Fountain Bluff Lookout Tower
Fish Rearing Ponds
PIPELINE
LEVEE
S A N D
BLUFF
FOUNTAIN
0
1/2
1 mi
0
1/2
1
1 1/2 km


To Stop 6
To Stop 1
To Stop 5
NATIONAL
FOUNTAIN
GRAND TOWER
OAKWOOD
Happy Hollow
Goodbread Cemetery
Henson Cemetery
Hudson Cemetery
OAKWOOD BOTTOMS
GREENTREE RESERVOIR
INTERPRETIVE SITE
Johns Spur
BM 367
BM 360
BM 362
PIPELINE
Walker Hill
Grand Tower
Howardton
BM 359
BM 465
0 ½ 1 mi
0 ½ 1 1½ km

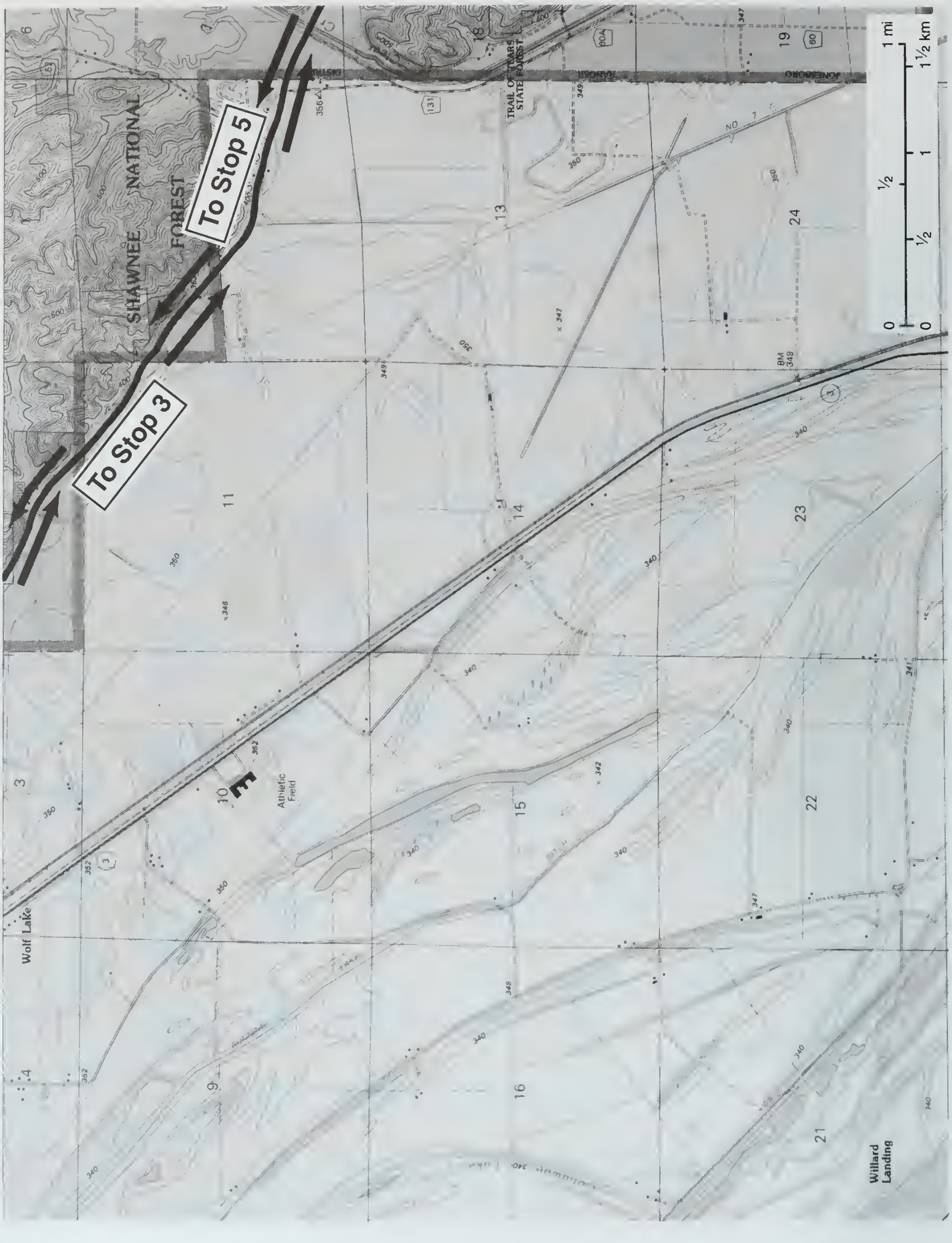

To Stop 1
To Stop 5
1
2
MC CANN SPRINGS
WINTERS POND
Kings Ferry
Grassy Knob
WILDERNESS BOUNDARY
CLEAR
Old Trail Point
Government Rock
MURPHYSBORO RANGER DISTRICT
LEVEE
MUDDY
RIVER
GRAND TOWER
ISLAND
CHUTE
Cemetery
Mobile Home Park
PERRY CO.
JACKSON CO.
0 1/2 1 mi
0 1/2 1 1 1/2 km


To Stop 1
To Stop 3
To Stop 5
1
2
CLEAR SPRINGS
WILDERNESS AREA
SHAWNEE
NATIONAL
FORE
LARUE-PINE HILLS
NATIONAL NATURAL LANDMARK
MC CANN SPRINGS
WINTERS POND
Old Trail Point Observation
Pine Ridge Observation
Saddle Hill Observation
Crooked Tree Observation
MC GEE HILL
Pine Hills
MURPHYSBORO
JONESBORO
Halsey
Aldridge
Cemetery
LEVEE
GRAND
MUDDY
RIVER
JACKSON CO
UNION CO
0 ½ 1 mi
0 ½ 1 1½ km

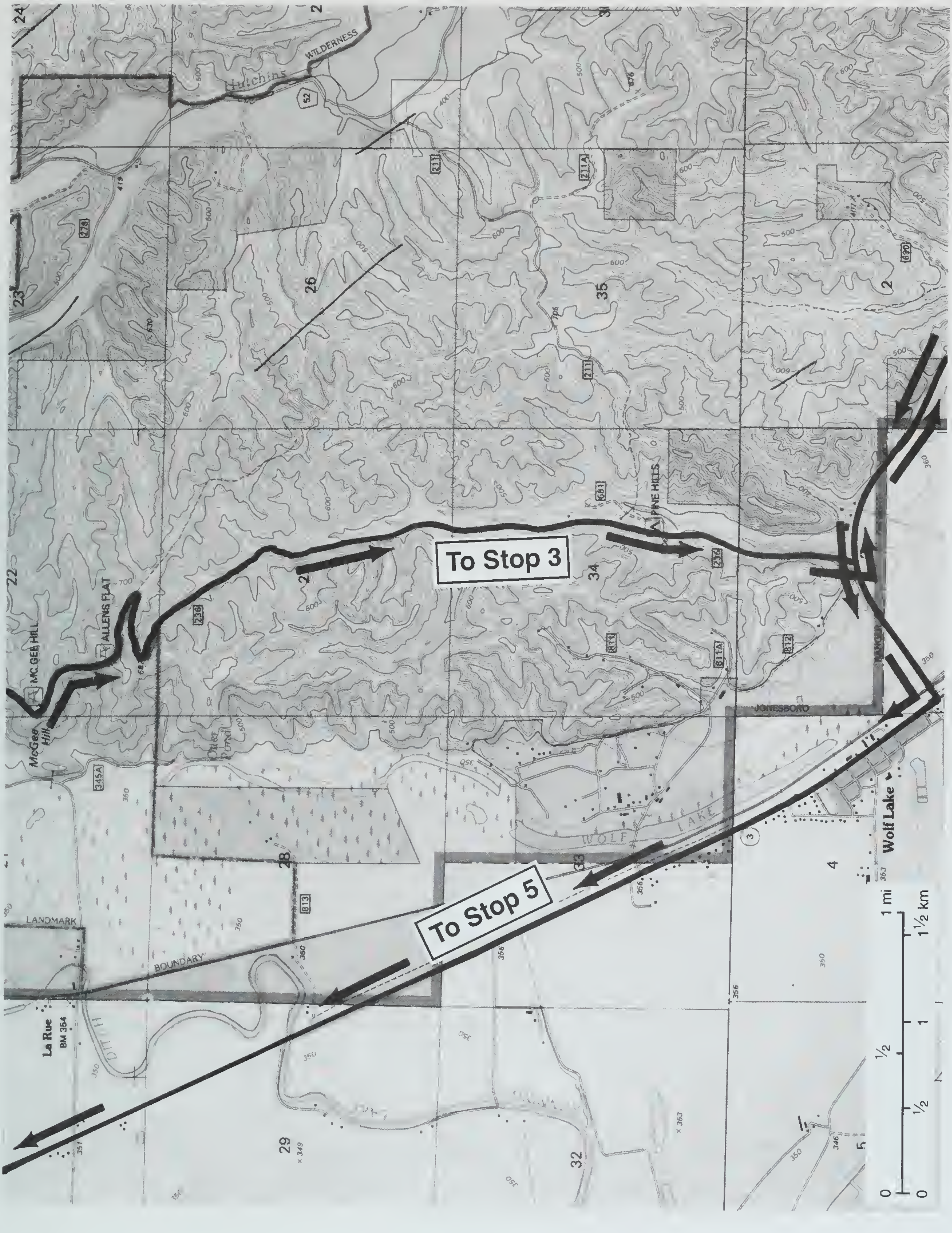

To Stop 3
To Stop 5
Wolf Lake
La Rue
BM 354
McGee Hill
MC GEE HILL
ALLENS FLAT
PINE HILLS
WILDERNESS
Hutchins
LANDMARK
BOUNDARY
JONESBORO
WOLF LAKE
RUNNING LAKE
DITCH
0 1/2 1 mi
0 1/2 1 1/2 km

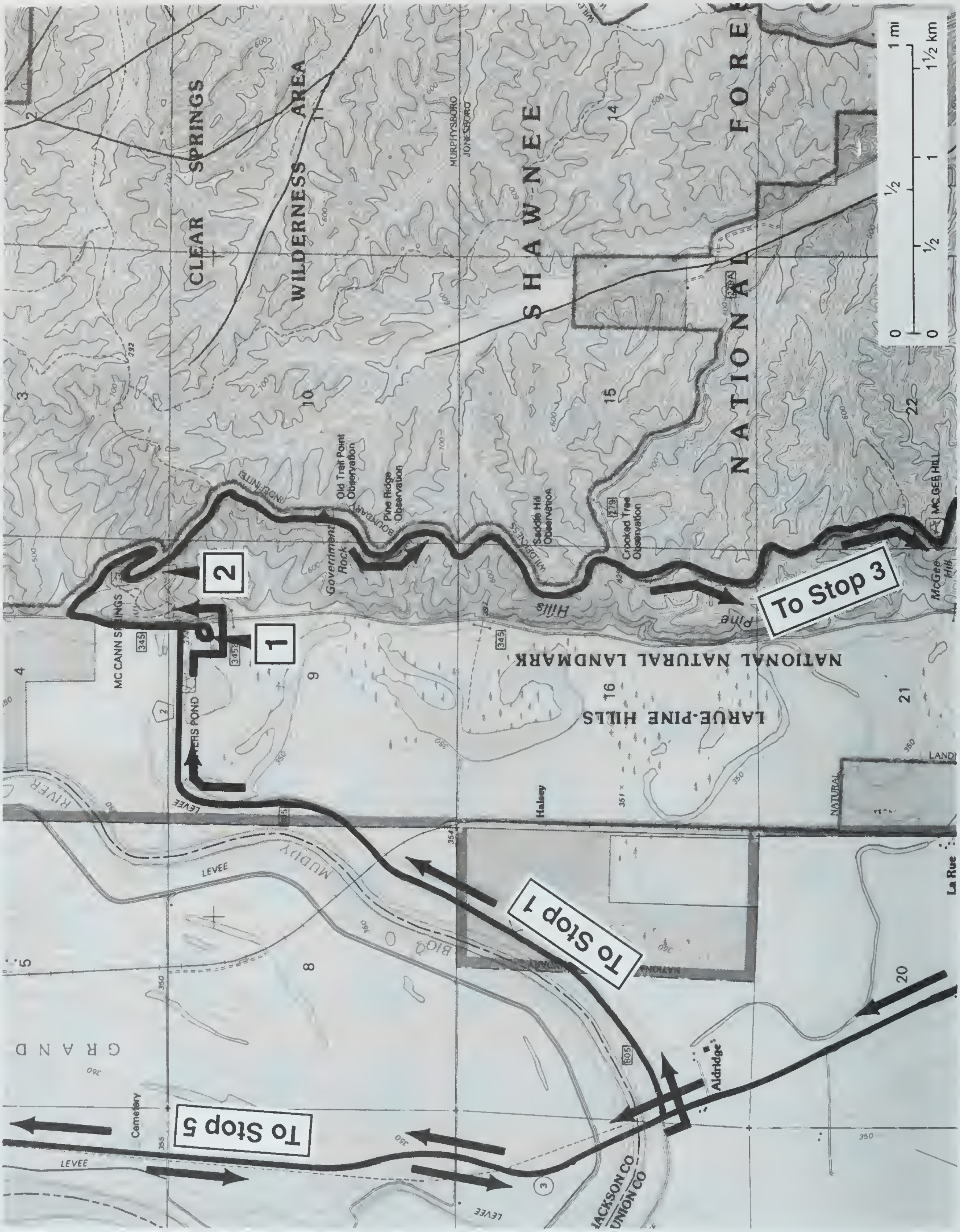
To Stop 5
To Stop 3
NATIONAL
REST
TRAIL OF TEARS
STATE FOREST
Wolf Lake
Athletic Field
E
Willard Landing
1 mi
1½ km

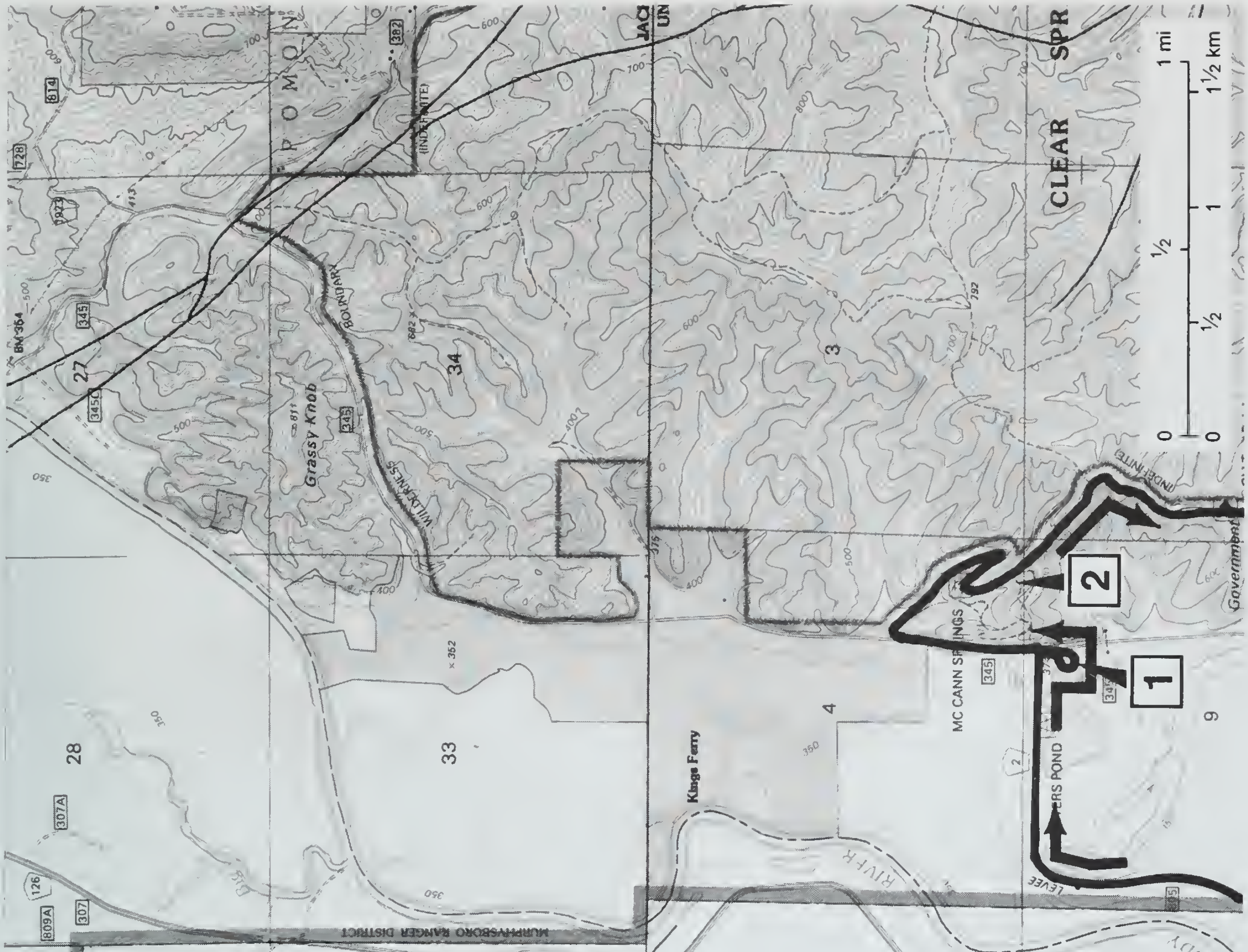
TRAIL OF TEARS
STATE FOREST
4
3
LUNCH
Campground
Lookout Tower
Clear Cr
Cany Creek
Dutch
Cr
CLEAR CREEK
BOUNDARY
DITCH
LEVEE
FOREST
Green
Creek
Rest Area
Dutch
BLACK DIAMOND
127
146
0
½
1 mi
0
½
1
1½ km



