State of Illinois
Rod R. Blagojevich, Governor

Illinois Department of Natural Resources
Illinois State Geological Survey

Guide to the Geology of the Horseshoe Lake State Conservation Area and Surrounding Area, Alexander County, Illinois

Wayne T. Frankie, Joseph A. Devera, and Mary Seid

Geological Science
Field Trip Guidebook 2008A

April 26, 2008
May 31, 2008

Cover photograph: *Exposure of Ordovician age Kimmswick Limestone along the Mississippi River at Thebes, Illinois. The historic Thebes Railroad Bridge is shown in the background. (photograph by Wayne T. Frankie).*

Geological Science Field Trips The Illinois State Geological Survey (ISGS) conducts four tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that have led to their origin. Each trip is an all-day excursion through one or more Illinois counties. Frequent stops are made to explore interesting phenomena, explain the processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers who prepare earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for every ten students.

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

Five U.S. Geological Survey 7.5-minute Quadrangle maps (Cache, Mill Creek, Tamms, Thebes, and Thebes Southwest) provide coverage for this field trip area.

ISGS Illinois State Geological Survey

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

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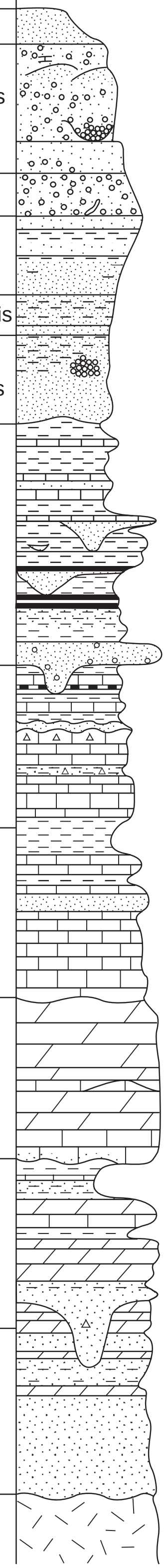
Era		Period or System and Thickness	Epoch	Age (years ago)	General Types of Rocks
CENOZOIC "Recent Life"	Age of Mammals	Quaternary 0–500'	Holocene	10,000	Recent; alluvium in river valleys
			Pleistocene Glacial Age	1.8 m	Glacial till, glacial outwash, gravel, sand, silt, and lake deposits of clay and silt; wind deposits of loess and sand dunes. Deposits cover nearly all of state except northwest corner and southern tip
		Tertiary 0–500'	Pliocene	5.3 m 33.7 m	Chert gravel, present in northern, southern, and western Illinois
			Eocene	54.8 m	Mostly micaceous sand with some silt and clay; present only in southern Illinois
			Paleocene	65 m	Mostly clay, little sand; present only in southern Illinois
MESOZOIC "Middle Life"	Age of Reptiles	Cretaceous 0–300'		144 m 290 m	Mostly sand, some thin beds of clay, and, locally, gravel; present only in southern and western Illinois
PALEOZOIC "Ancient Life"	Age of Amphibians and Early Plants	Pennsylvanian 0–3,000' ("Coal Measures")		323 m	Largely shale and sandstone with beds of coal, limestone, and clay
		Mississippian 0–3,500'		354 m	Black and gray shale at base, middle zone of thick limestone that grades to siltstone chert and shale; upper zone of interbedded sandstone, shale, and limestone
	Age of Fishes	Devonian 0–1,500'		417 m	Thick limestone, minor sandstones, and shales; largely chert and cherty limestone in southern Illinois; black shale at top
	Age of Invertebrates	Silurian 0–1,000'		443 m	Principally dolomite and limestone
		Ordovician 500–2,000'		490 m	Largely dolomite and limestone but contains sandstone, shale, and siltstone formations
		Cambrian 1,500–3,000'		543 m	Chiefly sandstones with some dolomite and shale; exposed only in small areas in north-central Illinois
		Precambrian			Igneous and metamorphic rocks; known in Illinois only from deep wells



Generalized geologic column for Illinois.

CONTENTS

HORSESHOE LAKE STATE CONSERVATION AREA AND SURROUNDING AREA

REGIONAL SETTING

The extreme southern part of Illinois, known as Little Egypt, is one of the state's most historic areas, both in geologic and human development. This field trip will acquaint you with the geology, landscape, and mineral resources for part of Alexander County, Illinois. The starting point for the field trip is the Horseshoe Lake State Conservation Area, located in western Alexander County. Horseshoe Lake is known as the "goose capitol of Illinois."

Alexander County is located at the southernmost tip of Illinois where the Ohio River and Mississippi River come together. The Mississippi River borders Alexander County on the west and the south, the Ohio River on the southeast, Pulaski County to the west, and Union County on its northern border. Alexander County has an area of 236 square miles and a 2000 population of 9,590; its population in 1900 was 19,384 and in 1890 was 16,563. According to the 1820 census, one year after the county's formation, 625 people were in the area, which included nearly all of what is now Pulaski County.

Alexander County was formed on March 4, 1819, from part of Union County, and was named for William M. Alexander, an early settler and physician. Dr. Alexander was a state representative in the second (1820–1822) and third (1822–1824) Illinois General Assemblies and became the Speaker of the Illinois House of Representatives. The present county seat, Cairo, is the largest city in the region and is listed in the *National Register of Historic Places.* The Alexander County seat was at America, 1819–1833: Unity, 1833–1845: Thebes, 1845–1859: and Cairo 1859 to the present. Pulaski County was formed from the original Alexander County in 1843.

GEOLOGIC FRAMEWORK

The field trip area is one of two regions in Illinois where Paleozoic, Mesozoic, and Cenozoic strata occur together. The field trip area lies within parts of two physiographic provinces—the Coastal Plain Province and the Ozark Plateaus Province. The western portion of the Coastal Plain Province includes the broad flat-lying floodplains of the modern Mississippi River and the ancient Ohio River. The topography surrounding the floodplains within the Coastal Plain Province includes areas defined by low, gentle hills formed upon soft Mesozoic and Cenozoic sediments. The field trip includes stops within the southwestern part of the Ozark Plateaus Province, a region of rugged hills and high surface elevations, underlain by deeply weathered Paleozoic chert and cherty limestone formations. The physiographic provinces are discussed on pages 5 and 6 of this guide.