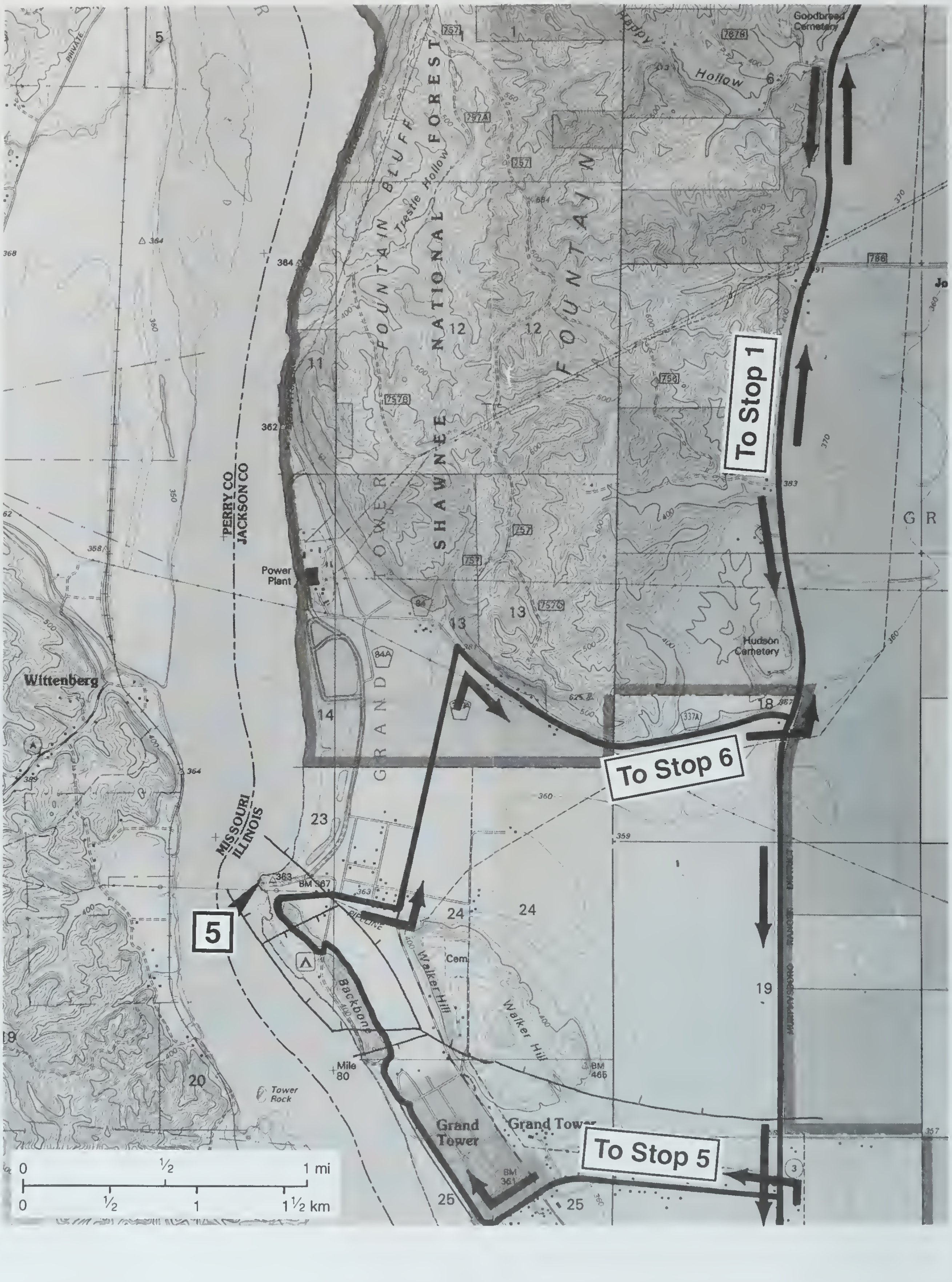
To Stop 3
To Stop 5
SHAWNEE NATIONAL FOREST
TRAIL OF TEARS STATE FOREST
Wolf Lake
Athletic Field
Willard Landing
0 1/2 1 mi
0 1/2 1 1/2 km

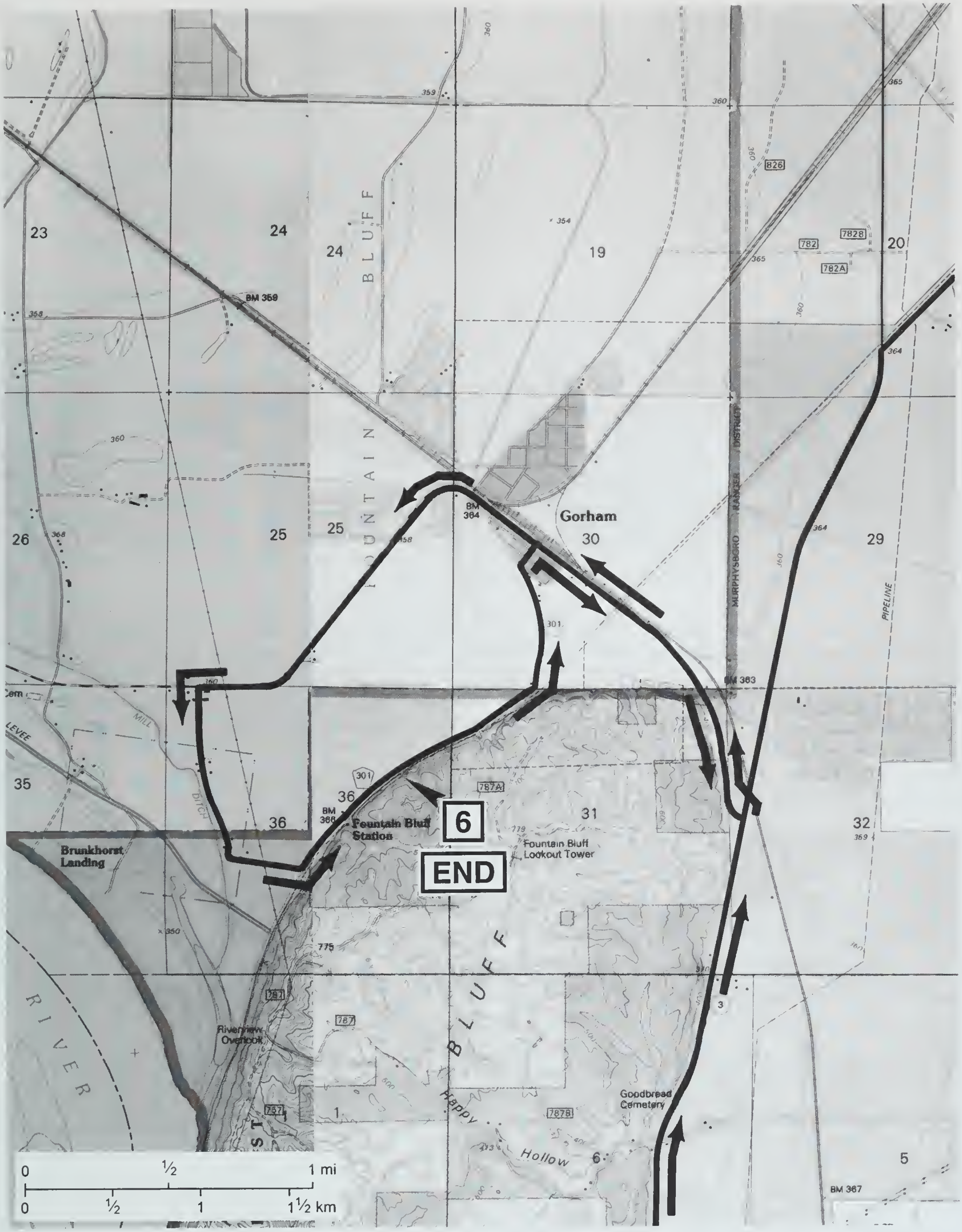

To Stop 3
To Stop 5
Wolf Lake
La Rue
BM 354
McGee Hill
MC GEE HILL
ALLENS FLAT
PINE HILLS
JONESBORO
LANDMARK
BOUNDARY
WILDERNESS
Hutchins
WOLF LAKE
1 mi
1½ km


To Stop 1
To Stop 3
To Stop 5
1
2
CLEAR SPRINGS
WILDERNESS AREA
SHAWNEE NATIONAL FOREST
LARUE-PINE HILLS
NATIONAL NATURAL LANDMARK
MC CANN SPRINGS
Government Rock
Old Trail Point Observation
Pine Ridge Observation
Saddle Hill Observation
Crooked Tree Observation
MC GEE HILL
McGee Hill
Pine Hills
MUDDY
BIG
RIVER
GRAND
LEVEE
Cemetery
Aldridge
La Rue
Haley
JACKSON CO
UNION CO
MURPHYSBORO
JONESBORO
0
½
1 mi
0
½
1
1½ km



To Stop 1
To Stop 5
1
2
MC CANN SPRINGS
Kings Ferry
Grassy Knob
CLEAR SPR
GRAND TOWER
ISLAND
CHUTE
RIVER
LEVEE
MURPHYSBORO RANGER DISTRICT
WILDERNESS BOUNDARY
PERRY CO.
JACKSON CO.
Mobile Home Park
Government
0 ½ 1 mi
0 ½ 1 1½ km


To Stop 1
To Stop 6
To Stop 5
5
SHAWNEE NATIONAL FOREST
FOUNTAIN BLUFF
Trestle Hollow
Happy Hollow
Goodbread Cemetery
Hudson Cemetery
Power Plant
PERRY CO
JACKSON CO
MISSOURI
ILLINOIS
Wittenberg
Tower Rock
Grand Tower
Backbone
Walker Hill
Cem
Mile 80
0 ½ 1 mi
0 ½ 1 1½ km


23
24
24
BLUFF
19
20
26
25
25
FOUNTAIN
Gorham
30
29
BM 369
BM 364
BM 363
MURPHYSBORO RANGER DISTRICT
PIPELINE
826
782
7828
782A
787A
787
787B
35
36
36
31
32
BM 368
Fountain Bluff Station
Brunkhorst Landing
Fountain Bluff Lookout Tower
6
END
LEVEE
MILL
DITCH
RIVER
BLUFF
Riverview Overlook
Goodbread Cemetery
Happy Hollow
1
6
5
BM 367
301
3
0
½
1 mi
0
½
1
1½ km

STOP DESCRIPTIONS

STOP 1 Winter's Pond – La Rue Swamp (center NW NE, Sec. 9, T11S, R3W, 3rd PM, Wolf Lake 7.5-Minute Quadrangle, Union County)

Winter's Pond is a borrow pit. Soil was "borrowed" from here and used to build the levees along the Big Muddy River just north of the pond. After the soil was removed, the pit filled with water. Plants and animals moved in, and Winter's Pond became what you see today (fig. 11). The pond is 3 to 4 feet deeper than the rest of the surrounding swamp.

The levees were built to provide a dry road and control floodwater from the Big Muddy River. The floodwaters no longer flow into Winter's Pond and La Rue Swamp. Where does the water in the wetlands come from? Water flows through the limestone bluffs and emerges in springs at the base of the bluffs. These springs fill the swamp with cool, clean water. The leeves also help protect the wetlands by protecting them from any possible contaminants that may be transported by the Big Muddy River. Occasional flooding of the swamp does happen when floodwater crests the levees.

East of Winter's Pond is a precipitous tan-gray bluff that is composed of thin-bedded, siliceous, lime-mudstones and dolostones of the Bailey Limestone (fig. 12). These vertical cliffs were carved by the meandering of the ancestral Mississippi River and by meltwater torrents of the Illinois and Wisconsin continental glaciers. The Pine Hills provide a portal into the past, a time window for peering into an Early Devonian sea that existed 390 million years ago.

This ancient sea was relatively deep and home to siliceous sponges that sparsely dotted the dim sea floor. Polychaete worms grazed and sifted organic nutrients from the limey mud bottoms. Vagrant trilobites scavenged the turbid sea-floor in search for food. Occasionally, skeletal remains of shallow-water trilobites were transported into this deeper water setting via storms. Some of the trilobite shells were bored into by small clionid-like sponges. Ostracodes, small bean-shaped, bivalved crustaceans, also flourished on the sea floor. A lot of the skeletal material was broken when it was transported to this environment. Crinoid, brachiopod, and bryozoan debris were all conveyed to this environment by mudflows or density currents induced by storms.

Floating in the water column were siliceous microrganisms called radiolarians. Larger invertebrates like conulariids (cone-shaped to pyramidal shells composed of chitinophosphate) also lived in the sea at this time. Straight nautiloid cephalopods ranging in length from 12 to 16 inches swam and stalked the wandering trilobites on the sea floor.

The evidence for this reconstruction has been found as fossils in the layers of rock at Pine Hills. However, fossil invertebrates are rare in the limestone strata of the Bailey Limestone. Most of the fossils have been found in the upper third of the Bailey Limestone.

La Rue–Pine Hills/Otter Pond Research Natural Area
This Research Natural Area, with 14 natural communities, is the most diverse area in the entire state. Plant species from eastern forests can be found growing with plants typical of the Ozarks. Northern prairie species meet southern swamp species.

The La Rue Road, at the base of the bluffs, is known nationwide as the only road in the United States that is closed biannually for snake migration. In the spring, copperheads, cottonmouths, and

Figure 11 Winter's Pond at Stop 1 (photo by W. Frankie).

timber rattlesnakes, along with a variety of water snakes, leave their winter dens in the limestone bluffs. They travel across the road to spend the summer months in the swamp. In the fall the migration is reversed. To protect these animals, the road is closed for several weeks in the spring and the fall. Visitors come from far and near to observe this most unusual event.

La Rue–Pine Hills/Otter Pond became our nation's 250th Research Natural Area in 1991. This 2,811-acre tract of the Shawnee National Forest includes La Rue Swamp (named for the nearby town of La Rue, which is now a ghost town), the Pine Hills (named for the stands of native short-leaf pines on the bluffs above), and Otter Pond (an abandoned meander of the Mississippi River).

Research natural areas (RNAs) are permanently protected to maintain biological diversity and to provide places for research and monitoring of undisturbed natural areas. RNAs provide places for us, and future generations, to learn about our national natural heritage. The La Rue–Pine Hills/Otter Pond Research Natural Area provides protection for a unique collection of forest, wetland, prairie, glade, and geologic features.

More than 1,200 species of plants and animals make their homes in the La Rue–Pine Hills/Otter Pond Research Natural Area. Many are threatened or endangered species. Over thousands of years, these plants and animals have developed unique relationships with each other and with the landscape. You are a part of this incredible biodiversity network, and your visit will affect these relationships.

Figure 12 Bailey Limestone in the bluffs of the Pine Hills, from Levee Road leading to Stop1 (photo by W. Frankie).

Pine Hills contains more species of plants than are found in the entire Great Smokey Mountains National Park. Northern prairie plants, southern swamp types, and plants typically found in forests to the east and west are all represented. Over 1,150 species of plants have been found here—that's 35% of the total species for the entire state of Illinois.

Ninety percent of the Illinois mammal species, 65 species of reptiles and amphibians, and over 150 resident bird species are all found here. The invertebrates are still being counted! La Rue–Pine Hills also provides important habitat for migrating birds, the federally endangered Indiana bat, state threatened bobcat, and many other state threatened and endangered animals. This rich biodiversity is possible largely because of the geological diversity of this area.

Amphibians and Reptiles of the La Rue–Pine Hills Area—*by Christopher A. Phillips, Illinois Natural History Survey*

The La Rue–Pine Hills area is home to more than 25 species of amphibians and 40 species of reptiles. This represents about 60% of the amphibian species and 70% of the reptile species found in Illinois. The close proximity of upland and lowland habitats found at La Rue–Pine Hills is responsible for this incredible species diversity. At La Rue–Pine Hills, the limestone bluffs of the Mississippi River are adjacent to extensive swamps that occupy the old channel of the Big Muddy River. There are many excellent examples of each of these habitat types in Illinois, but rarely are they found together in the nearly pristine condition that occurs at La Rue–Pine Hills. This juxtaposition of habitat types provides many amphibian and reptile species with all their life cycle requirements, including foraging and reproduction in the swamps and over-wintering in the bluffs. Another aspect of the combination of upland and lowland habitats has made the La Rue–Pine Hills area famous: the migration of amphibians and reptiles, especially snakes, from one habitat to another. The main north–south road at La Rue–Pine Hills runs between the bluffs and the swamps. Hundreds of amphibians and reptiles can be observed crossing this road in the spring and again in the fall. So many amphibians and reptiles cross here that the Forest Service has been closing the main road for several weeks in the spring and fall for over 15 years.

Some of the more unusual amphibian and reptile species of the La Rue–Pine Hills area include the cave salamander (*Eurycea lucifuga*), bird-voiced treefrog (*Hyla avivoca*), mole salamander (*Ambystoma talpoideum*), green treefrog (*Hyla cinerea*), green water snake (*Nerodia cyclopion*), mud snake (*Farancia abacura*), cottonmouth (*Agkistrodon piscivorous*), copperhead (*Agkistrodon contortrix*), and timber rattlesnake (*Crotalus horridus*). In addition, La Rue–Pine Hills is the only known Illinois location for the scarlet snake (*Cemophora coccinea*), and only one specimen has ever been observed.

Potential for Groundwater Contamination at Illinois Nature Preserves—*by Randall A. Locke II, Illinois State Water Survey*

As of September 1998, the Illinois Nature Preserve System consisted of 279 nature preserves covering over 36,800 acres (14,700 hectares) in 73 of the 102 Illinois counties. A *nature preserve* is a site that is formally dedicated pursuant to the Illinois Natural Areas Preservation Act (525 ILCS 30/9). It must retain a high degree of its presettlement character or have ecological, geological, or archaeological features of scientific or educational significance (McFall and Karnes 1995). Once sites are dedicated, they are protected from future land use changes in perpetuity, and up to $10,000 per day in civil penalties can be assessed for damages. Sites are maintained in their natural condition by local residents, natural resource professionals, and the Illinois Nature Preserve Commission.

Another form of protection is also available to preserves. In Illinois, groundwater can be designated as a *Class III*, or *Special Resource Groundwater.* One definition of Class III Groundwater is groundwater that contributes to a dedicated nature preserve (35 Illinois Administrative Code 620.230(b)). Such designation allows for the development and application of water quality standards that may be more stringent than the standards currently used in an area. Designation requests for 84 preserves are anticipated as recharge areas for these sites are delineated.

Adjacent land uses can impact preserves, especially where groundwater and surface water from developed areas flow into a preserve. Potential groundwater contamination sources include residential septic systems, roads where de-icers are used, agricultural fields and feedlots, leaking surface impoundments, and leaking underground storage tanks. Unfortunately, baseline data are often not available at nature preserves to detect possible water quality or quantity alteration as a result of off-site activities.

During 1994 through 1996, the Illinois State Water and Geological Surveys undertook three tasks to assess the potential for groundwater contamination of Illinois nature preserves (Locke et al. 1997). First, a shallow groundwater sensitivity map of the state (scale: 1:500,000) was prepared using Geographic Information System techniques. It shows the potential for movement of contaminants from land surface into shallow groundwater based on soil leaching characteristics and depth to the uppermost aquifer. Two hundred and seven nature preserves were screened, and nearly half of them were categorized as having high or very high sensitivity to groundwater contamination. Second, initial field assessments were conducted that assessed the local hydrology, geology, and surrounding land uses at 85 nature preserves. Roughly 30% of those sites were classified as highly- or very highly-vulnerable to groundwater contamination. Third, Spring Grove Fen Nature Preserve in McHenry County was characterized in detail by constructing monitoring wells and collecting water samples from August 1995 through October 1996.

Although we will not be stopping at Otter Pond in the southern part of the La Rue Swamp Nature Preserve (see route maps), Winter's Pond at Stop 1 is approximately 3 miles due north of it, and is in a similar hydrologic and geologic setting. In February 1996, an initial field assessment was conducted at La Rue Swamp. As with other nature preserves in the southern portion of the state, La Rue Swamp has shallow permeable geologic materials that transmit groundwater to the site (that is, potential contamination routes), but has few potential sources of contamination. Therefore, the groundwater contamination potential was categorized as low on a seven-category scale of very low to very high. This category is in large part due to the lack of development on land to the east that contributes groundwater to La Rue Swamp.

Both Winter's Pond and La Rue Swamp are in the floodplain at the base of the east bluff of the Mississippi River Valley. Well records in the floodplain near La Rue Swamp show 20 to 30 feet of fine-grained Cahokia Alluvium overlying up to 70 feet of Henry Formation sand and gravel (fig. 13). The regional groundwater flow direction is from east to west and is dominated by the over 300 feet of relief at the valley wall. In the floodplain, meander scars and ditches often control more complex local flow patterns.

STOP 2 Inspiration Point – Pine Hills (SE SE SE, Sec. 4, T11S, R3W, 3rd PM, Wolf Lake 7.5-Minute Quadrangle, Union County)

Inspiration Point Trail will take you through the dry, open woods of the ridge top, along the top of 300-foot limestone cliffs to one of the most spectacular views in Illinois. If you continue on the trail past Inspiration Point towards McCann Springs picnic area, the trail will begin a steep descent into the moist, rich woods of a north-facing slope. Look for changes in plant and animal life as you move through these different areas. Enjoy your hike through this spectacular natural area. Please, leave it so that others (including the permanent residents) can continue to enjoy. Stay on the trail and carry out everything you carry in, and only what you carry in.

Toward the west is a view of the Mississippi River and its valley. The walls of the Mississippi River Valley, which rise 350 to 400 feet above the floodplain, owe their steepness to the resistance to erosion of the Devonian cherty limestone. The valley flat is slightly more than 4 miles wide at this point. Although at present the Mississippi flows against the Missouri side of the valley, it has not always done so. Swampy areas along abandoned channels and meander scars of the river can be seen. Directly below are the Big Muddy River—flowing towards its confluence with the Mississippi River—and Winter's Pond (fig. 14). During spring rains, the narrow stream channels along the top of the bluffs have bottoms that broaden slightly before forming cascades or waterfalls over the underlying Bailey Limestone.