Precambrian Era

Through several billion years of geologic time, the area encompassing the extreme southern portion of Illinois has undergone many changes. Bedrock strata here range in age from more than 520 million years old (the Cambrian Period) to less than 1.8 million years old (the Tertiary Period). Figure 1 shows the succession of Paleozoic rock strata a drill bit would penetrate in this area if the rock record were complete and all formations were present.

The boundary between two major geologic structures, the Illinois Basin to the north and the Mississippi Embayment to the south, occurs along the northern part of the field trip area (fig. 2). The Illinois Basin is a large bedrock structure containing a thick sequence of Paleozoic sedimentary rocks that have settled into a great spoon-shaped depression, 250 to 300 miles in diameter, that covers most of Illinois and adjacent parts of Indiana and Kentucky (figs. 1, 2, and 3). The deepest part of the Basin in Illinois is about 65 miles northeast of Cairo. The Precambrian rocks are more than 10,000 feet below sea level at Cairo, and the Paleozoic rocks thicken to the north from a thickness of about 10,300 feet at Cairo to more than 11,300 feet near Olmsted.

Paleozoic Era

About 520 million years ago, during the Cambrian Period at the beginning of the Paleozoic Era, 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 that were deposited in the shallow seas that repeatedly covered this subsiding basin. The region continued to sink until at least 20,000 feet of sedimentary strata were deposited in the deepest part of the Basin in southeastern Illinois and western Kentucky. At various times during this era, the seas withdrew and deposits were weathered and eroded. As a result, some gaps exist in the sedimentary record in Illinois.

The Horseshoe Lake field trip area is situated near the extreme southwestern margin of the Illinois Basin and is underlain by about 12,500 feet of Paleozoic rocks ranging in age from Cambrian to Middle Mississippian. Only Paleozoic rocks of Upper Ordovician, Silurian, and Devonian are exposed (fig. 1). Ordovician and

ERA	SYSTEM	SERIES	GROUP	FORMATION	GRAPHIC COLUMN	THICKNESS (ft)
CENOZOIC	QUATERNARY	PLEISTOCENE		Loess, alluvium, and colluvium		0–250
	TERTIARY-QUATERNARY	PLIOCENE-PLEISTOCENE		Mounds Gravel		0–50
	TERTIARY	EOCENE		Wilcox		0–250
		PALEOCENE		Porters Creek		0–150
				Clayton		0–20
MESOZOIC	CRETACEOUS	GULFIAN		Owl Creek		0–10
				Levings Member McNairy		25–455
				Tuscaloosa		0–170
	MISSISSIPPIAN	CHESTERIAN		Little Bear Soil*		0–10
				(formations not differentiated in this report)		1,000
		VALMEYERIAN		Ste. Genevieve		200–240
				St. Louis		350
				Salem		250–425
				Ullin		150–580
				Fort Payne		0–670
				Springville		5–50
		KINDERHOOKIAN	New Albany Shale	Chouteau		0–4
PALEOZOIC	DEVONIAN	UPPER				100–300
		MIDDLE		Alto-Lingle		0–50
				Grand Tower		0–80
		LOWER		Dutch Creek Sandstone		1,200
				Clear Creek		
				Backbone		
				Grassy Knob		
				Bailey		
	SILURIAN	? CAYUGAN ?		Bain-bridge: Moccasin Springs Mbr		200
		NIAGARAN		Bain-bridge: St. Clair Mbr		
		ALEXANDRIAN		Sexton Creek		5–90
				Edgewood		
	ORDOVICIAN	CINCINNATIAN		Girardeau		0–30
			Maquoketa Shale	Scales, Thebes Ss Mbr		100–300
		CHAMPLAINIAN	Galena	Cape		0–8
				Kimmswick Limestone		100–150
			Platteville			550–650
			Ancell	Joachim		385
				Dutchtown		200
				St. Peter		100–150
				Everton		90–500
		CANADIAN	Prairie du Chien	Shakopee		3,100–3,300

* Soil developed on Paleozoic rocks that range in age from Ordovician to Mississippian.

Figure 1 Generalized stratigraphic column of the upper rock formations in the field trip area (modified from Kolata et al. 1981).

Silurian strata consist predominantly of limestone and dolomite, although some shale, siltstone, and sandstone are present. Devonian rocks consist largely of chert and cherty limestone formations and some sandstone. These strata were deposited in shallow seas that covered the midcontinent region. Hundreds of feet of younger Mississippian and Pennsylvanian strata, which occur a few miles to the north and east, also once covered the Horseshoe Lake area, but erosion stripped them away during the 150 to 190 million years or so that followed the withdrawal of the Pennsylvanian seas and preceded the advance of the later Cretaceous seas.

The youngest Paleozoic rocks) likely were deposited in undetermined thickness across this region and then subsequently removed by erosion over millions of years. The base of the Cambrian sedimentary rocks rests upon an ancient Precambrian basement of crystalline granitic rocks more than one billion years old (fig. 3).

STRUCTURAL SETTING

Tectonic Uplift and Faulting

The tectonic uplifting of the Pascola Arch is responsible for the regional northward dip of Paleozoic rocks along the southern portion of the Illinois Basin (fig. 3). This uplifting and subsequent erosion created the east-west escarpment of Mississippian and Pennsylvanian aged strata in southern Illinois. The escarpment forms the southern edge of the Illinois Basin. South of this escarpment, deeply eroded Paleozoic rocks are overlain by Cretaceous and Tertiary sediments, which were deposited in the Mississippi Embayment area (fig. 2). The geologic map (fig. 4) 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.