The Pine Hills are mantled by windblown silts (loess) or rock dust from the glacial ice age. Below the unconsolidated silt is a cherty formation called the Grassy Knob Chert, which ranges in thickness from 10 to 50 feet. The Grassy Knob Chert grades into the Bailey Limestone below. A large percentage of the Pine Hills at the bluffs are composed of the Bailey Limestone (approximately 150–250 feet

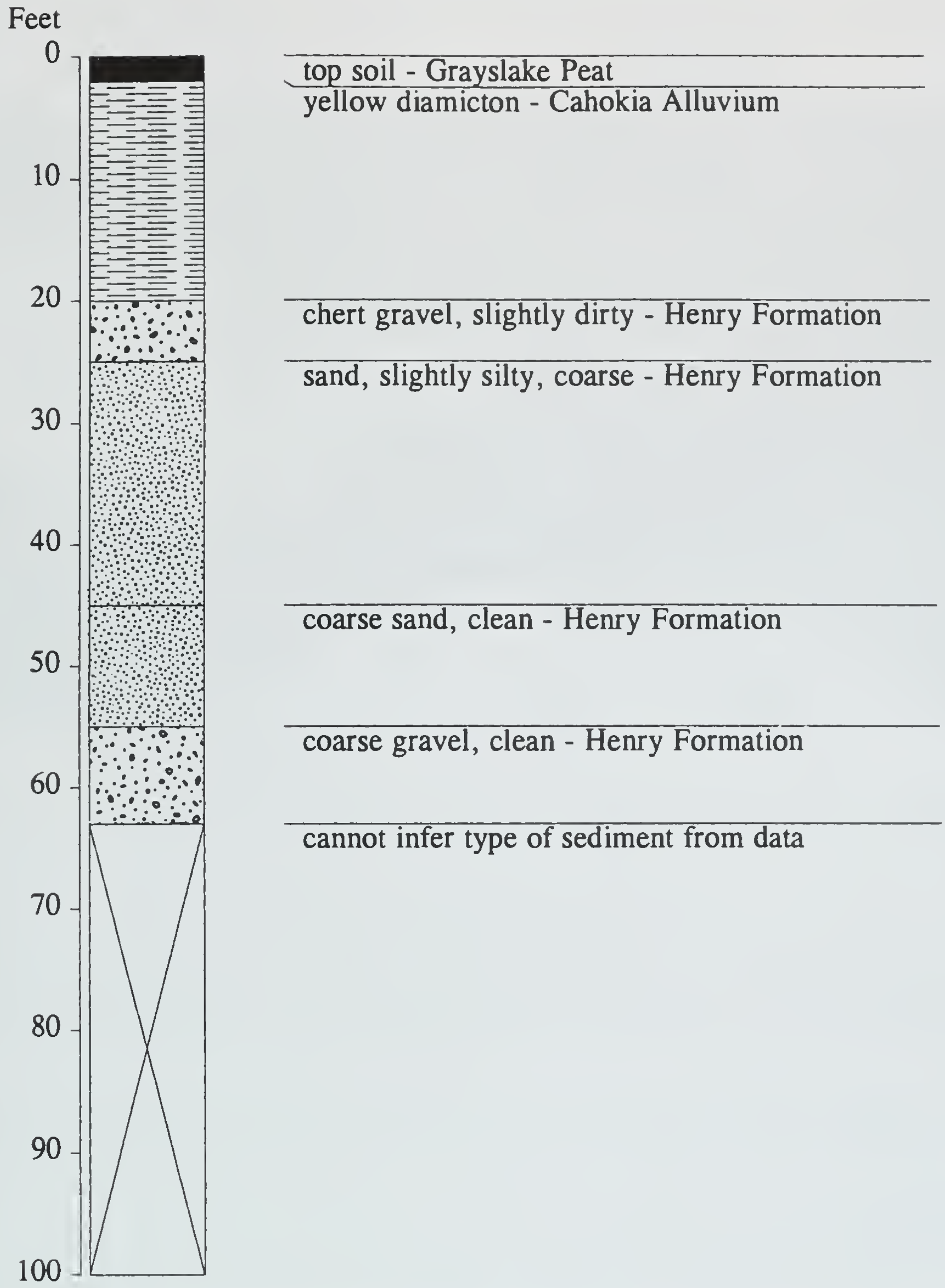


Figure 13 Stratigraphic column of floodplain deposits from a well near Otter Pond, in the SE SE SE quarter of Section 21, T11S, R3W.

exposed), whereas the basal portion of the Grassy Knob acts as a cap at the bluff line. To the east of the bluff, the Grassy Knob thickens to 200 feet.The Grassy Knob Chert is named for exposures on Grassy Knob, a prominent high area on the east wall of the Mississippi River Valley overlooking the Big Muddy River in Jackson County, about 2 miles north of here.

Figure 14 View of Winter's Pond and La Rue Swamp, looking south from Inspiration Point at Stop 2 (photo by W. Frankie).

The Grassy Knob Chert is off-white to yellow, dense, thick, wavy bedded chert with nodular chert beds in the basal portion. Weathering and iron staining produce zones of reddish chert where it is exposed. Fossils are very rare, but horizontal tubular burrows are common. The chert beds were originally siliceous lime-mudstones like the underlying Bailey but have been altered and replaced with silica.

The top of Inspiration Point is composed of the Bailey Limestone. The trace fossil *Zoophycos* sp. can be observed at this location. A zone of *Zoophycos* occurs at or near the top of the Bailey in Illinois and Missouri. This trace fossil is a good indicator of quiet water environments with anoxic (low oxygen) conditions.

STOP 3 Lunch: Trail of Tears State Forest Shelter No. 1 (NW SE SW, Sec. 8, T12S, R2W, 3rd PM, Jonesboro 7.5-Minute Quadrangle, Union County) Are you hungry?

Trail of Tears State Forest

The State Forest System in Illinois was established to set aside lands for the growing of timber needed in production of forest products, for watershed protection, and to provide outdoor recreation. Trail of Tears State Forest is a multiple-use site managed for timber, wildlife, ecosystem preservation, watershed protection, and recreation.

Trail of Tears State Forest lies within the southern section of the Ozark Hills, one of the most rugged landscapes in Illinois. The hills are composed of chert (a weathered limestone residue). Soils are shallow and susceptible to erosion. Ridge tops are narrow, rocky, and dry. Clear streams with gravel bottoms occur in the narrow forested valleys, hemmed in by the steep terrain.

The variety in plant communities is influenced by the terrain. Dry ridge tops and south-facing slopes have black oaks, white oaks, and hickories. Extremely dry sites contain prairie-like openings (barrens and hill prairies) with a mingling of gnarled, open-grown trees and shrubs such as wild azalea, farkleberry, and low-bush blueberry. The shaded north-facing slopes and protected coves support stands of American beech, tuliptree and sugar maple, or red oak, tuliptree and sweetgum. A rich understory of shrubs (including pawpaw, buckeyes, bladdernut and hornbeam) exists in moister sites. In stream valleys, a canopy of American elm, sweetgum, tuliptree, sycamore and sugar maple over a shrub layer of redbud, deciduous holly and spicebush, as well as thickets of wild cane (bamboo) occur. The wildflower flora of the forest's lower slopes and valleys is lush and diverse. On a walk in the spring, a visitor can see many of the woodland wildflowers native to southern Illinois. In all, 620 species of flowering plants, ferns, and fern allies are reported to occur at the state forest.

There are many species of songbirds, including those restricted to large woodland tracts. Two species of poisonous snakes, timber rattlesnakes and northern copperheads, occur here. They are no danger to cautious visitors and must be left as part of the forest's natural environment; indiscriminate killing of snakes is prohibited. Woodland mammals such as fox and grey squirrels, chipmunks, flying squirrels, opossums, skunks, and raccoons are common. Larger mammals known to inhabit the forest are whitetailed deer, red and grey foxes, coyotes, and the wary bobcat.

Historically, the area was used extensively by prehistoric Native Americans. Individuals and small groups hunted game or gathered nuts within the Ozarks, but established their settlements closer to the Mississippi River or Clear Creek. Chert was mined (for making tools) at Iron Mountain, east of the forest.

As European settlers entered (around 1803), Native Americans were pushed south and west. In 1838–39, the Cherokee, Creek, and Chickasaw nations were forced by the U.S. Army to move from the southeast to reservations in Oklahoma Territory. They overwintered at makeshift camps 4 miles south of the forest's southern boundary. Bitter cold and starvation claimed hundreds of lives. The cruel trek came to be known as the Trail of Tears. The state forest's name memorializes the tragic event.

In 1929, the State purchased 3,000 acres as the Kohn-Jackson Forest, later named Union State Forest. During the 1930s, the Civilian Conservation Corps (CCC) camp operated in the forest. The CCC constructed many of the stonework stabilization walls and log-stone shelters within the picnic area and along the forest roads.

The Trail of Tears State Forest of today encompasses 5,114 acres administered by the Division of Land Management. The nursery is operated by the Division of Forest Resources.

Some of the state forest's natural ecosystems are permanently protected within the 222-acre Ozark Hills Nature Preserve. As part of the Illinois Nature Preserves System, Ozark Hills is a living remnant of our state's natural heritage.

One of Illinois' two plant propagation centers, the Union State Nursery, occupies 120 acres of the forest. Approximately 10 acres of the nursery are devoted annually to growing nursery stock. The nursery produces up to 3 million seedlings a year! Certain tree plantations with the forest are seed sources for producing genetically superior stock.

The forest is divided into 27 management compartments, where the relationships of different timber harvest techniques and their effects upon ecosystems are studied. Although sales from those harvests help support related programs at this and other state sites, research and educational use of timber sites on the state forest have a value far beyond any monetary gain from timber sales.

Woodland openings are managed to provide food and cover for upland game species and those small mammals that are important food for predators. Some areas are planted in small grains; others are burned or mowed to maintain grassy habitat for nesting birds and the insects upon which they feed. Hollow trees are left for cavity-nesting wildlife.

Nursery Program of the Illinois Department of Natural Resources, Division of Forest Resources

The Division of Forest Resources operates two nurseries: the Mason State Nursery at Topeka, Illinois, in Mason County, and the Union State Nursery at Jonesboro, Illinois, in Union County. Both facilities have been in operation since the early 1930s. Production has traditionally been tree species for afforestation or reforestation projects on public and private property. The production of shrub species, for wildlife habitat enhancement, has always been a part of the nurseries' production schedule. A third species component was added to the nurseries' production palette in the late 1970s, followed by a fourth component of wetland plant production in the early 1990s.

In the 1970s, the Department of Conservation (now the IDNR) began to expand its activities to include personnel and programs designed to protect and manage the prairie and other natural community areas of the state.

Nursery program During the 1930s and into the 1940s, nursery-produced seedlings were used for planting surface-mined lands, Department of Conservation properties, and Soil Conservation Service projects. Of the plants produced, less than 20% were used on private lands. Starting in the late 1940s and into the 1960s, over 85% of the seedlings were used on private lands. Annual nursery production peaked at 12,019,400 seedlings in 1957. This production level was a result of the Federal Soil Bank Program.

In 1957, over 72% of the production was coniferous species. Shrub species (mainly multiflora rose) accounted for 23% of the production. Less than 5% of the seedlings distributed were native hardwoods.

While this percentage breakdown (with its large emphasis on conifers) continued into the early 1980s, a change in production strategy occurred in 1983. This change in strategy resulted in a major shift in emphasis from conifers to native hardwoods, and involved the discontinuation of the production of non-native plant species (such as amur honeysuckle and autumn olive).

Currently, nursery production averages approximately 5 million seedlings per year. The shift to hardwood production has had a major impact on the production capabilities of the nurseries. While coniferous production can average 25 to 30 trees per square foot, seedbed densities for the hardwood species (black walnut and oaks) is only six trees per square foot.

The distribution of production in 1994 was 23% conifers, 64% native hardwood trees, 9% native shrub species, and 4% prairie forbs.

In 1957, the nurseries were involved in producing about 15 species. Today both nurseries are involved in the production of over 200 plant species. Production involves roughly 59 native tree and shrub species; 56 prairie forb species; 9 warm-season grasses; 21 woodland understory trees, shrubs, and herbaceous species; and 76 wetland species. The number of different species produced annually fluctuates greatly due to seed availability for any given species.

Union State Nursery The Union State Nursery lies entirely within the boundaries of the Trail of Tears State Forest. While the state forest was purchased in 1928, the nursery was not established until 1931. Initial production involved the purchase of lining-out stock that was then grown as multi-year transplants. Actual production of planting stock from seed was not started until 1934.

The nursery consists of 28 acres of seedbed that are under irrigation. In addition, the nursery manages 34 acres of black walnut seed orchards, and 22 acres of oak seed collection areas.

Soils found in the nursery area are the Drury Silt Loam, Alford Silt Loam, Haymond Silt Loam, and Elsah Silt Loam. These soils are predominantly clay and silt with only about 20% to 30% sand. Some areas of the nursery contain a coarse residual gravel. Subsoil drainage is generally good. Field activity can occur in the spring following rain falls of up to 1 inch.

The pH of the pine fields averages 5.0–6.0, and the pH of the hardwood fields averages 6.0–6.8. Application of sulfur and composted tree bark is utilized to maintain pH levels for the production of pine seedlings.

Phosphorus and potassium levels are generally good and are maintained by frequent testing and applications of the respective fertilizer. Nitrogen levels are maintained through top dressing of seedling crops and cover crops.

Organic levels are currently about 3 %. This level had been reached through the incorporation of composted tree bark.

STOP 4 Clear Creek Chert – Trail of Tears State Forest (NW SE SW, Sec. 7, T12S, R2W, 3rd PM, Jonesboro 7.5-Minute Quadrangle, Union County)

The Clear Creek Chert is exposed in a natural cut-bank along a west flowing creek. The exposure is located on the south side of the road and across from the entrance to the Union State Nursery. This formation is the uppermost Lower Devonian unit in the Illinois Basin. The Clear Creek Chert differs from the Bailey and Grassy Knob by having more fossiliferous zones and better developed tripoli deposits. The Clear Creek Chert, which is white to light gray with reddish clays in places, was a shallow-water limestone that was altered to chert and tripoli by ancient hydrothermal activity or hot silica-rich groundwater.

Tripoli is a powdery white substance that is a local economic mineral. It is composed of tiny quartz crystals called microcrystalline silica. This industrial mineral is mined in Alexander County. This microcrystalline silica is produced in varying degrees of fineness for abrasives, polishing compounds, and extenders in paints and plastics. A very fine-sized grade is known as "white rouge," which is used for polishing optical lenses. Over 80% of the tripoli mined is used as a whitener and extender in paint (Berg and Masters 1994). Next time you visit your local hardware store, look for a tube of tripoli polishing compound.

At this location, diagenetic alteration was not complete. Limestone is still present along with abundant silica replacement. So, the rocks have been only partially altered. Dissolution of limestone can cause the chert deposits in many areas to collapse, producing wavy beds.

A zone of spiriferid brachiopods occurs at this location. They can be found in the lower part of the cut-bank. Fossils can be found in the chert gravel within the stream. The Clear Creek Chert contains trilobites, a variety of brachiopods, graptolites, burrows, and borings. The brachiopod found at this location belongs to the genus *Devonospirifer.*

STOP 5 Devil's Bake Oven – Grand Tower (fig. 15) (NW SW SE NE, Sec. 23, T10S, R4W, 3rd PM, Altenburg 7.5-Minute Quadrangle, Jackson County)

Certain characteristics and features surrounding Grand Tower are described by Mark Twain in his book *Life on the Mississippi:*

> The former town gets its name from a huge, squat pillar of rock, which stands up out of the water on the Missouri side of the river—a piece of nature's fanciful handiwork—and is one of the most picturesque features of scenery of that region. For nearer or remoter neighbors, the Tower has the Devil's Bake Oven—so called, perhaps, because it does not powerfully resemble any body else's bake oven; and the Devils's Tea-table—this latter a great smooth-surfaced mass of rock, with diminishing wine-glass stem, perched some fifty or sixty feet above the river, beside a beflowered and garlanded precipice, and sufficiently like a tea-table to answer for any body, Devil or Christian. . . .
>
> The town of Grand Tower was evidently a busier place than it had been in old times, but it seemed to need some repairs here and there, and a new coat of whitewash all over. Still, it was pleasant to me to see the old coat once more. "Uncle" Mumford, our second officer, said the place had been suffering from high water and consequently was not looking its best now. But he said it was not strange that it didn't waste whitewash on itself, for more lime was made there, and of a better quality, than anywhere in the West; and added, "On a dairy farm you never can get any milk for your coffee, nor any sugar for it on a sugar plantation; and it is against sense to go to a lime town to hunt for whitewash." In my own experience I knew the first two items to be true: and also that people who sell candy don't care for candy; therefore there was plausibility in Uncle Mumford's final observation that "people who make lime run more to religion than whitewash." Uncle Mumford said, further, that Grand Tower was a great coaling centre and a prospering place.

Measuring only ¼ acre, Grand Tower is reported to be the smallest national park in the United States; it was originally set aside as a federal preserve in 1871 by President Grant.

For some time, the stories surrounding the furnaces at Grand Tower have only mentioned them as belonging to iron production. However, Mr. Twain indicated that the iron furnaces were originally used to hydrate lime for the production of whitewash. Painting a fence with whitewash truly is an

Figure 15 Devil's Bake Oven at Grand Tower, Stop 5 (photo by W. Frankie).

enjoyable experience (Would you like to take a turn?). Evidently the whitewash industry folded, and the furnaces were converted to the production of iron.

Remnants of ovens used in producing iron are to be found along the one-way drive south through the park beyond the camping area. In 1865, the Grand Tower Mining, Manufacturing and Transportation Company started an iron works at Grand Tower. A few years later, they erected a large shipyard. In the early 1870s, the Lewis Iron Company erected an iron furnace that reputedly was the largest furnace west of Pittsburgh at that time. Specimens of Grand Tower iron won a gold medal at the Centennial World's Fair in Philadelphia in 1876. A gold medal was also won, in 1878, at the Berlin Steel and Iron Fair (Jackson 1964).

There is a great deal of historical significance, legends, and folklore from the area. One of the more interesting stories described as local lore at the Devil's Bake Oven is the story of the haunted type section.

Legend has it that the Bake Oven is haunted. The story goes that the superintendent of the lime kilns company built a house on the east side of the Bake Oven. The foundation of the house still exists today, as do the kilns. Over 120 years ago, the superintendent lived with his young and beautiful daughter alone in the house. His wife died giving birth to his child.

As the young girl grew into the image of his adorable wife, he became more and more overprotective of her. He would not let her go into town or come out to the kiln-works, even though she was nearly 20 years old. Then, one glorious clear day in spring, when her father was working at the kilns, she met a river rogue as his keel-boat landed on the sandy bar near her house. Although he was handsome, he had that dastardly look and was quite possibly a part-time, swashbuckling river pirate, she thought. None the less, when their eyes met there was instant chemistry. There was a tingling in her heart. It was love at first sight.

When her father found out about this “river rat,” he banished him from the area and locked his daughter in the stone house at the Bake Oven. She could only see her love from the window as he passed on his boat. The superintendent stationed an armed guard at the door of his house. Love sick, the poor woman pined away and died after years of imprisonment. To this very day on dark and windy evenings, the local people have heard a mournful lament come from the ruins of the old house. Some people have also claimed to see a ghostly vapor or a hazy white figure of a young woman walking from the crumbling foundation down to the sand bar at the water’s edge.

Geology The rocks exposed at Grand Tower, Illinois, reveal evidence of a major fault zone that trends northwest to southeast across the area (fig. 16). The Grand Tower Limestone (Middle Devonian) is tilted 25° to the northeast and is bounded by faults within the Ste. Genevieve Fault Zone (fig. 17). The bedding can be seen dipping steeply into the ground at the prominence called the Devil’s Bake Oven, the type section for the Grand Tower Limestone. The “Devil’s Backbone” is a ridge that lies south of and runs southeast behind the Bake Oven. The Backbone is composed of the Lingle and Grand Tower Formations (Middle Devonian), as well as the Lower Devonian Clear Creek Chert and Backbone Limestone (fig. 18).

The Grand Tower Limestone was deposited under a warm, shallow seaway that contained numerous shoals built by crinoids and slightly deeper, middle-shelf patch reefs built by rugose corals and stromatoporoids (massive encrusting sponge like organisms). Fossils abound in this limestone. On the back side of the Bake Oven, which is stratigraphically the upper part of the unit, chonetid brachiopods, barrel-shaped orthoconic (straight cone) cephalopods, and bivalves can be found. The Grand Tower Limestone represents a rare deepening-upward carbonate sequence that may relate to active structures in the area during deposition. Most limestone sequences shallow upward, or progress from deeper water deposits to shallower water deposits upward through the sucession of layers. The Grand Tower is different; it goes from a tidally deposited beach sandstone (Dutch Creek) at the base that grades upward into a white, cross-bedded, crinoidal grainstone indicating the existence of off-shore shallow shoals. The unit then interfingers with boundstones or coralline patch reefs that give way to dark gray-brown lime-mudstones. The deepest-water deposits, the lime-mudstones, contain tempestites or storm deposits containing concentrations of shelly brachiopods. Therefore, local tectonic down-warping is probably responsible for the deposition of this limestone.

Rattlesnake Ferry Fault and monocline. The main fault of the Ste. Genevieve Fault Zone in Illinois is commonly known as the Rattlesnake Ferry Fault (fig.19). The name, which was applied first by Weller and Ekblaw (1940), was taken from a now-defunct village on the Big Muddy River about 4 miles east of Grand Tower. Although generally spoken of as a fault, the Rattlesnake Ferry structure actually is a faulted flexure or monocline. Faults, where present, follow the line of steepest dips on the northeast-dipping limb of the monocline. Since the fold and faults clearly developed in the same tectonic activity, they are discussed together here.

The Rattlesnake Ferry Fault and monocline cross the Mississippi River into Illinois just north of Grand Tower (fig. 19). From Grand Tower, the structure continues on a heading of S 80° E, 4 miles beneath the floodplain of the Mississippi River. It reappears in the bluffs at Rattlesnake Ferry, where its strike abruptly changes to S 40° E. From Rattlesnake Ferry to Bald Knob, a distance of about 7 miles, the deformed zone is narrow, the monocline dips steeply and is locally overturned, and the

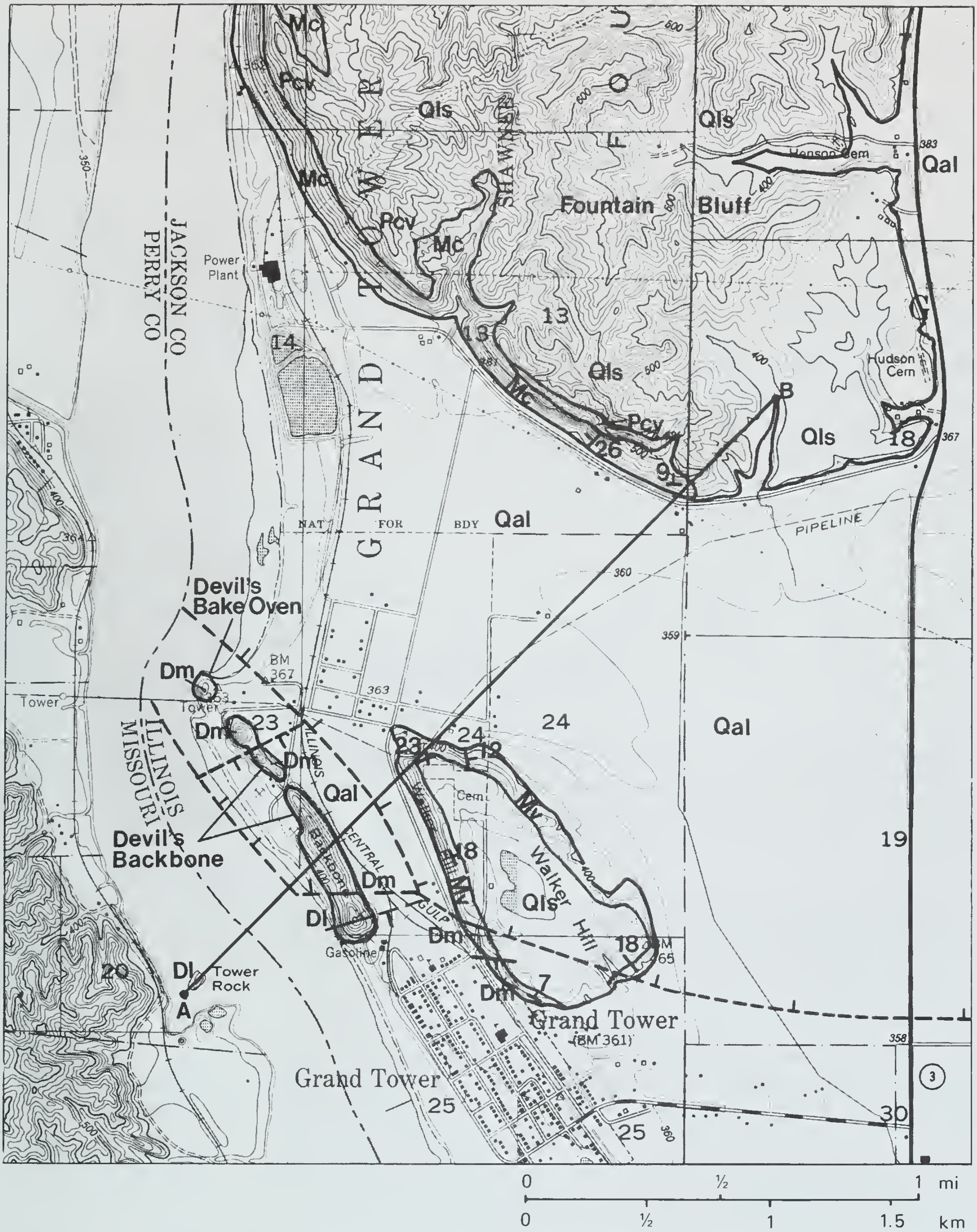
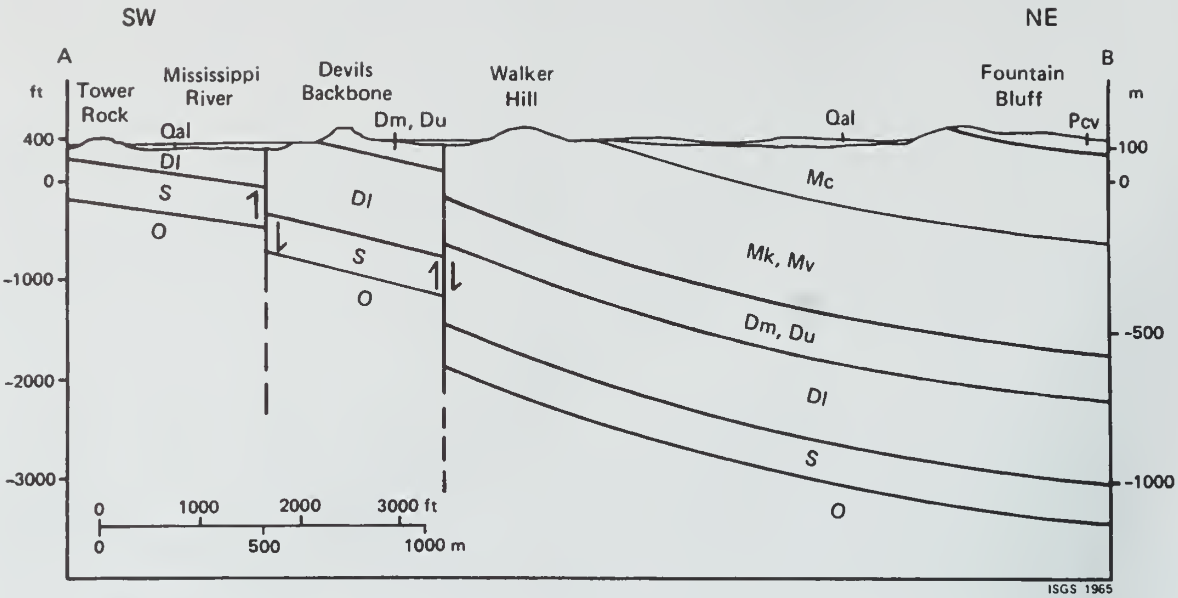


Figure 16 Geologic map of the Ste. Genevieve Fault Zone at Grand Tower. Line of cross section A–B shown on figure 17 (modified from Nelson and Lumm 1985).



Qal QUATERNARY alluvium
PENNSYLVANIAN
Pcv Caseyville Formation
MISSISSIPPIAN
Mc Chesterian Series
Mk, Mv Kinderhookan and Valmeyeran Series

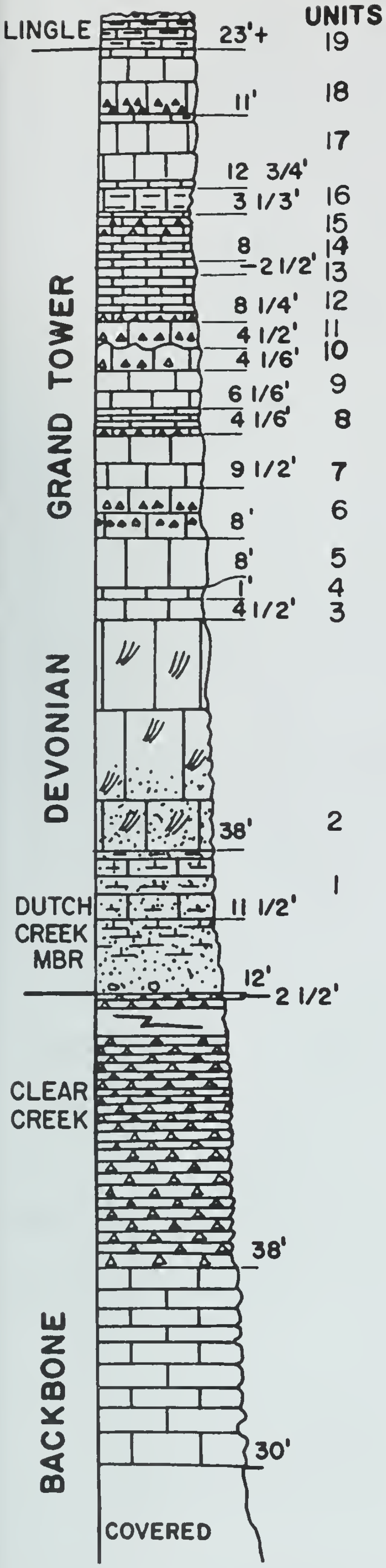
DEVONIAN
Dm, Du Middle and Upper Devonian Series
Dl Lower Devonian Series
S SILURIAN
O ORDOVICIAN

Figure 17 Cross section of line A–B, figure 16, near Grand Tower (modified from Nelson and Lumm 1985).

displacement on the fault is large. Surface faults splinter and die out a short distance southeast of Bald Knob, but the monocline continues on a heading of S 15° to 20° E for several miles farther south. The fold gradually becomes broader and gentler, its displacement decreases, and it loses its identity.

Structure at Grand Tower Figure 16 is a geologic map of the Ste. Genevieve Fault Zone at Grand Tower. Structure is known from surface exposures of bedrock in the Devil's Bake Oven, the Devil's Backbone, Walker Hill, and Fountain Bluff. All these hills are isolated remnants or bedrock islands on the floodplain, created by repeated shifts in the course of the Mississippi River during Quaternary and earlier time.

Two parallel faults, both downthrown to the northeast, are mapped in Missouri opposite Grand Tower. These trace to the two faults that straddle the Devil's Bake Oven and most of the Devil's Backbone (fig. 16). The southern of the two faults cuts the southern end of the Backbone on a heading of S 80° E. This fault displaces Grand Tower and Lingle Limestone on the north against Clear Creek Chert and Backbone Limestone on the south, for a stratigraphic offset of approximately 450 feet downward to the north. The fault surface is not visible, but exposures are sufficient to indicate that it dips steeply. The other large fault is entirely covered by alluvium between the Backbone and Walker Hill. The existence of this fault is indicated by the fact that measured dips of strata on Walker Hill and the Devil's Backbone are not great enough to account for differences of elevation of strata on the two hills. The throw on the fault is probably 350 to 400 feet, with the northeast side downthrown (fig. 17).



UNIT 19 - Limestone, brownish-gray, argillaceous, thin-bedded. Ranges from biomicrite in lower 20 feet (L1) to biopelmicrite at top (L2, L3). Contains abundant brachiopods, solitary corals, and trilobites.

UNIT 18 - Limestone, brownish-gray, lithographic, massive, lower 4 feet cherty, brachiopod-ostracode-crinoid biomicrite, burrowed.

UNIT 17 - Limestone, brownish-gray, lithographic, massive, upper 9 inches thin-bedded, ostracode-brachiopod-crinoid biomicrite, burrowed.

UNIT 16 - Limestone, bluish-gray, argillaceous, massive, brachiopod-gastropod-ostracode biomicrite.

UNIT 15 - Limestone, pinkish-brown, lithographic, thin-bedded with shaley partings, upper 2.5 feet chery, brachiopod-ostracode biomicrite with "fish" fragments, some voids filled with sparry calcite, burrowed.

UNIT 14 - Limestone, light gray, very fine-grained, crinoid-brachiopod-ostracode biomicrite, burrowed.

UNIT 13 - Limestone, borwnish-gray, crinoid-brachiopod biomicrite in upper part to crinoid-brachiopod biomicrudite with many forams in lower part. Upper part lighter in color than lower part. Ostracodes, <u>Tentaculites</u>, gastropods, and corals are also present. Some sparry calcite occurs as crack and pore fillings.

UNIT 12 - Limestone, brownish-gray, crinoid-brachiopod biomicrite, with some sparry calcite in cracks, thin-bedded, some chert at base.

UNIT 11 - Limestone, brownish-gray, cherty, brachiopod-crinoid-ostracode biomicrite.

UNIT 10 - Limestone, brownish-gray, lithographic, brachiopod, crinoid-ostracode biomicrite, conglomeratic, phosphatic, and with buff-gray chert at base.

UNIT 9 - Limestone, brownish-gray, very fine-grained, calcarenitic, brachiopod-crinoid-ostracode biomicrite, burrowed.

UNIT 8 - Limestone, dark brownish-gray, lithographic, crinoid-brachiopod biomicrite, thin-bedded with tan chert at the base.

UNIT 7 - Limestone, brownish-gray, thick-bedded, crinoid-brachiopod biomicrite with some bryozoans present. Bioturbate.

UNIT 6 - Limestone, brownish-gray, clayey and silty, crinoid-brachiopod biomicrite with some bryozoans present. Some sparry calcite cement present. Prominent chert band forms reentrant in Bakeoven.

UNIT 5 - Limestone, brownish-gray, massive, crinoid-brachiopod-gastropod biomicrudite with some <u>Tentaculites</u> and bryozoans present. Brachiopods are both punctate and impunctate.

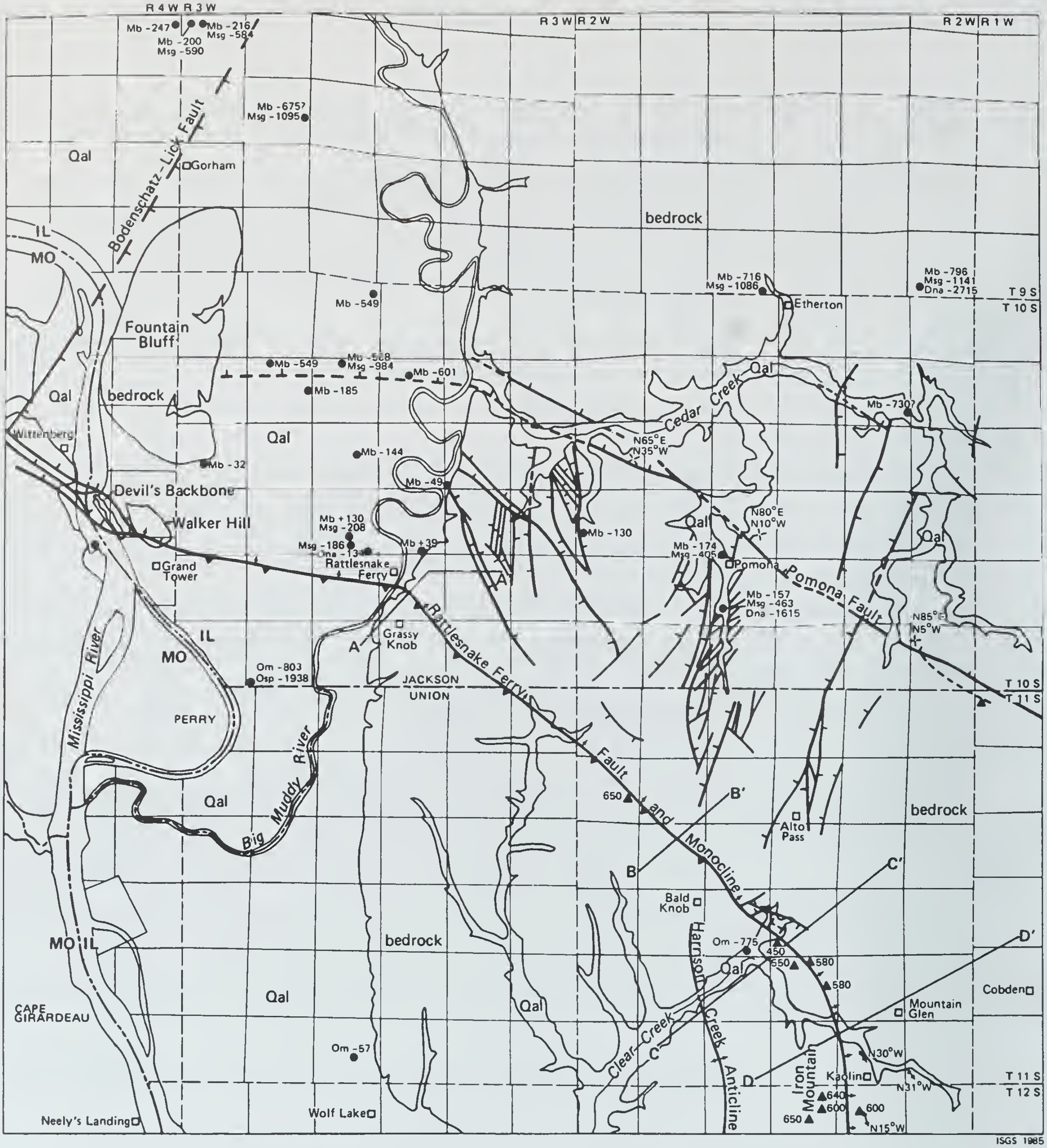
UNIT 4 - Limestone, brownish-gray, crinoid-brachiopod biomicrudite with some bryozoans present, mottled. Brachiopods punctate and impunctate.

UNIT 3 - Limestone, brownish-gray, crinoid-brachiopod biomicrite in the upper part. Brachiopods are both punctate and impunctate and some bryozoans occur also. The lower part consists of biosparite to biomicrite (crinoid-brachiopod) with some biomicrudite present. Numerous "fucoids", brachiopods and corals (<u>Hexagonaria</u>) are present.