Regionally, the Paleozoic strata are tilted downward about 2 degrees to the north and east into the Illinois Basin (fig. 3). The Horseshoe Lake area is located close to that portion of southern Illinois where faulting of Paleozoic strata has been extensive. As a consequence, the stratigraphic relationships of the various rock units are complicated. Numerous northeast-southwest–trending strike-slip faults and associated normal faults, high-angle reverse faults, folds, and grabens occur in the area. Harrison (1999) suggests that these faults may be related to the deeply buried Reelfoot Rift (fig. 2). Stratigraphic and structural evidence indicates that these faults were active during Late Ordovician time. Recent geological mapping has found evidence of continued movement along faults in the Cretaceous and Tertiary strata and within the Quaternary deposits. There has been moderately recent seismicity within the field trip area. Data from the *Central Mississippi Valley Earthquake Catalog, July 1975–June 1992,* listed five earthquakes, ranging from 0.9 to 2.5 on the Richter scale within the Thebes Quadrangle (Harrison 1999). The field trip area is located along the northern margin of the Mississippian Embayment approximately 25 miles north of the New Madrid Seismic Zone (not shown on map).

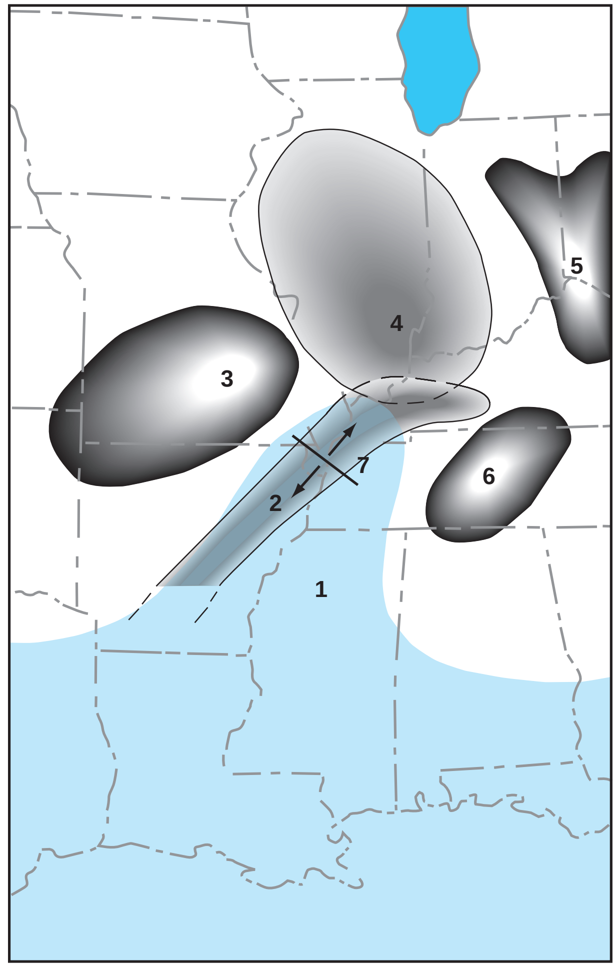


Figure 2 Map showing the general location of the Mississippi Embayment (1) and adjacent major structures: (2) Reelfoot Rift, (3) Ozark Dome, (4) Illinois Basin, (5) Cincinnati Arch, (6) Nashville Dome, and (7) Pascola Arch.

Mississippi Embayment

The Mississippi Embayment, floored by Paleozoic strata, is a broad, gentle syncline (or trough) that deepens southward toward the Gulf of Mexico; the northern part of the axis of the syncline trends northeastward, paralleling the major structural trend in extreme southern Illinois. This trough, the Embayment Syncline, is bordered on the west by the Ozark Dome; on the east by the Nashville Dome, a large bedrock arch in western

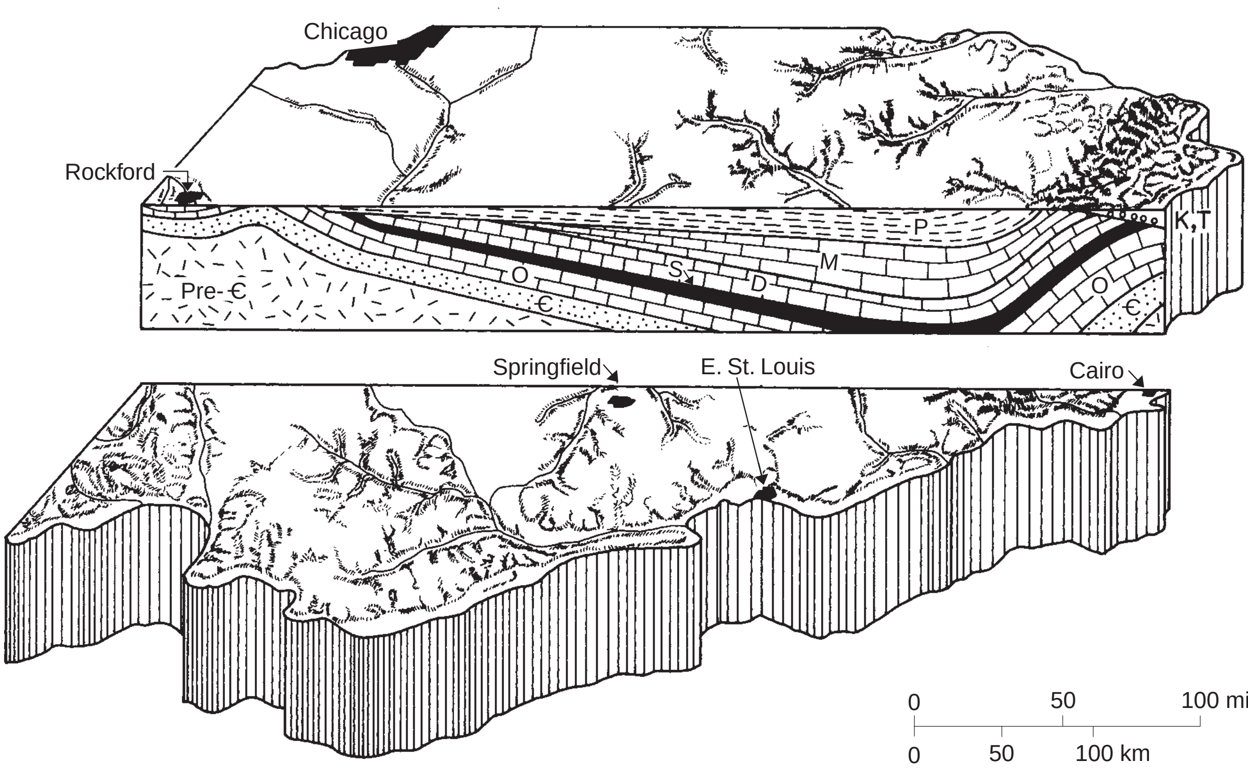


Figure 3 Stylized north-south cross section shows the structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks has been greatly exaggerated, and younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-€) granites. They form a depression filled with layers of sedimentary rocks of various ages: Cambrian (€), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). Scale is approximate.