UNIT 2 - Limestone, light gray, medium to coarse-grained, massive, crinoid-brachiopod biosparite in upper part, crinoid-brachiopod biomicrite with considerable sparry calcite in the middle, and a crinoid-brachiopod biosparudite with some micrite in the lower part. Lower part arenaceous, strongly cross-bedded in lower half, indistinctly crossbedded in upper half, with ripple marks and wavey beds. Silty and clayey at base.

UNIT 1 - Limestone, light gray, medium to coarse-grained, arenaceous, argillaceous, crinoid-brachiopod biosparudite which is somewhat micritic with interbedded light gray, calcareous sandstones.

Figure 18 Generalized columnar section at the Devil's Bake Oven and Devil's Backbone, north of Grand Tower (modified from Collinson in Meents and Swann 1965, Fraunfelter 1987).



Qal Quaternary alluvium

● borehole, elevation (ft) at top of unit

Mb	Beech Creek Limestone (Chesterian)
Msg	Ste. Genevieve Limestone
Dna	New Albany Shale
Om	Maquoketa Shale
Osp	St. Peter Sandstone

- reverse fault, tic on upthrown side
- fault, tic on downthrown side
- anticline
- monocline
- N85°E N5°W systematic fractures
- N30°W calcite-filled fractures
- ▲ 650 outcrop of Eocene(?) gravel, elevation in ft
- A—A' line of cross section (figs. 20, 21)

Figure 19 Structural features of the Ste. Genevieve Fault Zone, Jackson and Union Counties (modified from Nelson and Lumm 1985).

The two faults merge and cross the southern end of Walker Hill on a bearing of slightly south of east. The displacement of this fault, 800 feet (245 m) downward to the north, equals the sum of throws on the two faults that straddle the Backbone. Grand Tower Limestone (Middle Devonian) is juxtaposed with Valmeyeran Salem Limestone (middle Mississippian). The main fault surface is not visible in outcrop, but small faults or fractures in Salem Limestone may be observed immediately north of the fault zone; they dip steeply and contain breccia and nearly vertical (dip-slip) slickensides.

Several small faults on Devil's Backbone trend east-northeast and thus run obliquely to larger faults nearby. The small faults are nearly vertical or steeply inclined normal faults showing no drag and little or no gouge, breccia, slickensides, or mineral fillings. Fractures or joints in the limestone are rare and not systematic except in the area of faults.

The monocline is relatively gentle at Grand Tower (fig. 17). Dips range from 15° to 25° on Devil's Backbone, from 12° to 23° on Walker Hill north of the fault, and about 10° or less on Walker Hill south of the fault.

Changes in inclination are gradual. Steep dips, such as are common elsewhere along the Rattlesnake Ferry Fault, are not observed. In most cases, bedding strikes roughly parallel to the nearest large fault. The total uplift at Grand Tower is slightly more than 3,000 feet. Only about 800 feet, or 25% to 30% of the total, is due to faulting; the rest is due to folding. Width of the deformed zone is difficult to define. Rocks at both ends of the cross section (fig. 17) are gently tilted, but the dip flattens very gradually in both directions away from the fault zone.

From Walker Hill to Rattlesnake Ferry, the fault zone and flexure are entirely concealed by Quaternary alluvium. The covered portion of the structure is approximately 3½ miles long and bears S 80° E. Nelson and Lumm (1985) provide a more detailed description of the Rattlesnake Ferry fault zone in the ISGS Contract/Grant Report 1985-3 *Ste. Genevieve Fault Zone, Missouri and Illinois.*

STOP 6 Fountain Bluff (NW SE NE, Sec. 36, T9S, R4W, 3rd PM, Gorham 7.5-Minute Quadrangle, Jackson County)

Fountain Bluff is composed of the basal Pennsylvanian Caseyville Formation. It contains upper Mississippian formations on the southern side of the bluff (fig 16). At this location, the steep bluff is made up of layers of quartz-rich, coarse- to medium-grained sandstone that contains iron in the form of Liesegang bands. The iron banding can be seen from the road high up on the bluff. It formed from ancient groundwater that was rich in iron. The Liesegang bands distort the original bedding and form a boxwork-like texture within the sandstone. Primary sedimentary structures occur in the form of cross bedding and tabular bedding, whereas the contorted bedding was formed later by the Liesegang bands.

The depositional setting in this area was dominated by deltaic sedimentation. The rocks were deposited in a river-dominated deltaic setting. Large amounts of sands, silts, and clays were derived from the east and northeast where a huge mountain chain had developed from plate tectonic collision. This area was engulfed by terrigenous (land-generated) material that has been preserved as Fountain Bluff.

Figure 20 Petroglyphs (carved images) in the Caseyville Sandstone at Fountain Bluff at Stop 6 (photo by W. Frankie).

Fountain Bluff Rock Art Site (11J27)—*by Mark J. Wagner, Center for Archaeological Investigations, Southern Illinois University at Carbondale*

The Fountain Bluff site is one of the most well-known rock art sites in southern Illinois (fig. 20). It primarily contains petroglyphs (carved images), although pictographs (painted images) may also have been present at one time. The site apparently has been known since at least the late nineteenth century, when a mention of "Indian rock carvings" at Fountain Bluff appeared in the Jackson County history. The site did not come to the attention of the archaeologists, however, until the 1950s. Since that time, the site has been severely damaged by the chalking in of most of the petroglyphs to take pictures of them, the repainting of pictographs with house paint to "preserve" them, shooting of the bird petroglyphs with shotguns, and the carving of names and initials.

The rock art at the Fountain Bluff site appears to date to the Late Woodland (A.D. 450–900) and Mississippian (A.D. 900–1550) periods. Images that may date to the Late Woodland period include carvings of deer, small people, and birds. These images may have been created by shamans, a type of religious practitioner common in pre-farming societies. Shamans enter trances as part of religious ceremonies in which they experience out-of-body sensations as they fly to other worlds to search for lost souls, consult spirits, and communicate with the dead. Animals, small human-like figures, and especially birds are common figures at shaman-related rock art sites. Look on the back of one of the large rocks at the west end of the shelter floor to see a group of small people that may be shaman-created images. A deer located on the side wall at the west end of the site also may be related to shamanistic ceremonies. The numerous birds on the rear wall possibly may be representations of the shaman in flight. Notice the shotgun-blast scars that surround the birds at the west end of the shelter.

During the Mississippian period (A.D. 900–1550) shamans appear to have been replaced by priests as society became more complex, larger settlements appeared, and farming became a way of life. Mississippian images at Fountain Bluff include the cross-in-circle and human hands. The cross-in-circle is a very old symbol that variously represents the sun, sacred fire, or the Upper World. During the eighteenth century, many Indians built their fires with a cross-pattern of four logs similar to the design on the rear. Human hands also have a variety of meanings. Look on the side of one of the large blocks on the shelter floor for a human hand. During the Mississippian period, human hands often symbolized the sun. The carving or painting of hands on a wall also can indicate spiritual ownership of a particular place. During the historic period (post–A.D. 1673), warriors who struck an enemy were allowed to paint human hands over their mouths as a war honor. The recovery of copper plates with human figures with hands over their mouths from some Mississippian sites indicates that this same practice may have existed during the Mississippian period.

REFERENCES

Allen, John W., 1963, Legends and Lore of Southern Illinois: Carbondale, Southern Illinois University, p. 106–108, 313–315.

Buschbach, T.C., and D.R. Kolata, 1991, Regional setting of the Illinois Basin, *in* M.W. Leighton, D.R. Kolata, D.F. Oltz, and J.J. Eidel, editors, Interior Cratonic Basins: American Association of Petroleum Geologists, Memoir 51, p. 29–55.

Clark, P.U., M.R. Greek, and M.J. Schneider, 1988, Surface morphology of the southern margin of the Laurentide Ice Sheet from Illinois to Montana (Abstr.), *in* Program and Abstracts of the Tenth Biennial Meeting: American Quaternary Association, University of Massachusetts, Amherst, p. 60.

Clark, S.K., and J.S. Royds, 1948, Structural trends and fault systems in Eastern Interior Basin: American Association of Petroleum Geologists Bulletin, v. 32, no. 9, p. 1728–1749.

Damberger, H.H., 1971, Coalification pattern of the Illinois Basin: Economic Geology, v. 66, no. 3, p. 488–494.

Fraunfelter, G.H., 1973, Middle Devonian Limestones at Grand Tower, Illinois, *in* F.G. Ethridge, G.H. Fraunfelter, and J. Utgaard, editors, Depositional Environments of Selected Lower Pennsylvanian and Upper Mississippian Sequences of Southern Illinois: 37th Annual Tri-State Field Conference, Southern Illinois University, Carbondale, p. 139–147.

Fraunfelter, G.H., 1987, Geologic features near Grand Tower, Illinois—The Devil's Backbone, the Devil's Bake Oven, and Fountain Bluff, *in* D.L. Biggs, editor, Geological Society of America Centennial Field Guide—North-Central Section, Art. 60, p. 245–250.

Herzog, B.L., B.J. Stiff, C.A Chenoweth, K.L. Warner, J.B. Sieverling, and C. Avery, 1994, Buried Bedrock Surface of Illinois: Illinois State Geological Survey, Illinois Map 5; scale, 1:500,000; size, 33.25" x 60.75".

Horberg, C.L., 1950, Bedrock Topography of Illinois: Illinois State Geological Survey, Bulletin 73, 111 p.

Jackson, M., 1964, Historical Briefs, *in* Grand Tower, Illinois, on the Mississippi River: Grand Tower Development Committee, 8 p. brochure.

Leighton, M.M., G.E. Ekblaw, and C.L. Horberg, 1948, Physiographic Divisions of Illinois: Illinois State Geological Survey, Report of Investigations 129, 19 p.

Lineback, J.A., et al., 1979, Quaternary Deposits of Illinois: Illinois State Geological Survey Map; scale, 1:500,000; size, 40" x 60"; color.

Locke R.A. II, R.C. Berg, H.A. Wehrmann, M.V. Miller, and D.A. Keefer, March 1997, Vulnerability of Illinois Nature Preserves to Potential Ground-Water Contamination—Volume I. Methodology and Initial Assessment: Illinois State Water Survey Contract Report 612, 125 p.

Mc Fall, D., and J. Karnes, editors, 1995, A Directory of Illinois Nature Preserves, Volume 1: Illinois Department of Natural Resources, Springfield, Illinois, 195 p.

Meents, W.F., and D.H. Swann, 1965, Grand Tower Limestone (Devonian) of Southern Illinois: Illinois State Geological Survey Circular 389, 34 p.

Nance, R.B., and C.G. Treworgy, 1981, Strippable Coal Resources of Illinois. Part 8—Central and Southeastern Counties: Illinois State Geological Survey, Circular 515, 32 p.

Nelson, J.W., 1995, Structural Features in Illinois: Illinois State Geological Survey, Bulletin 100, 144 p.

Nelson, W.J., and D.K. Lumm, 1985, Ste. Genevieve Fault Zones, Missouri and Illinois: Illinois State Geological Survey Contract/Grant Report 1985-3, 94 p.

Piskin, K., and R.E. Bergstrom, 1975, Glacial Drift in Illinois: Illinois State Geological Survey, Circular 490, 35 p.

Reinertsen, D.L., and P.C. Reed, 1988, A Guide to the Geology of the Wolf Lake Area, Union and Jackson Counties: Illinois State Geological Survey, Geological Science Field Trip Guide Book 1988D, 36 p., plus attachments.

Samson, I.E., 1994, Illinois Mineral Industry in 1992 and Review of Preliminary Mineral Production Data for 1993: Illinois State Geological Survey, Illinois Mineral Notes 112, 43 p.

Savage, T.E., 1920, The Devonian Formations of Illinois: American Journal of Science, 4th ser., v. 49, p. 169–182.

State of Illinois, 1994, Illinois Administrative Code, Title 35, Section 620.230 - Class III: Special Resource Groundwater, State of Illinois, Springfield, Illinois.

State of Illinois, 1997, Illinois Compiled Statutes, 1996 State Bar Association Edition, Volume 6, Chapter 525, Act 30, Section 9, West Group, Saint Paul, Minnesota, p. 341–347.

Twain, Mark, 1874, Life on the Mississippi; 1903 ed., Harper & Brothers, New York, p. 183–184.

Weller, J.M., and G.E. Ekblaw, 1940, Preliminary Geologic Map of Parts of the Alto Pass, Jonesboro, and Thebes Quadrangles: Illinois State Geological Survey Report of Investigations 70, 26 p.

Willman, H.B., E. Atherton, T.C. Buschbach, C. Collinson, J.C. Frye, M.E. Hopkins, J.A. Lineback, and J.A. Simon, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey, Bulletin 95, 261 p.

Willman, H.B., and J.C. Frye, 1970, Pleistocene Stratigraphy of Illinois: Illinois State Geological Survey, Bulletin 94, 204 p.

Willman, H.B., et al., 1967, Geologic Map of Illinois: Illinois State Geological Survey Map; scale, 1:500,000; size, 40" x 56"; color.

Willman, H.B., J.A. Simon, B.M. Lynch, and V.A. Langenheim, 1968, Bibliography and Index of Illinois Geology through 1965: Illinois State Geological Survey, Bulletin 92, 373 p.

Worthen, A.H., 1875, Geology and Paleontology: Geological Survey of Illinois, v. 6, 538 p.

GLOSSARY

The following definitions are adapted in total or in part from several sources; the principal source is R.L. Bates and J.A Jackson, eds.,Glossary of Geology, 3rd ed.: American Geological Institute, Alexandria, VA, 1987, 788 p.

Ablation - Separation and removal of rock material and formation of deposits, especially by wind action or the washing away of loose and soluble materials.

Age - An interval of geologic time; a division of an epoch.

Aggrading stream - One that is actively depositing sediment in its channel or floodplain because it is being supplied with more load than it can transport.

Alluviated valley - One that has been at least partially filled with sand, silt, and mud by flowing water.

Alluvium - A general term for clay, silt, sand, gravel, or similar unconsolidated sorted or semisorted sediment deposited during comparatively recent time by a stream or other body of running water.

Anticline - A convex-upward rock fold in which strata have been bent into an arch; the strata on either side of the core of the arch are inclined in opposite directions away from the axis or crest; the core contains older rocks than does the perimeter of the structure.

Aquifer - A geologic formation that is water-bearing and which transmits water from one point to another.

Argillaceous - Said of rock or sediment that contains, or is composed of, clay-sized particles or clay minerals.

Arenite - A relatively clean quartz sandstone that is well sorted and contains less than 10% argillaceous material.

Base level - Lower limit of erosion of the land's surface by running water. Controlled locally and temporarily by the water level of stream mouths emptying into lakes, or more generally and semipermanently by the level of the ocean (mean sea level).

Basement complex - The suite of mostly crystalline igneous and/or metamorphic rocks that generally underlies the sedimentary rock sequence.

Basin - A topographic or structural low area that generally receives thicker deposits of sediments than adjacent areas; the low areas tend to sink more readily, partly because of the weight of the thicker sediments; the term also denotes an area of relatively deep water adjacent to shallow-water shelf areas.

Bed - A naturally occurring layer of earth material of relatively greater horizontal than vertical extent that is characterized by physical properties different from those of overlying and underlying materials. It also is the ground upon which any body of water rests or has rested, or the land covered by the waters of a stream, lake, or ocean; the bottom of a stream channel.

Bedrock - The solid rock (sedimentary, igneous, or metamorphic) that underlies the unconsolidated (non-indurated) surface materials (for example, soil, sand, gravel, glacial till, etc.).

Bedrock valley - A drainageway eroded into the solid bedrock beneath the surface materials. It may be completely filled with unconsolidated (non-indurated) materials and hidden from view.

Braided stream - A low-gradient, low-volume stream flowing through an intricate network of interlacing shallow channels that repeatedly merge and divide, and are separated from each other by branch islands or channel bars. Such a stream may be incapable of carrying all of its load. Most streams that receive more sediment load than they can carry become braided.

Calcarenite - Describes a limestone composed of more or less worn fragments of shells or pieces of older limestone. The particles are generally sand-sized.

Calcareous - Said of a rock containing some calcium carbonate ($CaCO_3$), but composed mostly of something else; (synonym: limey).

Calcining - The heating of calcite or limestone to its temperature of dissociation so that it loses its carbon dioxide; also applied to the heating of gypsum to drive off its water of crystallization to make plaster of paris.

Calcite - A common rock-forming mineral consisting of $CaCO_3$; it may be white, colorless, or pale shades of gray, yellow, and blue; it has perfect rhombohedral cleavage, appears vitreous, and has a hardness of 3 on the Mohs scale; it effervesces (fizzes) readily in cold dilute hydrochloric acid. It is the principal constituent of limestone.

Chert - Silicon dioxide (SiO_2); a compact, massive rock composed of minute particles of quartz and/or chalcedony; it is similar to flint, but lighter in color.

Clastic - Said of rocks composed of particles of other rocks or minerals, including broken organic hard parts as well as rock substances of any sort, transported and deposited by wind, water, ice or gravity.

Closure - The difference in altitude between the crest of a dome or anticline and the lowest structural or elevation contour that completely surrounds it.

Columnar section - A graphic representation, in the form of one or more vertical column(s), of the vertical succession and stratigraphic relations of rock units in a region.

Conformable - Said of strata deposited one upon another without interruption in accumulation of sediment; beds parallel.

Delta - A low, nearly flat, alluvial land form deposited at or near the mouth of a river where it enters a body of standing water; commonly a triangular or fan-shaped plain extending beyond the general trend of a coastline.

Detritus - Loose rock and mineral material produced by mechanical disintegration and removed from its place of origin by wind, water, gravity, or ice; also, fine particles of organic matter, such as plant debris.

Disconformity - An *unconformity* marked by a distinct erosion-produced irregular, uneven surface of appreciable relief between parallel strata below and above the break; sometimes represents a considerable time interval of nondeposition.

Dolomite - A mineral, calcium-magnesium carbonate ($Ca,Mg[CO_3]_2$); also the name applied to sedimentary rocks composed largely of the mineral. It is white, colorless, or tinged yellow, brown, pink, or gray; has perfect rhombohedral cleavage; appears pearly to vitreous; effervesces feebly in cold dilute hydrochloric acid.

Drift - All rock material transported by a glacier and deposited either directly by the ice or reworked and deposited by meltwater streams and/or the wind.

Driftless Area - A 10,000-square-mile area in northeastern Iowa, southwestern Wisconsin, and northwestern Illinois where the absence of glacial drift suggests that the area may not have been glaciated.

End moraine - A ridge or series of ridges formed by accumulations of drift built up along the outer margin of an actively flowing glacier at any given time; a moraine that has been deposited at the lower or outer end of a glacier.

Epoch - An interval of geologic time; a division of a period. (Example: Pleistocene Epoch).

Era - The unit of geologic time that is next in magnitude beneath an eon; it consists of two or more periods. (Example: Paleozoic Era).

Escarpment - A long, more or less continuous cliff or steep slope facing in one general direction; it generally marks the outcrop of a resistant layer of rocks, or the exposed plane of a fault that has moved recently.

Fault - A fracture surface or zone of fractures in Earth materials along which there has been vertical and/or horizontal displacement or movement of the strata on opposite sides relative to one another.

Flaggy - Said of rock that tends to split into layers of suitable thickness for use as flagstone.

Flood plain - The surface or strip of relatively smooth land adjacent to a stream channel produced by the stream's erosion and deposition actions; the area covered with water when the stream overflows its banks at times of high water; it is built of alluvium carried by the stream during floods and deposited in the sluggish water beyond the influence of the swiftest current.

Fluvial - Of or pertaining to a river or rivers.