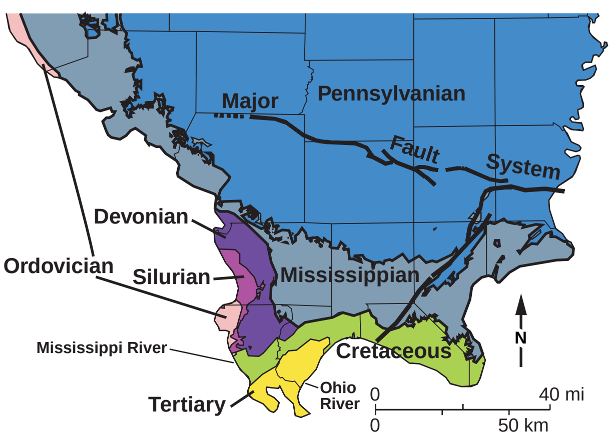


Figure 4 Bedrock geology in southern Illinois.

Tennessee; and on the north by the southern margin of the Illinois Basin (fig. 2). The Embayment Syncline was formed by movements of the Earth's crust that began during late Cretaceous time (about 90 million years ago) and continued until about 33.7 million years ago in Tertiary time. As the trough subsided, an arm of the sea advanced northward into the Embayment from the present site of the Gulf of Mexico, inundating the southern tip of Illinois at least twice during Cretaceous time and twice during Tertiary time. The Tertiary inundation marked the last time that the sea reached into Illinois. The Cretaceous and Tertiary strata deposited during these invasions filled the Embayment Syncline and formed a wedge-shaped body of unconsolidated marine and nonmarine clays, silts, sands, and gravels. Gradually the wedge thickens southward from a thin erosional edge in extreme southern Illinois to more than 3,000 feet near Memphis, Tennessee. In the field trip area, a maximum thickness of about 600 feet of these relatively young sedimentary strata overlaps and rests unconformably on much older Paleozoic sedimentary rocks (figs. 1 and 3).

After the sea withdrew at the end of Eocene time, the region was uplifted, and erosion has continued to the present. At some time during the Pliocene-Pleistocene Epoch, from about 5.3 million years ago to about 1.8 million years ago, a great river system flowed across the region. Streams from this system deposited an extensive sheet of sand and coarse gravel over a large area of southern Illinois. These materials, collectively called the Mounds Gravel, thinly mantle the Paleozoic, Mesozoic, and early Cenozoic strata and cap most of the hills surrounding the Mississippian Embayment (fig. 3). These Pliocene-Pleistocene gravels are discussed at Stop 2, Black Powder Hollow.

The northeast-trending faults south of Thebes are part of the Commerce Fault Zone, a complex system of trans-extensional faulting in the Thebes Quadrangle (Harrison, personal communication). Trans-extensional faulting means that the faults yield small pull-apart grabens containing overlying strata of Paleozoic, Mesozoic, and Cenozoic rocks.

GLACIAL HISTORY

The extensive continental glaciers that covered much of northern North America including large portions of Illinois and the Midwest during the Pleistocene Epoch (the "Ice Age") did not extend as far south as the Horseshoe Lake area. The Illinois Episode of glaciation was the most extensive in the state. At its maximum advance, the glacier extended westward from north of Harrisburg in Saline County to south of Carbondale in Jackson County. The southernmost point of continental glaciation is about 1.5 miles south of the north boundary of Johnson County, approximately 45 miles north-northeast of Cairo. Although till deposited directly by the glaciers is not found here, glacial outwash, composed of silt, sand, and gravel, was deposited by sediment-laden meltwater streams pouring away from the ice fronts during both advance and waning of the glaciers. Major river valleys, such as the Mississippi and Ohio Valleys, were the main channels for escaping meltwaters and were greatly deepened and widened during times of greatest flood. When meltwater flow decreased, however, the valleys became filled and choked with outwash materials; these valley trains extended far beyond the ice margins. Near the junction of the Mississippi and Ohio Rivers, outwash deposits in the Mississippi River are as much as 250 feet thick. About 14,000 to 15,000 years ago, near the end of the last glacial stage (Wisconsin Episode) in Illinois, a great meltwater flood poured down these valleys, causing major changes in the channels of the Mississippi and Ohio Rivers. See Stop 6 for discussion.

Covering the landscape is a thin cover of material called loess. These windblown sediments were deposited during all of the glacial episodes, from the pre-Illinois Episode (approximately 1.6 million years ago) to the last glacial episode, the Wisconsin Episode (about 25,000 to 13,500 years ago). These loess deposits mantle the Ordovician, Silurian, Devonian, Mississippian, Cretaceous, Tertiary, and glacial outwash deposits throughout the field trip area. The silt was blown from the floodplains of the Mississippi River and the ancient Ohio River when it occupied the Cache River-Bay Creek Valley. Although loess is more than 80 feet thick in places along the Mississippi Valley, the loess thins eastward to a maximum of about 15 feet in the field trip area. Loess is generally less than 3 feet thick on the lower river terraces because of erosion.

GEOMORPHOLOGY

The field trip area is located near the junction of, and is influenced by, four prominent physiographic provinces (fig. 5): the southern portion of the Shawnee Hills Section (Interior Low Plateaus Province), the northern portion of the Mississippi Embayment Section (Coastal Plain Province), the southeastern portions of the Salem Plateau Section (Ozark Plateaus Province), and the southern portion of the Till Plains Section (Central Lowland Province). A major influence on the geomorphology of the field trip area was established by Pleistocene meltwaters (relict glacio-fluvial features). The physiographic boundary for the most influential physiographic province (Central Lowland Province-Till Plains Section) is farthest away, 50 miles to the north. Although the field trip area was not glaciated, the present landforms and courses of the Ohio and Mississippi Rivers were significantly modified during the Wisconsin Episode (the last major glaciation). Subsequent erosion by wind and rain has continued to modify the landscape.

The convergence of four or more major physiographic provinces is a rare geologic phenomenon that occurs in only five other places in the United States. Of these, the Mississippian Embayment-Cache River Valley is thought to be the most diverse assemblage of species

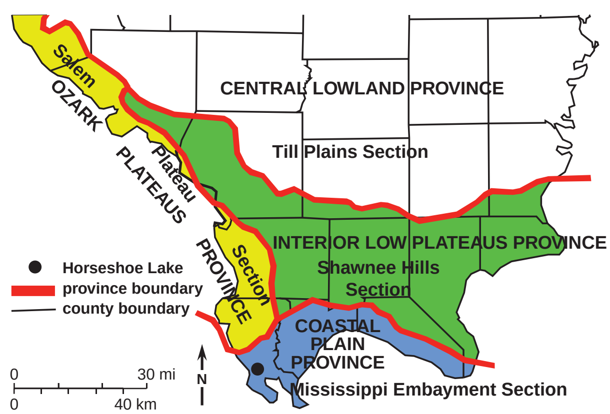


Figure 5 Physiographic provinces of Illinois (Leighton et al. 1948).

and natural communities in close proximity to one another. Specifically, the area is bounded on the west by the Ozark Hills, on the north and east by the Shawnee Hills, and on the south (ignoring low lines of hills that, strictly speaking, define the watershed) by the Mississippi and Ohio Rivers.

NATURAL RESOURCES

Economic minerals that have been mined in Alexander County include sand and gravel, novaculite chert, and tripoli. Historic mining within Alexander County includes early pioneers excavating clay, near Fayville, for pottery. In addition, Native Americans quarried the Mill Creek Chert, near Mill Creek for use in making a variety of agricultural tools such as hoes and projectiles such as spears and arrowheads.

GUIDE TO THE ROUTE

We will start the field trip at the spillway shelter and picnic area at Horseshoe Lake State Conservation Area (NE¼, SE¼, NE¼, Sec. 21, T16S, R2W, 3rd P.M., Cache 7.5-minute Quadrangle, Alexander County). Mileage will start at the parking lot on the east side of the picnic shelter.

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!
- Stay off all mining equipment.
- Parents must closely supervise their children at all times.

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

Five U.S. Geological Survey 7.5-minute Quadrangle maps (Cache, Mill Creek, Tamms, Thebes, and Thebes Southwest) provide coverage for this field trip area.

START. Horseshoe Lake State Conservation Area We will start at the spillway shelter and picnic area at Horseshoe Lake State Conservation Area (NE¼ SE¼ NE¼, Sec. 21, T16S, R2W, 3rd P.M., Cache 7.5-minute Quadrangle, Alexander County). Mileage will start at the parking lot on the east side of the picnic shelter. Set your odometer to 0.0.

Miles to next point	Miles from start	
0.0	0.0	Exit parking lot in front of the spillway shelter and picnic area along East Side Drive. TURN RIGHT onto Promised Land Road/955 N. The area surrounding Horseshoe Lake was known by the early settlers as "The Promised Land." As in the biblical Promised Land, these pioneers were looking forward to settling and making a new start and a new home.
0.1	0.1	Cross spillway.
0.3	0.4	T-intersection from the right (West Side Drive/1060 E and Promised Land Road/950 N). CONTINUE AHEAD. To the left, running parallel to Promised Land Road, is the abandoned Missouri Pacific Railroad grade.
0.6	1.0	Cross abandoned Missouri Pacific Railroad grade.

0.7	1.7	STOP (one-way). T-intersection (Miller City Road/925 E and Promised Land Road/950 N). TURN LEFT onto Miller City Road. After making the turn, notice the large pile of sand to the left (see Stop 1 for discussion). The village of Miller City, named for the three Miller brothers, Sidney, Jessie, and Gene, is located at this junction. A post office was established here in 1911. At its height of development, Miller City had three grocery stores, a railroad and freight station, a number of large warehouses, a blacksmith shop, a stockyard with loading pens, several churches, and a school. The Missouri Pacific Railroad made two round-trips a day between Cairo and Miller City. This passenger train was called the Cotton Belt. A "jitney," which was a railroad token, was used for the 25¢ fair between Cairo and Miller City.
0.6	2.3	Y-intersection (Miller City Road and Santa Fe Road). VEER RIGHT onto Santa Fe Road.

STOP 1. Santa Fe Levee and The Great Flood of 1993—15 Years Later (NW¼ NE¼ NE¼, Sec. 30, T16S, R2W, 3rd P.M., Cache 7.5-minute Quadrangle, Alexander County). On the day of the field trip, park along Santa Fe Road.

0.0	2.3	Exit Stop 1. Continue on Santa Fe Road.
2.1	4.4	Road ascends to top of Santa Fe Levee. Burnham Island is to the left; the Santa Fe Chute is located between the island and the levee. The main channel of the Mississippi River flows on the west side of Burnham Island.
0.3	4.7	T-intersection from the right (Tankville Road/1050 N). CONTINUE AHEAD. A good view of Santa Fe Chute lies directly ahead.
0.5	5.2	T-intersection from the right (Shasta Road/1105 N and Santa Fe Road/750 E). CONTINUE AHEAD.
0.5	5.7	Walter Bishop's home is on the right. The one-room Hartsook School was located approximately 0.45 miles north of the Bishop's home at the base of the levee. Notice the gravel along the top of the levee. This gravel was mined from the Black Powder Hollow sand and gravel pit (Stop 2).
1.6	7.3	T-intersection from the right at the curve in the levee (Mo-Pac Road, the abandoned railroad grade for the Missouri Pacific Railroad).
0.5	7.8	STOP (one-way). T-intersection (Santa Fe Road and Fayville Road). TURN LEFT onto Fayville Road. Early settlers in this area used an "Indian" Trail that followed along the base of the bluffs between Tamms, Olive Branch, and Fayville. This trail was originally one of the old bison traces that crossed Illinois before the arrival of European settlers. The large cutout area located directly ahead is an abandoned sand and gravel pit that was used to supply material to repair the Santa Fe Levee following the flood of 1993.
0.1	7.9	Unnamed cemetery on the right after making the turn.
0.3	8.2	Abandoned quarry on the right has an exposure of McNairy Formation sand. Enter Fayville.