Formation - The basic rock unit, one distinctive enough to be readily recognizable in the field and widespread and thick enough to be plotted on a map. It describes the strata, such as limestone, sandstone, shale, or combinations of these and other rock types. Formations have formal names, such as Joliet Formation or St. Louis Limestone (Formation), generally derived from the geographic localities where the unit was first recognized and described.

Fossil - Any remains or traces of a once-living plant or animal preserved in rocks (arbitrarily excludes Recent remains); any evidence of ancient life. Also used to refer to any object that existed in the geologic past and for which evidence remains (for example, a fossil waterfall)

Friable - Said of a rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder, such as a soft and poorly cemmented sandstone.

Geology - The study of the planet Earth that is concerned with its origin, composition, and form, its evolution and history, and the processes that acted (and act) upon it to control its historic and present forms.

Geophysics - Study of the Earth with quantitative physical methods. Application of the principles of physics to the study of the earth, especially its interior.

Glaciation - A collective term for the geologic processes of glacial activity, including erosion and deposition, and the resulting effects of such action on the Earth's surface.

Glacier - A large, slow-moving mass of ice formed on land by the compaction and recrystallization of snow.

Gradient - A part of a surface feature of the Earth that slopes upward or downward; the angle of slope, as of a stream channel or of a land surface, generally expressed by a ratio of height versus distance, a percentage or an angular measure from the horizontal.

Igneous - Said of a rock or mineral that solidified from molten or partly molten material (that is, from magma).

Indurated - Said of compact rock or soil hardened by the action of pressure, cementation and, especially, heat.

Joint - A fracture or crack in rocks along which there has been no movement of the opposing sides (see also *Fault*).

Karst - Collective term for the land forms and subterranean features found in areas with relatively thin soils underlain by limestone or other soluble rocks; characterized by many sinkholes separated by steep ridges or irregular hills. Tunnels and caves formed by dissolution of the bedrock by groundwater honeycomb the subsurface. Named for the region around Karst in the Dinaric Alps of Croatia where such features were first recognized and described.

Lacustrine - Produced by or belonging to a lake.

Laurasia - A protocontinent of the Northern Hemisphere, corresponding to Gondwana in the Southern Hemisphere, from which the present continents of the Northern Hemisphere have been derived by separation and continental displacement. The supercontinent from which both were derived is Pangea. Laurasia included most of North America, Greenland, and most of Eurasia, excluding India. The main zone of separation was in the North Atlantic, with a branch in Hudson Bay; geologic features on opposite sides of these zones are very similar.

Lava - Molten, fluid rock that is extruded onto the surface of the Earth through a volcano or fissure. Also the solid rock formed when the lava has cooled.

Limestone - A sedimentary rock consisting primarily of calcium carbonate (the mineral, calcite). Limestone is generally formed by accumulation, mostly in place or with only short transport, of the shells of marine animals, but it may also form by direct chemical precipitation from solution in hot springs or caves and, in some instances, in the ocean.

Lithify - To change to stone, or to petrify; especially to consolidate from a loose sediment to a solid rock.

Lithology - The description of rocks on the basis of their color, structure, mineral composition, and grain size; the physical character of a rock.

Local relief - The vertical difference in elevation between the highest and lowest points of a land surface within a specified horizontal distance or in a limited area.

Loess - A homogeneous, unstratified accumulation of silt-sized material deposited by the wind.

Magma - Naturally occurring molten rock material generated within Earth and capable of intrusion into surrounding rocks or extrusion onto the Earth's surface. When extruded on the surface it is called lava. The material from which igneous rocks form through cooling, crystallization, and related processes.

Meander - One of a series of somewhat regular, sharp, sinuous curves, bends, loops, or turns produced by a stream, particularly in its lower course where it swings from side to side across its valley bottom.

Meander scars - Crescent-shaped swales and gentle ridges along a river's flood plain that mark the positions of abandoned parts of a meandering river's channel. They are generally filled in with sediments and vegetation and are most easily seen in aerial photographs.

Metamorphic rock - Any rock derived from pre-existing rocks by mineralogical, chemical, and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment at depth in Earth's crust (for example, gneisses, schists, marbles, quartzites, etc.)

Mineral - A naturally formed chemical element or compound having a definite chemical composition, an ordered internal arrangement of its atoms, and characteristic crystal form and physical properties.

Monolith - (a) A piece of unfractured bedrock, generally more than a few meters across. (b) A large upstanding mass of rock.

Moraine - A mound, ridge, or other distinct accumulation of glacial drift, predominantly till, deposited in a variety of topographic land forms that are independent of control by the surface on which the drift lies (see also *End Moraine*).

Morphology - The scientific study of form, and of the structures and development that influence form; term used in most sciences.

Natural gamma log - One of several kinds of measurements of rock characteristics taken by lowering instruments into cased or uncased, air- or water-filled boreholes. Elevated natural gamma radiation levels in a rock generally indicate the presence of clay minerals.

Nickpoint - A place with an abrupt inflection in a stream profile, generally formed by the presence of a rock layer resistant to erosion; also, a sharp angle cut by currents at base of a cliff.

Nonconformity - An unconformity resulting from deposition of sedimentary strata on massive crystalline rock.

Outwash - Stratified glacially derived sediment (clay, silt, sand, gravel) deposited by meltwater streams in channels, deltas, outwash plains, on flood plains, and in glacial lakes.

Outwash plain - The surface of a broad body of outwash formed in front of a glacier.

Oxbow lake - A crescent-shaped lake in an abandoned bend of a river channel. A precursor of a meander scar.

Pangea - The supercontinent that existed from 300 to 200 million years ago. It combined most of the continental crust of the Earth, from which the present continents were derived by fragmentation and movement away from each other by means of plate tectonics. During an intermediate stage of the fragmentation, between the existence of Pangea and that of the present widely separated continents, Pangea was split into two large fragments, *Laurasia* on the north and *Gondwana* in the southern hemisphere.

Ped - Any naturally formed unit of soil structure (for example, granule, block, crumb, or aggregate).

Peneplain - A land surface of regional scope worn down by erosion to a nearly flat or broadly undulating plain.

Period - An interval of geologic time; a division of an era (for example, Cambrian, Jurassic, Tertiary).

Physiography - The study and classification of the surface features of Earth on the basis of similarities in geologic strucure and the history of geologic changes.

Physiographic province (or division) - (a) A region, all parts of which are similar in geologic structure and climate and which has consequently had a unified geologic history. (b) Aa region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Point bar - A low arcuate ridge of sand and gravel developed on the inside of a stream meander by accumulation of sediment as the stream channel migrates toward the outer bank.

Radioactivity logs - Any of several types of geophysical measurements taken in bore holes using either the natural radioactivity in the rocks, or the effects of radiation on the rocks to determine the lithology or other characteristics of the rocks in the walls of the borehole. (Examples: natural gamma radiation log; neutron density log).

Relief - (a) A term used loosely for the actual physical shape, configuration, or general uneveness of a part of Earth's surface, considered with reference to variations of height and slope or to irregularities of the land surface; the elevations or differences in elevation, considered collectively, of a land surface (frequently confused with topography). (b) The vertical difference in elevation between the hilltops or mountain summits and the lowlands or valleys of a given region; "high relief" has great variation; "low relief" has little variation.

Rift - A long narrow trough, generally on a continent, bounded by normal faults, a graben with regional extent. Formed in places where the forces of plate tectonics are beginning to split a continent. (Example: East African Rift Valley).

Sediment - Solid fragmental matter, either inorganic or organic, that originates from weathering of rocks and is transported and deposited by air, water, or ice, or that is accumulated by other natural agents, such as chemical precipitation from solution or secretion from organisms. When deposited, it generally forms layers of loose, unconsolidated material (for example, sand, gravel, silt, mud, till, loess, alluvium).

Sedimentary rock - A rock resulting from the consolidation of loose sediment that has accumulated in layers (for example, sandstone, siltstone, mudstone, limestone).

Shoaling - Said of an ocean or lake bottom that becomes progressively shallower as a shoreline is approached. The shoaling of the ocean bottom causes waves to rise in height and break as they approach the shore.

Sinkhole - Any closed depression in the land surface formed as a result of the collapse of the underlying soil or bedrock into a cavity. Sinkholes are common in areas where bedrock is near the surface and susceptible to dissolution by infiltrating surface water. Sinkhole is synonymous with "doline," a term used extensively in Europe. The essential component of a hydrologically active sinkhole is a drain that allows any water that flows into the sinkhole to flow out the bottom into an underground conduit.

Slip-off slope - Long, low, gentle slope on the inside of a stream meander. The slope on which the sand that forms point bars is deposited.

Stage, substage - Geologic time-rock units; the strata formed during an age or subage, respectively. Generally applied to glacial episodes (for example, to the Woodfordian Substage of the Wisconsinan Stage.

Stratigraphy - The study, definition, and description of major and minor natural divisions of rocks, particularly the study of their form, arrangement, geographic distribution, chronologic succession, naming or classification, correlation, and mutual relationships of rock strata.

Stratigraphic unit - A stratum or body of strata recognized as a unit in the classification of the rocks of Earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

Stratum - A tabular or sheet-like mass, or a single, distinct layer of material of any thickness, separable from other layers above and below by a discrete change in character of the material or by a sharp physical break, or by both. The term is generally applied to sedimentary rocks, but could be applied to any tabular body of rock. (See also *Bed*)

Subage - A small interval of geologic time; a division of an age.

Syncline - A convex-downward fold in which the strata have been bent to form a trough; the strat on either side of the core of the trough are inclined in opposite directions toward the axis of the fold; the core area of the fold contains the youngest rocks. (See also *Anticline*).

System - A fundamental geologic time-rock unit of worldwide significance; the strata of a system are those deposited during a period of geologic time (for example, rocks formed during the Pennsylvanian Period are included in the Pennsylvanian System).

Tectonic - Pertaining to the global forces that cause folding and faulting of the Earth's crust. Also used to classify or describe features or structures formed by the action of those forces.

Tectonics - The branch of geology dealing with the broad architecture of the upper (outer) part of Earth; that is, the major structural or deformational features, their origins, historical evolution, and relations to each other. It is similar to structural geology, but generally deals with larger features such as whole mountain ranges, or continents.

Temperature-resistance log - A borehole log, run only in water-filled boreholes, that measures the water temperature and the quality of groundwater in the well.

Terrace - An abandoned floodplain formed when a stream flowed at a level above the level of its present channel and floodplain.

Till - Unlithified, nonsorted, unstratified drift deposited by and underneath a glacier and consisting of a heterogenous mixture of different sizes and kinds of rock fragments.

Till plain - The undulating surface of low relief in an area underlain by ground moraine.

Topography - The natural or physical surface features of a region, considered collectively as to form; the features revealed by the contour lines of a map.

Unconformable - Said of strata that do not succeed the underlying rocks in immediate order of age or in parallel position. A general term applied to any strata deposited directly upon older rocks after an interruption in sedimentation, with or without any deformation and/or erosion of the older rocks.

Unconformity - A surface of erosion or nondeposition that separates younger strata from older strata; most unconformities indicate intervals of time when former areas of the sea bottom were temporarily raised above sea level.

Valley trains - The accumulations of outwash deposited by rivers in their valleys downstream from a glacier.

Water table - The point in a well or opening in the Earth where groundwater begins. It generally marks the top of the zone where the pores in the surrounding rocks are fully saturated with water.

Weathering - The group of processes, both chemical and physical, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.

ANCIENT DUST STORMS IN ILLINOIS

Myrna M. Killey

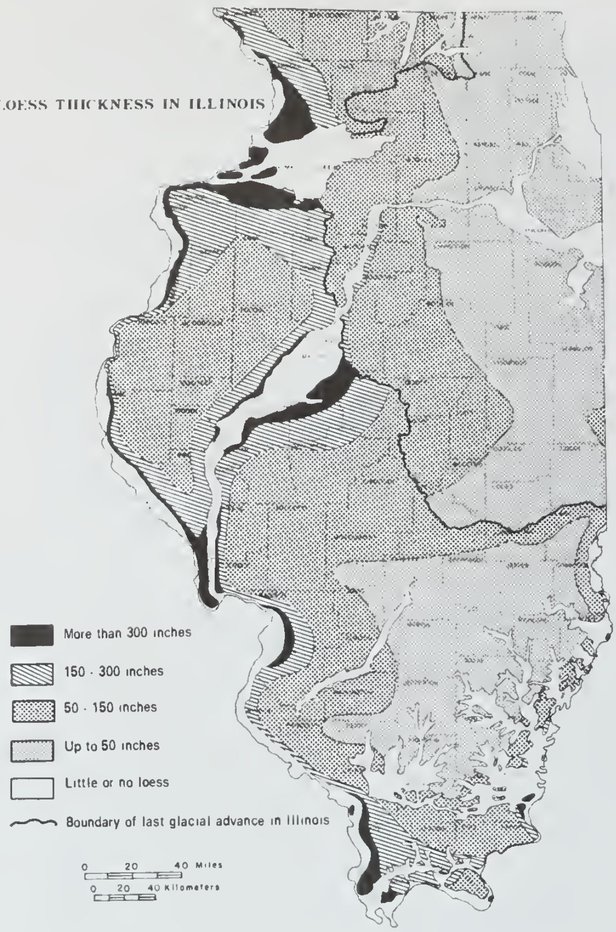
Fierce dust storms whirled across Illinois long before human beings were here to record them. Where did all the dust come from? Geologists have carefully put together clues from the earth itself to get the story. As the glaciers of the Great Ice Age scraped and scoured their way southward across the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

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

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

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

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



LOESS THICKNESS IN ILLINOIS

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

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

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

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

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS IN ILLINOIS

At the close of the Mississippian Period, about 310 million years ago, the sea withdrew from the Midcontinent region. A long interval of erosion that took place early in Pennsylvanian time removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. Ancient river systems cut deep channels into the bedrock surface. Later, but still during early Pennsylvanian (Morrowan) time, the sea level started to rise; the corresponding rise in the base level of deposition interrupted the erosion and led to filling the valleys in the erosion surface with fluvial, brackish, and marine sands and muds.

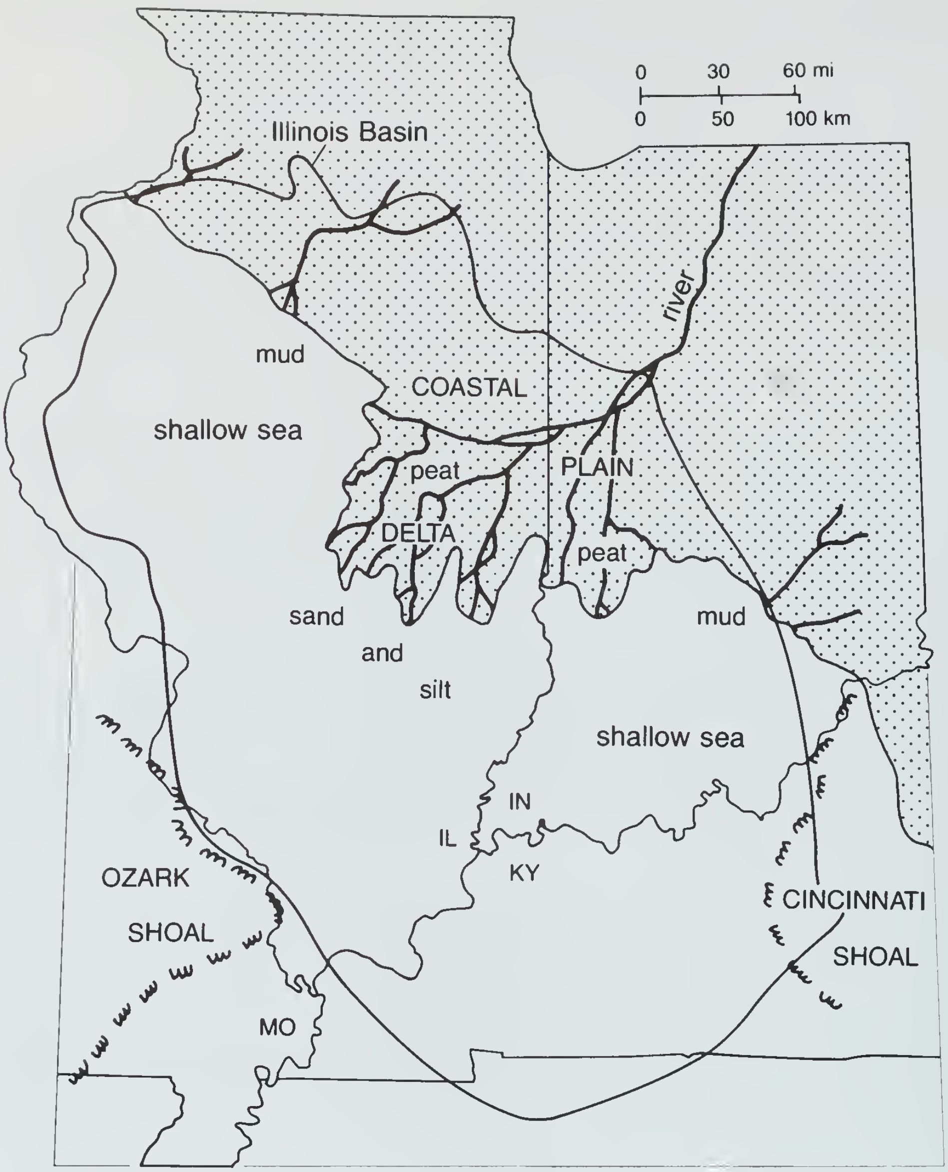
Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those of the preceding Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands to the northeast. This river system formed thin but widespread deltas that coalesced into a vast coastal plain or lowland that prograded (built out) into the shallow sea that covered much of present-day Illinois (see paleogeographic map, next page). As the lowland stood only a few feet above sea level, slight changes in relative sea level caused great shifts in the position of the shoreline.

During most of Pennsylvanian time, the Illinois Basin gradually subsided; a maximum of about 3000 feet of Pennsylvanian sediments are preserved in the basin. The locations of the delta systems and the shoreline of the resulting coastal plain shifted, probably because of worldwide sea level changes, coupled with variation in the amounts of sediments provided by the river system and local changes in basin subsidence rates. These frequent shifts in the coastline position caused the depositional conditions at any one locality in the basin to alternate frequently between marine and nonmarine, producing a variety of lithologies in the Pennsylvanian rocks (see lithology distribution chart).

Conditions at various places on the shallow sea floor favored the deposition of sand, lime mud, or mud. Sand was deposited near the mouths of distributary channels, where it was reworked by waves and spread out as thin sheets near the shore. Mud was deposited in quiet-water areas — in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Limestone was formed from the accumulation of limy parts of plants and animals laid down in areas where only minor amounts of sand and mud were being deposited. The areas of sand, mud, and limy mud deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sand, mud, and lime mud were deposited on the coastal plain bordering the sea. The nonmarine sand was deposited in delta distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies 100 or more feet thick were deposited in channels that cut through the underlying rock units. Mud was deposited mainly on floodplains. Some mud and freshwater lime mud were deposited locally in fresh-water lakes and swamps.