Fayville is located opposite the Mississippi River from Commerce, Missouri. This community was first known as McElmurry Station. Then it was changed to Commerce Landing, later became Santa Fe, and finally was named Fayville. The community is possibly the oldest settlement in Alexander County. An act of March 26, 1804, established a land office at Kaskaskia where the claim to the Spanish-French surveys of this ground were registered by John McElmurry, Joseph Standlee, and Abraham, Joshua, and Thomas Flannary. A post office was established in 1879. The population in 1913 was approximately 300, but later declined, and the post office was discontinued June 30, 1928. During its boom, Fayville included the post office, a two-room schoolhouse, a church, a pool hall, two hotels, four grocery stores, and many attractive homes. A steam ferry once operated between Fayville and Commerce, Missouri.

Early industry at Fayville included the manufacture of pottery, started by Theodore Sickman, an immigrant from Hanover, Germany. Sickman Pottery was sold in markets in Memphis and New Orleans.

The Aetna Powder Company operated a black powder and dynamite factory prior to World War I. During the war, a large amount of the dynamite was sold to the U.S. Government, some of which was passed on to the Allies, particularly Great Britain. Mule-drawn cars transported the supplies and finished dynamite in and out of the hollows ("hollers"). The Aetna Powder Company employed several hundred workers and was the largest employer in southern Illinois in 1916. During its operation, there were several explosions. One noteworthy large explosion, which claimed five lives, occurred on April 7, 1920. Ten thousand to 12,000 pounds of nitroglycerine in a tank house exploded, and the force of the explosion was felt 50 miles away. Many people thought it was an earthquake. This early industrial accident eventually led to the plant's closing in the early 1930s. Found at the Cairo Library was an undated photo of a group of 13 girls; the caption read: "Earning 37¢ an hour helping Uncle Sam make ammunition."

0.1 8.3 T-intersection from the right (Waldon Road/570 E). CONTINUE AHEAD.

At least 14 northeast-southeast–trending faults cross the Mississippi River within the Thebes Gap between Fayville and Thebes. These faults are part of the Commerce Fault Zone.

0.1 8.4 T-intersection from the right (Waldon Road/560 E and Fayville Road/1322 N). CONTINUE AHEAD. Abandoned McNairy quarry located in the bluff, behind the house to the right.

The abandoned Missouri Pacific Railroad elevated grade is on the right side of the road, and the abandoned Chicago and Eastern Illinois Railroad grade is on the left side of the road.

The first of a number of concrete foundations can be seen on the right and left sides of the road. These foundations were part of the former Aetna Powder Company's infrastructure, which included offices, warehouses, and powder manufacturing plants. The 1934 edition of the Thebes 15-minute topographic map shows 30 structures located along Fayville Road, 7 structures in Black Powder Hollow, and 17 in Dynamite Hollow.

0.6 9.0 T-intersections from the right (Black Powder Hollow). TURN RIGHT.

After making the turn, you will pass through the concrete piers for the abandoned Missouri Pacific Railroad elevated grade. The Cretaceous age McNairy sand is exposed on the left, just past the piers. Notice the fault within the outcrop; beds dip to the east. This is part of the 40-Mile Fault.

0.7 9.7 Black Powder Hollow Sand and Gravel Pit

STOP 2. Black Powder Hollow Sand and Gravel Pit (W½ SE¼ SE¼, Sec. 27, T15S, R3W, 3rd P.M., Thebes 7.5-minute Quadrangle, Alexander County).

0.0	9.7	Exit sand and gravel pit and retrace the route back to Fayville Road.
0.9	10.6	T-intersection (Fayville Road). TURN RIGHT.
0.7	11.3	T-intersection from the right (Dynamite Hollow). CONTINUE AHEAD.
0.7	12.0	Outcrop on the right, Silurian age Bainbridge Group.
0.3	12.3	Outcrop on the right, Ordovician age Girardeau Limestone.
0.2	12.5	Outcrop on the right, Silurian age Sexton Creek Limestone.
0.2	12.7	T-intersection from the right (Rock Springs Road). CONTINUE AHEAD.
0.1	12.8	Cross Orchard Creek. Fayville Road is now called Thebes Road.
1.2	14.0	Outcrop of Ordovician age Cape Limestone, overlain by the Thebes Sandstone Member on the right. Pass under Thebes Railroad Bridge. Outcrop continues on the right.

Enter Thebes, population 478. The historic Thebes Courthouse is located atop the bluff on the right. The courthouse was constructed using local stone quarried from Ordovician age Thebes Sandstone.

Thebes was established in the early 1800s by two Sparhawk brothers traveling up the Mississippi River from New Orleans. The men were attracted to the land along the river and the bluff overlooking it. They found a quantity of yellow poplar (“tulip”) trees, which they cut and shipped to New Orleans. The demand for this wood was great, as yellow poplar is termite-proof. Thebes was first known as Sparhawk Landing. The settlement was patented to Franklin G. Hughes and Joseph Chandler on October 15, 1835. It was platted March 2, 1846. The post office was established at Thebes on December 13, 1845.