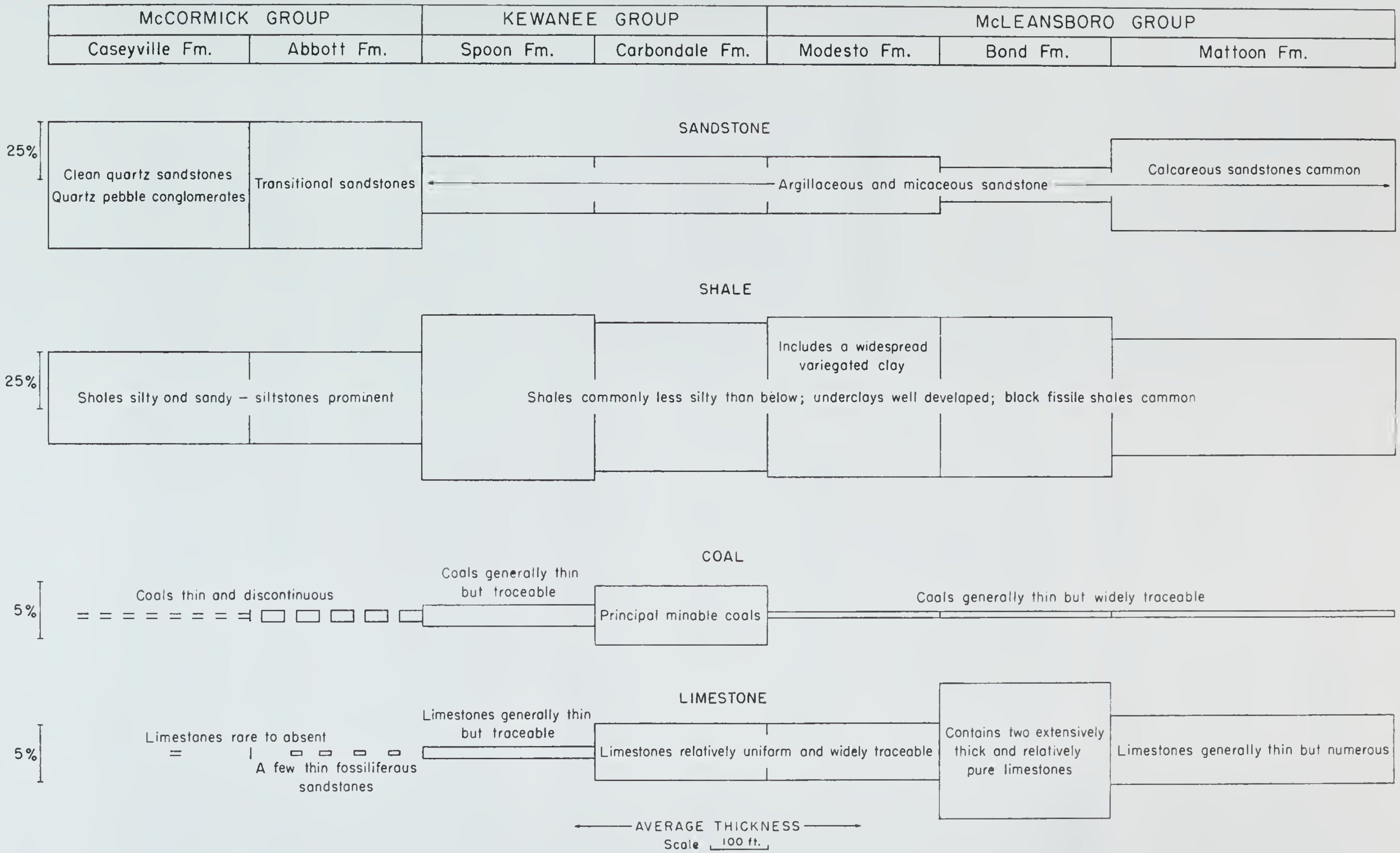
Beneath the quiet water of extensive swamps that prevailed for long intervals on the emergent coastal lowland, peat was formed by accumulation of plant material. Lush forest vegetation covered the region; it thrived in the warm, moist Pennsylvanian-age climate. Although the origin of the underclays beneath the coal is not precisely known, most evidence indicates that they were deposited in the swamps as slackwater mud before the accumulation of much plant debris. The clay underwent modification to become the soil upon which the lush vegetation grew in the swamps. Underclay frequently contains plant roots and rootlets that appear to be in their original places. The vast swamps were the culmination of nonmarine deposition. Resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were laid down over the peat.



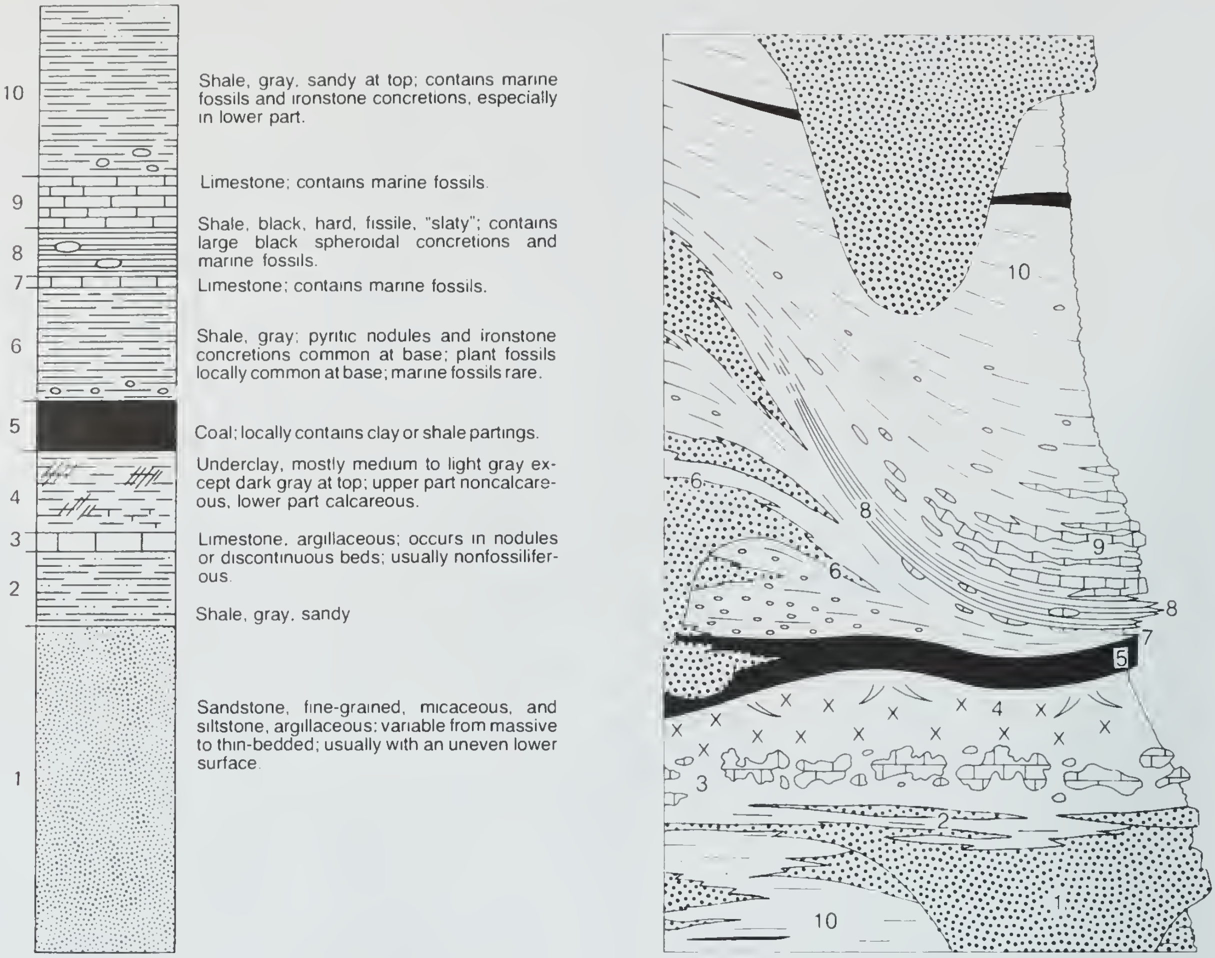
Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows a Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

The Pennsylvanian strata exhibit extraordinary variations in thickness and composition both laterally and vertically because of the extremely varied environmental conditions under which they formed. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and some limestones, however, display remarkable lateral continuity for such thin units. Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.



General distribution of the four principal lithologies in Pennsylvanian strata of Illinois.



The idealized cyclothem at left (after Willman and Payne, 1942) infers continuous, widespread distribution of individual cyclothem units, at right the model of a typical cyclothem (after Baird and Shabica, 1980) shows the discontinuous nature of many units in a cyclothem.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting shoreline. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an “ideally” complete cyclothem consists of ten sedimentary units (see illustration above contrasting the model of an “ideal” cyclothem with a model showing the dynamic relationships between the various members of a typical cyclothem).

Approximately 50 cyclothems have been described in the Illinois Basin but only a few contain all ten units at any given location. Usually one or more are missing because conditions of deposition were more varied than indicated by the “ideal” cyclothem. However, the order of units in each cyclothem is almost always the same: a typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal-gray shale portion (the lower six units) of each cyclothem is nonmarine: it was deposited as part of the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal and gray shale are marine sediments deposited when the sea advanced over the coastal plain.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm, humid Pennsylvanian climate. (Illinois at that time was near the equator.) The deciduous trees and flowering plants that are common today had not yet evolved. Instead, the jungle-like forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate (tropical). Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

Plant debris from the rapidly growing swamp forests — leaves, twigs, branches, and logs — accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented oxidation, and any decay of the peat deposits was due primarily to bacterial action.

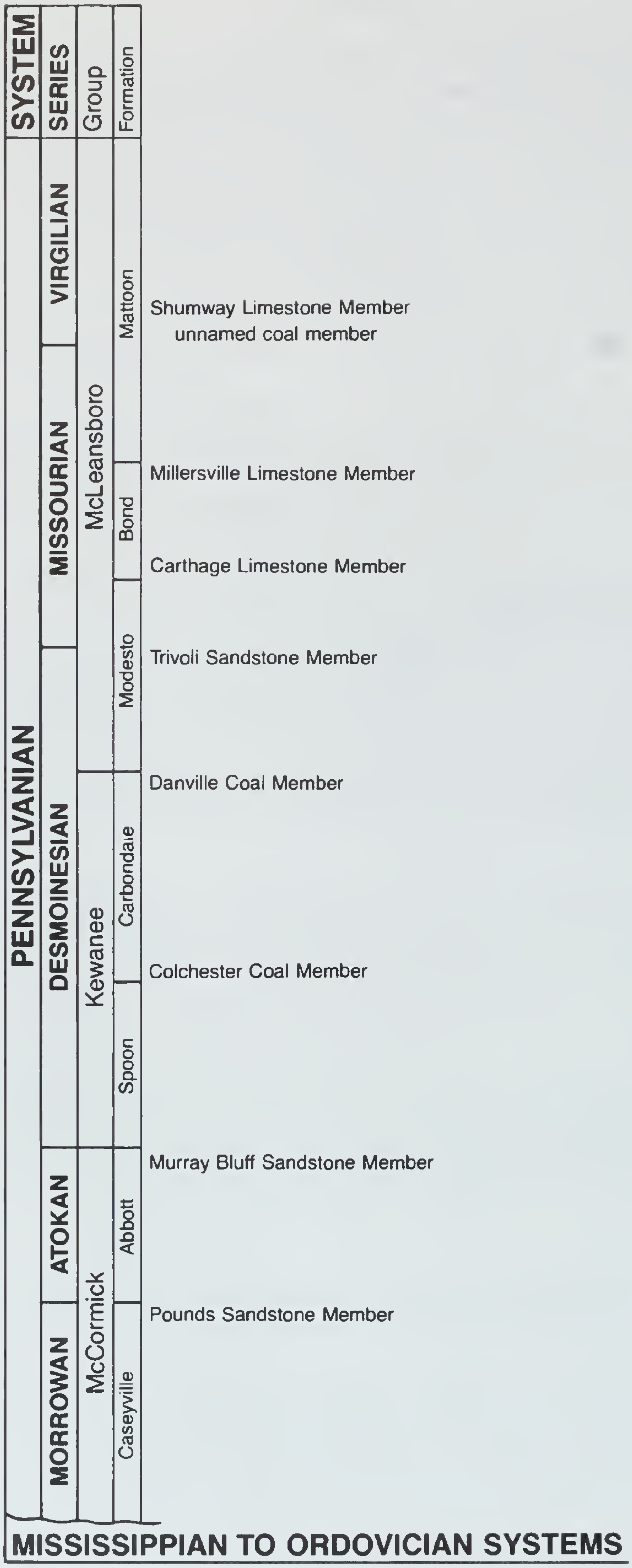
The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests, and the peat deposits were often buried by marine sediments. After the marine transgressions, peat usually became saturated with sea water containing sulfates and other dissolved minerals. Even the marine sediments being deposited on the top of the drowned peat contained various minerals in solution, including sulfur, which further infiltrated the peat. As a result, the peat developed into a coal that is high in sulfur. However, in a number of areas, nonmarine muds, silts, and sands from the river system on the coastal plain covered the peat where flooding broke through levees or the river changed its coarse. Where these sediments (unit 6 of the cyclothem) are more than 20 feet thick, we find that the coal is low in sulfur, whereas coal found directly beneath marine rocks is high in sulfur. Although the seas did cover the areas where these nonmarine, fluvial sediments covered the peat, the peat was protected from sulfur infiltration by the shielding effect of these thick fluvial sediments.

Following burial, the peat deposits were gradually transformed into coal by slow physical and chemical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coal-forming ("coalification") process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shale that occurs above many coals is uncertain. Current thinking suggests that the black shale actually represents the deepest part of the marine transgression. Maximum transgression of the sea, coupled with upwelling of ocean water and accumulation of mud and animal remains on an anaerobic ocean floor, led to the deposition of black organic mud over vast areas stretching from Texas to Illinois. Deposition occurred in quiet-water areas where the very fine-grained iron-rich



Generalized stratigraphic column of the Pennsylvanian in Illinois (1 inch = approximately 250 feet).

mud and finely divided plant debris were washed in from the land. Most of the fossils found in black shale represent planktonic (floating) and nektonic (swimming) forms — not benthonic (bottom-dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shale formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient water of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.

References

Baird, G. C., and C. W. Shabica, 1980, The Mazon Creek depositional event; examination of Francis Creek and analogous facies in the Midcontinent region: *in* Middle and late Pennsylvanian strata on margin of Illinois Basin, Vermilion County, Illinois, Vermilion and Parke counties, Indiana (R. L. Langenheim, editor). Annual Field Conference — Society of Economic Paleontologists and Mineralogists. Great Lakes Section, No. 10, p. 79-92.

Heckel, P. H., 1977, Origin of phosphatic black shale facies in Pennsylvanian cyclothems of mid-continent North America: American Association of Petroleum Geologist Bulletin, v. 61, p. 1045-1068.

Kosanke, R. M., J. A. Simon, H. R. Wanless, and H. B. Willman, 1960, Classification of the Pennsylvanian strata of Illinois: Illinois State Geological Survey Report of Investigation 214, 84 p.

Simon, J. A., and M. E. Hopkins, 1973, Geology of Coal: Illinois State Geological Survey Reprint 1973-H, 28 p.

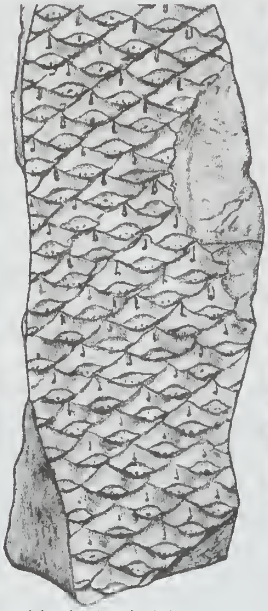
Willman, H. B., and J. N. Payne, 1942, Geology and mineral resources of the Marseilles, Ottawa, and Streator Quadrangles: Illinois State Geological Survey Bulletin 66, 388 p.

Willman, H. B., et al., 1967, Geologic Map of Illinois: Illinois State Geological Survey map; scale, 1:500,000 (about 8 miles per inch).

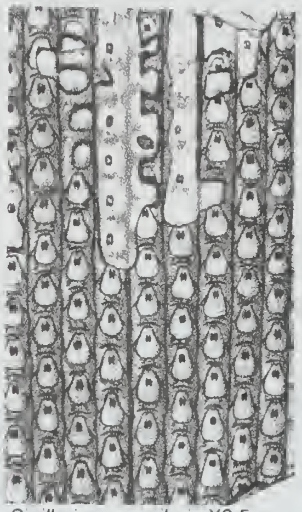
Willman, H. B., E. Atherton, T. C. Buschbach, C. W. Collinson, J. C. Frye, M. E. Hopkins, J. A. Lineback, and J. A. Simon, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

Common Pennsylvanian plants: lycopods, sphenophytes, and ferns

Lepidodendron aculeatum X0.8



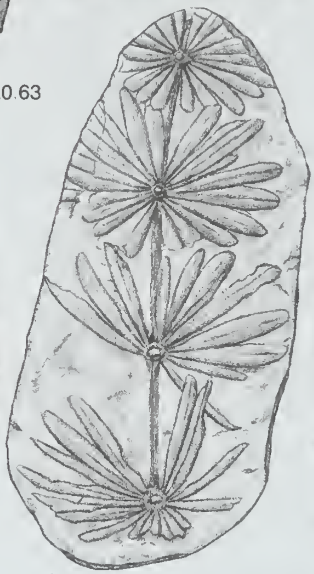
Lepidophloios laricinus X0.63



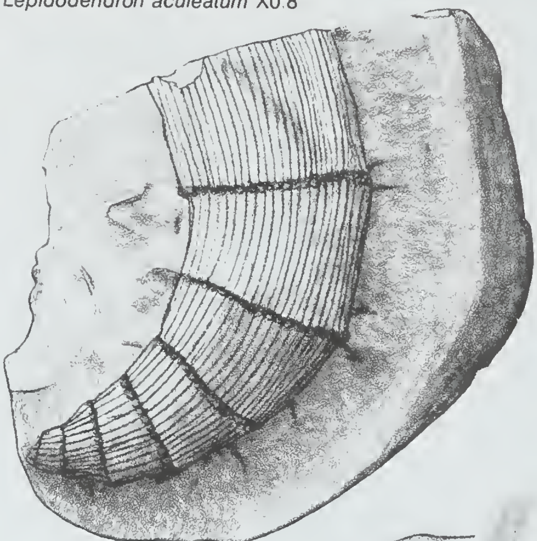
Sigillaria mammilaris X0.5

Stigmaria ficoides X0.32

Lepidostrobus ovatifolius X0.8

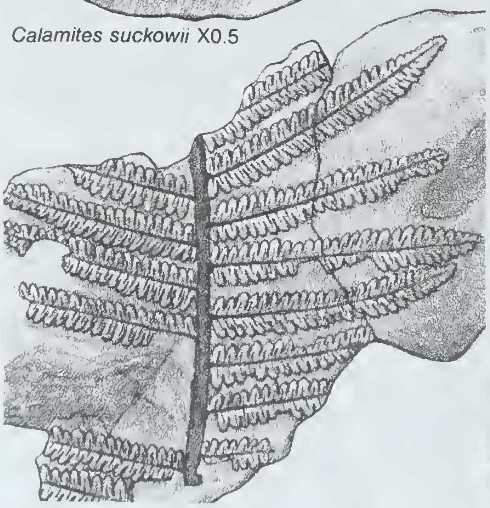


Annularia stellata X0.63



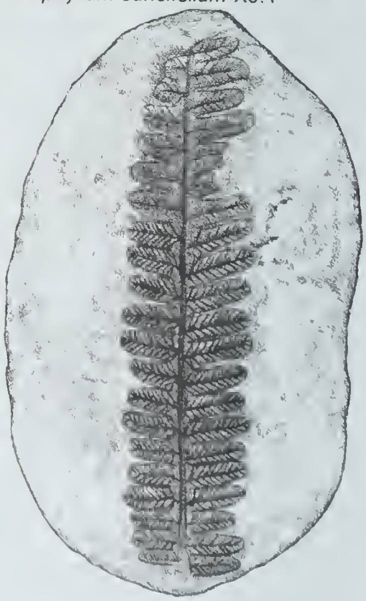
Calamites suckowii X0.5

Sphenophyllum cuneifolium X0.4



Pecopteris sp. X0.32

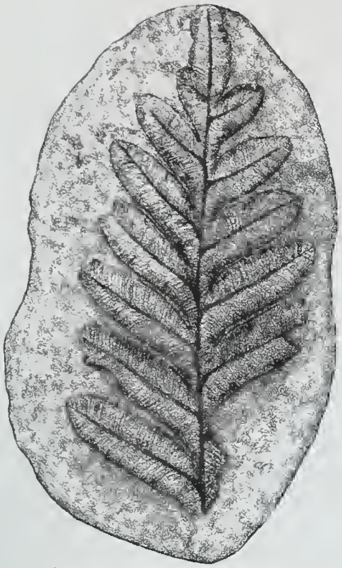
Pecopteris miltonii X2.0



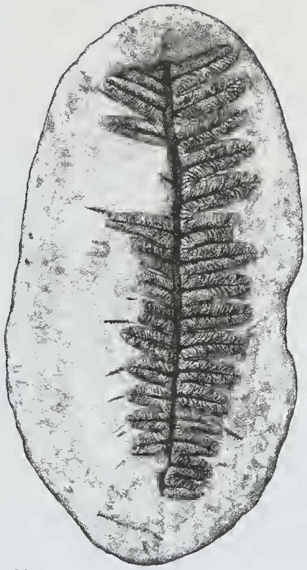
Pecopteris hemitelioides X1.0

J. R. Jennings, ISGS

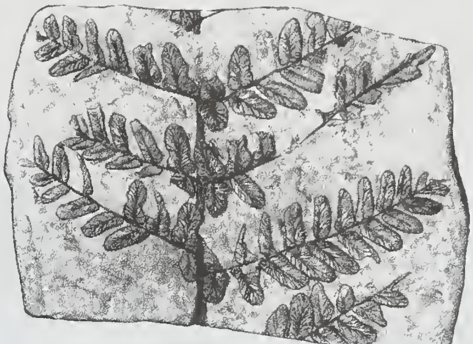
Common Pennsylvanian plants: seed ferns and cordaiteans