Thebes was the county seat of Alexander County from 1846 to 1859. In 1848, a two-story sandstone courthouse was built at a cost of $4,400. It was renovated in 1976 for $74,580. The courthouse sits atop a bluff, commanding a sweeping view of the Mississippi River. The architect was H. A. Barkhausen. Dred Scott, a black slave whose Supreme Court case made the pages of history, was jailed at Thebes. In pre-Civil War days, lawyer John Logan regularly argued cases in the courthouse. He later became a Civil War hero, U. S. Congressman, Senator, and vice presidential nominee. Abraham Lincoln is thought to have practiced law in the courthouse; however, there are no official court records indicating such. The Thebes Courthouse is on the *National Register of Historic Places.*

Readers of the Pulitzer Prize winner Edna Ferber’s novel *Show Boat* will remember that Thebes was the home port of Captain Andy Hawks’ “Cotton Blossom” show boat.

0.1	14.1	Sycamore Street. CONTINUE AHEAD. Road jogs to the left; you are now on Third Street.
0.05	14.15	Walnut Street. CONTINUE AHEAD. The concrete structure to the right, at the southwest corner of the Walnut and Fourth Street intersection, is the historic Thebes jail.

0.05	14.2	Oak Street. TURN LEFT.
0.05	14.25	Second Street. TURN LEFT. Prepare to park along Second Street.

STOP 3. Kimmswick Limestone and Thebes Railroad Bridge (SW¼ NW¼ NE¼, Sec. 17, T15S, R3W, 3rd P.M., Thebes 7.5-minute Quadrangle, Alexander County). On the day of the field trip, we will walk along the river from the public boat ramp.

0.0	14.25	Exit Stop 3. Continue toward Walnut Street. TURN LEFT.
0.05	14.3	Third Street. TURN RIGHT onto Third Street/Thebes Road. Follow the road back under the Thebes Railroad Bridge.
1.8	16.1	T-intersection from the left (Rock Springs Road). TURN LEFT.
0.2	16.3	Cross Orchard Creek. Pull over into the small parking lot on the right.

STOP 4. Girardeau Limestone at Rock Springs Hollow (SW¼ SE¼ NW¼, Sec. 21, T15S, R3W, 3rd P.M., Thebes 7.5-minute Quadrangle, Alexander County).

0.0	16.3	Exit parking lot. CONTINUE AHEAD on Rock Springs Road.
0.1	16.4	T-intersection from the right (Rock Springs Hollow Road/1560 N and Rock Springs Road/425 E). TURN RIGHT.
1.1	17.5	T-intersection from the left (Stamp Road/520 E and Rock Springs Hollow Road/1510 N). CONTINUE AHEAD.
0.1	17.6	Rock Springs Freewill Baptist Church on the left. On the right in the creek is an outcrop of Silurian age Moccasin Springs Formation of the Bainbridge Group.
0.4	18.0	T-intersection from the right (Black Powder Hollow Road/570 E and Rock Springs Hollow Road/1500 N). CONTINUE AHEAD.
0.15	18.15	Outcrop of Cretaceous age McNairy Formation in the creek on the right.
0.15	18.3	Outcrop of Cretaceous age, McNairy Formation gravel lag deposits overlain by Pleistocene age windblown loess in creek on the right.
0.1	18.4	T-intersection from the left (Denton Road and Rock Springs Hollow Road/1505 N). TURN LEFT.
0.3	18.7	STOP (one-way). Intersection of Denton Road and Illinois Route 3. TURN RIGHT onto Illinois Route 3.
1.7	20.4	Crossroad intersection (Brownville Road/780 E to the left, Twente Crossing Road/780 E to the right, and Illinois Route 3/1440 N). CONTINUE AHEAD.

1.6	22.0	Enter Olive Branch, once known as Cross Roads because the north-south and east-west trails crossed at this location. The Olive Branch Post Office was established in 1876. The name Olive Branch is a biblical reference.
0.3	22.3	Crossroad intersection (Pigeon Roost Road/924E to the left, Fayville Road/926E to the right, and Illinois Route 3/1362N). CONTINUE AHEAD.
		Pigeon Roost Hollow was named for the countless number of passenger pigeons that in the earliest recorded history of this area marked this as their roosting and breeding grounds. Early settlers in this area harvested the passenger pigeons for eating, and some were pickled and packed into barrels or large pottery jars made by Theodore Sickman Pottery at Santa Fe. Pigeon meat was sometimes preserved by covering it with salt from the salt wells near Equality. The barrels and jars of pigeons packed in salt were barged down river to be sold in Memphis and New Orleans.
		The Kaskaskia tribe occupied a winter village near the mouth of Pigeon Roost Hollow. The tribe's chief was named Roenza. The village was located where the Olive Branch School once stood. A large number of Native American artifacts were discovered during construction of the school.
0.2	22.5	Crossroad intersection (Olive Street to the left and Miller City Road/950 E to the right, and Illinois Route 3/1360 N). TURN RIGHT onto Miller City Road.
		The bluffs immediately to the north of the intersection belong to the Lower Devonian Bailey Limestone formation. A graben (a downdropped block, bounded by two faults) can be seen on the left at road level before the turn. This graben and associated faults are part of the Commerce Fault Zone.
1.3	23.8	T-intersection from the left (Island Road/1265 N). CONTINUE AHEAD.
0.15	23.95	Cross Black Creek.
1.2	25.15	T-intersection from the right (Shasta Road/1125 N). CONTINUE AHEAD.
0.25	25.4	T-intersection from the left (West Side Road/1100 N and Miller City Road/890 E). TURN LEFT.
		The road immediately crosses a man-made levee across Horseshoe Lake. Farther along the road, the large cypress trees near the West Side Campground were planted by the Civilian Conservation Corps.
3.5	28.9	STOP (one-way). T-intersection (Promised Land Road/950 E and West Side Drive/1060 E). TURN LEFT and cross spillway.
0.5	29.4	T-intersection from the left (East Side Drive/1100 E and Promised Land Road/ 955 N). TURN LEFT and pull into parking lot.

STOP 5. Horseshoe Lake State Conservation Area - Lunch (NE¼ SE¼ NE¼, Sec. 21, T16S, R2W, 3rd P.M., Cache 7.5-minute Quadrangle, Alexander County).

0.0	0.0	After lunch, exit the parking lot and CONTINUE AHEAD on East Side Drive. Reset your odometer to 0.0.