Alethopteris serlii X0.63



Alethopteris ambigua X0.63



Neuropteris rarinervis X0.5

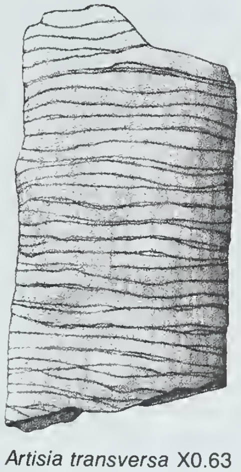
Mariopteris nervosa X0.8

Neuropteris scheuchzeri X0.63

Sphenopteris rotundiloba X0.8

Trigonocarpus parkinsonii X1.25

Cordaicladus sp. X1.0



Artisia transversa X0.63

Cordaicarpon major X2.0

Cordaites principalis X0.63

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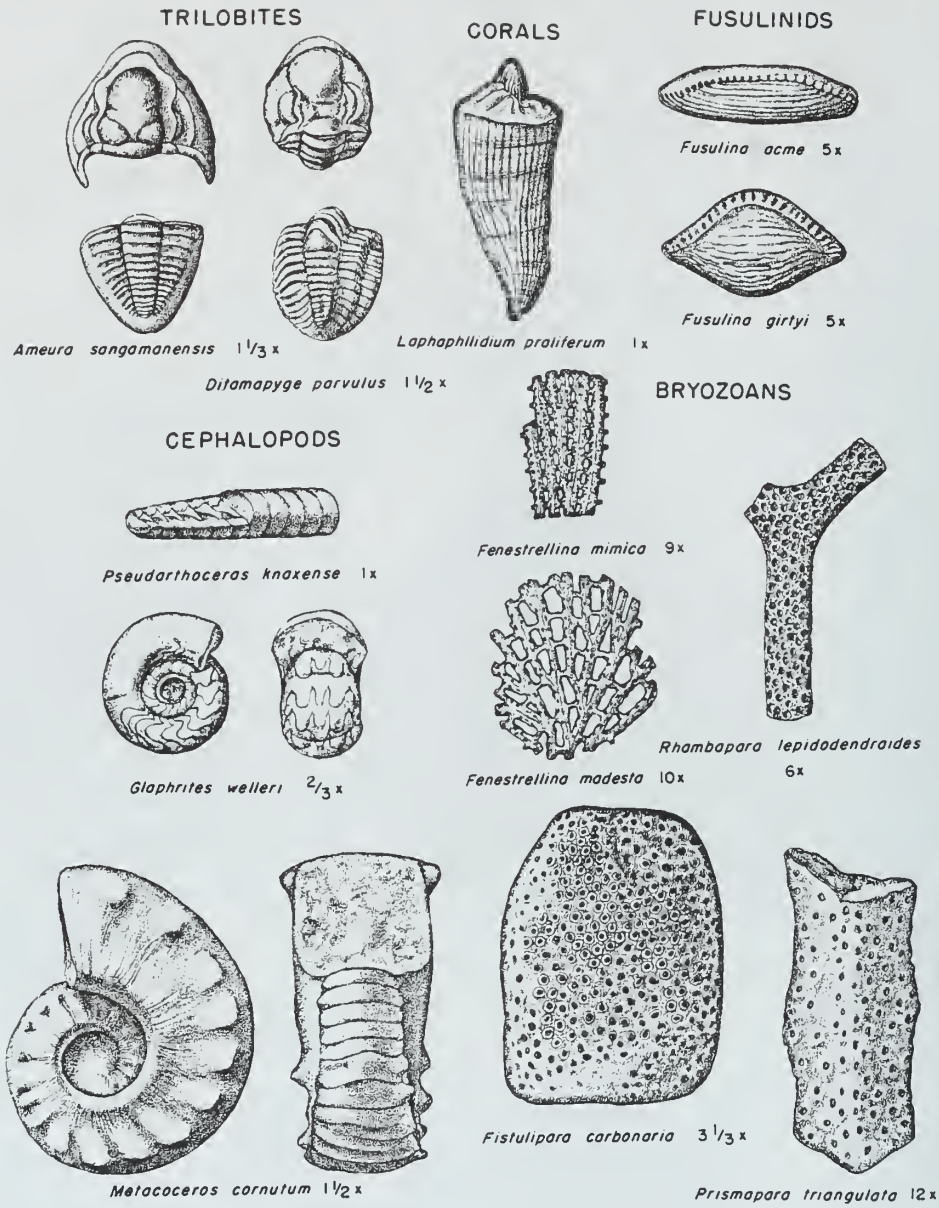

TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5x
Fusulina girtyi 5x
Ameura sangamanensis 1 1/3 x
Laphaphllidium praliferum 1x
Ditamapyge parvulus 1 1/2 x
BRYOZOANS
CEPHALOPODS
Pseudarthoceras knaxense 1x
Fenestrellina mimica 9x
Glaphrites welleri 2/3 x
Fenestrellina madesta 10x
Rhambapara lepidodendraides 6x
Metacoceras cornutum 1 1/2 x
Fistulipara carbonaria 3 1/3 x
Prismapara triangulata 12x

PELECYPODS

Nucula (Nuculopsis) girtyi 1x

Edmonia ovata 2x

Astartella concentrica 1x

Dunbarella knighti 1½x

Cardiomorpha missouriensis "Type A" 1x

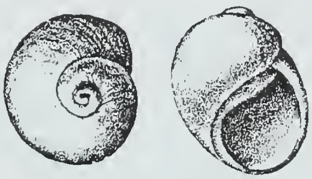
Cardiomorpha missouriensis "Type B" 1½x

GASTROPODS

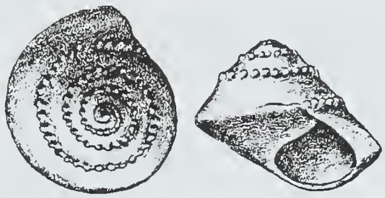
Euphemites carbonarius 1½x

Trepospira illinoisensis 1½x

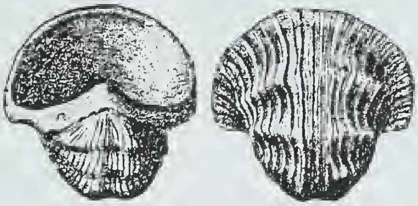
Donaldina robusta 8x



Naticopsis (Jedria) ventricosa 1½x



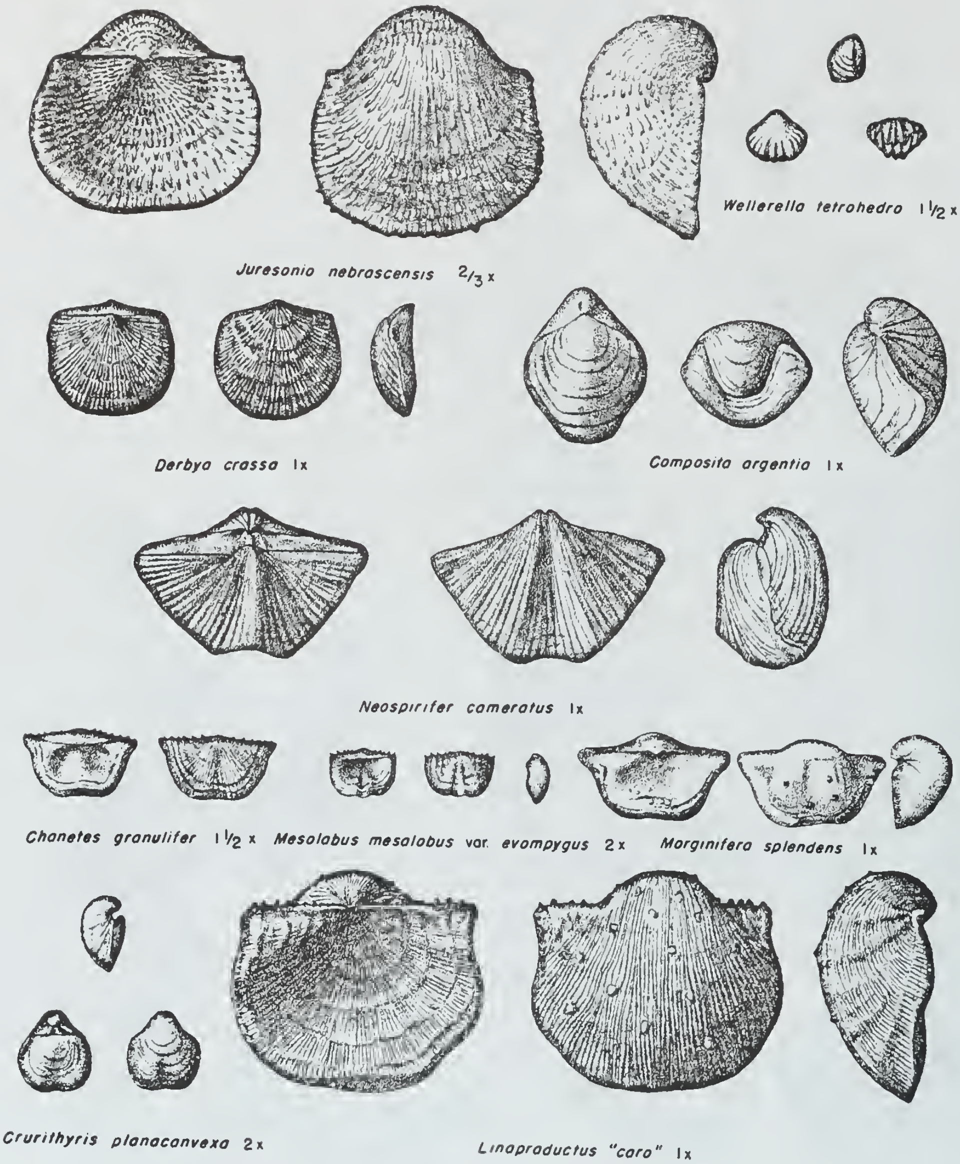
Trepospira sphaerulata 1x

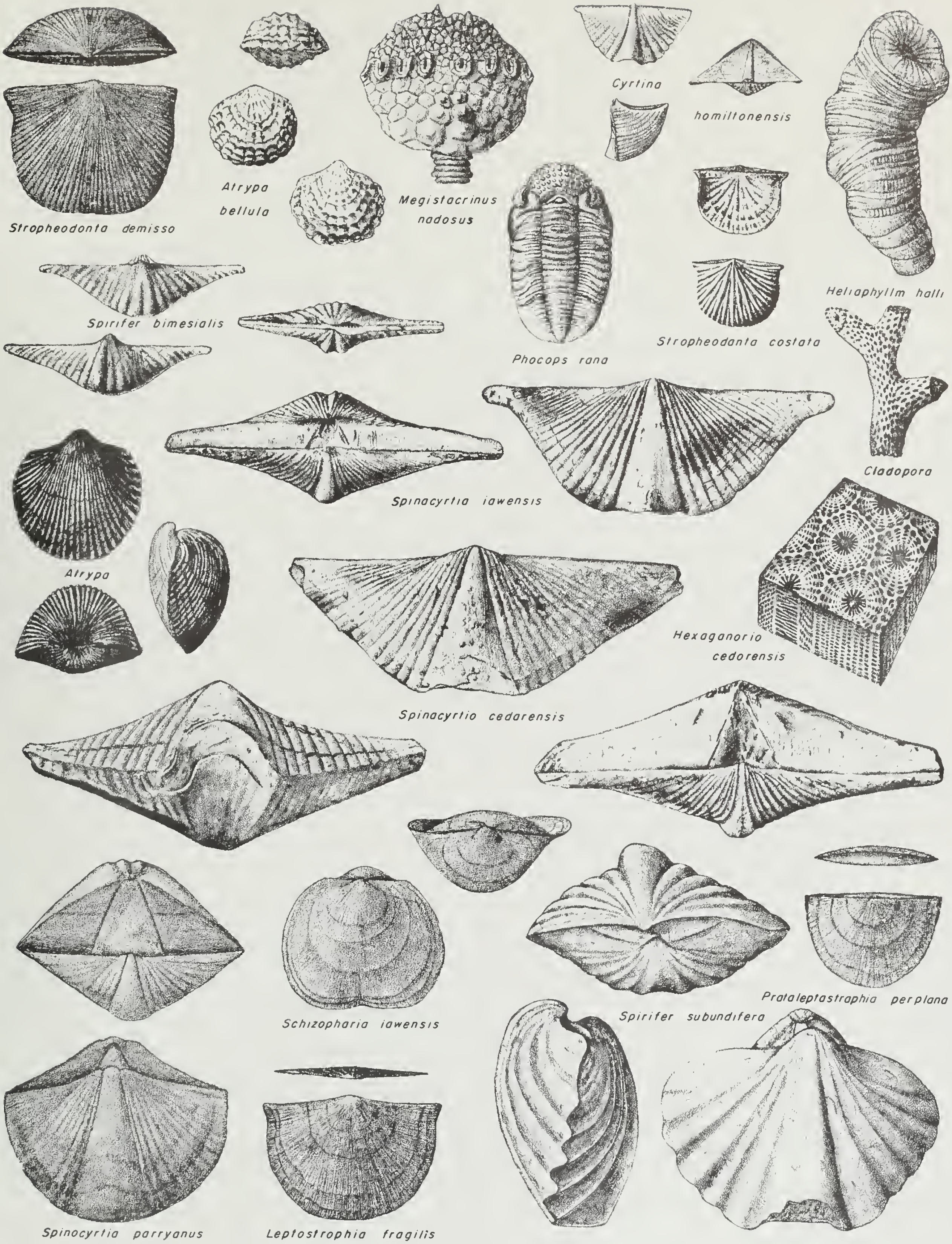


Knightites montfortianus 2x

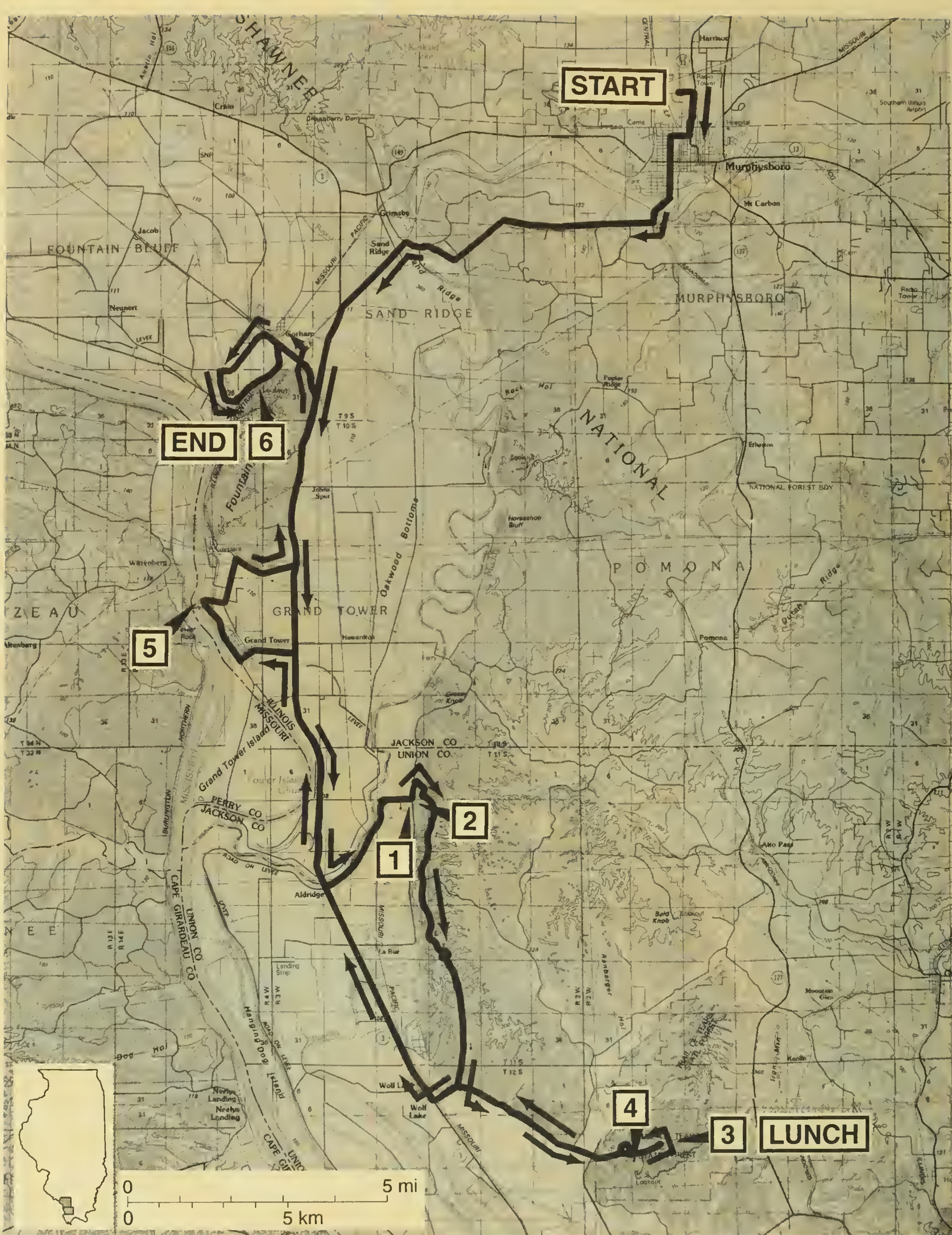
Glabrocingulum (Glabrocingulum) grayvillense 3x

BRACHIOPODS





Representative Devonian fossils of northwestern Illinois.


START
LUNCH
END
1
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6
Murphysboro
MURPHYSBORO
SHAWNEE
NATIONAL
FOUNTAIN BLUFF
SAND RIDGE
GRAND TOWER
POMONA
Grand Tower
Gorham
Aldridge
Wolf Lake
Pomona
JACKSON CO
UNION CO
PERRY CO
JACKSON CO
ILLINOIS
MISSOURI
Grand Tower Island
Oakwood Bottoms
0 5 mi
0 5 km