2.0	2.0	Horseshoe Lake campground is on the left.
0.3	2.3	STOP (one-way). Intersection (Illinois Route 3/1175 E and East Side Drive/1150 N). TURN LEFT.
1.1	3.4	T-intersection from the left (Office Refuge Road/1100 E). CONTINUE AHEAD.
0.5	3.9	Great view of silica mines along bluffs to the north of Olive Branch.
0.3	4.2	T-intersection from the right (Unity Road/1040 E). CONTINUE AHEAD.
0.2	4.4	T-intersection from the left (Vaughn Lane). CONTINUE AHEAD.
0.5	4.9	T-intersection from the right (Old Mill Road/1000 E). CONTINUE AHEAD. Enter Olive Branch, population 879.
0.5	5.4	T-intersection from the right (Railroad Street/955 E and Illinois Route 3/1360 N). TURN RIGHT onto Railroad Street, known as the Tamms-Olive Branch Road.
0.6	6.0	T-intersection from the right (Old Mill Road/1000 E and Tamms-Olive Branch Road 1400 N). CONTINUE AHEAD. Note: Railroad Street changes north of this intersection to Tamms-Olive Branch Road.
		An abandoned silica mine is located in the bluffs on the left. The Olive Branch Mineral Company converted a cotton gin into a silica mill near Olive Branch at some time prior to 1928. The mill was sold in 1928 to the newly formed Egyptian Mineral Products Company. In addition to silica, the company sold a “white” china clay obtained from deposits within the Devonian age Grassy Knob Chert northeast of Olive Branch. The novaculite beds north of Olive Branch contain several beds of silica clay within the lower part of the bluffs.
0.6	6.6	T-intersection from the left. Entrance to Novaculite Quarry. TURN LEFT.

STOP 6. Olive Branch-Sandy Ridge Novaculite Quarry (S½ SW¼ NW¼, Sec. 28, T15S, R2W, 3rd P.M., Tamms 7.5-minute Quadrangle, Alexander County).

0.0	6.6	Exit quarry and retrace route back to Tamms-Olive Branch Road.
0.25	6.85	Intersection with Tamms-Olive Branch Road. TURN LEFT.
0.05	6.9	T-intersection from the right (Sandy Ridge Road/1455 N and Tamms-Olive Branch Road/1050 E). CONTINUE AHEAD.
		The flat-lying land to the right is the floodplain of the ancient Ohio River valley, now occupied by the modern Cache River. The Cache River, located 3.5 miles to the east, forms the western boundary between Alexander County and Pulaski County.
0.5	7.4	T-intersection from the right. (Clank Road/1500 N and Tamms-Olive Branch Road/1060 E). CONTINUE AHEAD.
0.3	7.7	Cross Road Run Creek. T-intersection from the left (Maggie Lane/1520 N and Tamms-Olive Branch Road/1065 E). CONTINUE AHEAD.

0.7	8.4	T-intersection from the right (Davie Road/1600 N and Tamms-Olive Branch Road/1095 E). CONTINUE AHEAD.
1.2	9.6	T-intersection from the right (Sandy Creek Road/1715 N and Tamms-Olive Branch Road/ 1120 E). CONTINUE AHEAD, and cross Wolf Creek.
0.1	9.7	T-intersection from the left (Wolf Creek Road/1725 N and Tamms-Olive Branch Road/ 1120 E). CONTINUE AHEAD.
0.15	9.85	Cross West Branch of Sandy Creek.
0.25	10.1	Egyptian Community School on the left. Immediately north of the school is a T-intersection from the left (Diswood Road/1780 N). CONTINUE AHEAD.
0.1	10.2	Cross Sandy Creek.
0.1	10.3	STOP (one-way). Y-intersection (Tamms-Olive Branch Road/1790 N to the right and Sandy Creek-McCrite Road/Grapevine Trail/1790 N to the left). TURN LEFT onto Grapevine Trail. This intersection is identified as the community of Diswood on the Tamms 7.5 minute Quadrangle. Diswood (unincorporated) was once a logging camp. A post office was established at Diswood on March 5, 1895, and discontinued on September 29, 1917. After making the turn, you will be ascending the valley cut by Sandy Creek. Compare the width of the valley to the creek's present size. The creek we see today is underfit in relation to the width of the valley. At one time, Sandy Creek was a major downcutting tributary to the ancient Ohio River. The Cache River, occupying the ancient Ohio River valley, is another underfit stream in relation to the width of the Cache Valley. The base load of Sandy Creek within the valley consists almost entirely of Devonian chert.
2.9	13.2	Shawnee National Forest, Walnut Tree Experimental Station on the left. The area to the left was planted with walnut trees. CONTINUE AHEAD.
0.6	13.8	Cross Sandy Creek.
0.3	14.1	T-intersection from the right (Walnut Grove Lane). TURN RIGHT.
0.1	14.2	Cross cattle grate in road, pass through the gate, and cross the ford across Sandy Creek. Notice that the base load of the creek is dominated by Devonian chert.
0.8	15.0	Road curves to the left. T-intersection from the right. Entrance to Birk-McCrite Quarry. TURN RIGHT into the quarry.

STOP 7. Birk-McCrite Quarry UNIMIN Specialty Minerals, Inc., Lower Devonian Clear Creek Chert. Located northwest of Tamms (SE¼ SE¼ Sec. 21 and NE¼, NE¼, NE¼, Sec. 28, T14S, R2W, 3rd P.M., Mill Creek 7.5-minute Quadrangle, Alexander County). On the day of the field trip, follow directions of ISGS staff.

0.0	15.0	Exit quarry. TURN LEFT, and retrace the route back to Grapevine Trail Road.

1.0	16.0	Cross Sandy Creek at ford.
0.3	16.3	STOP (one-way). T-intersection (Grapevine Trail Road and Walnut Grove Lane). TURN LEFT onto Grapevine Trail.
3.2	19.5	McCrite Cemetery to the left, on the south side of the hill.
0.3	19.8	Y-intersection on the right (Tamms-Olive Branch Road/1120 E to the right and Tamms-Olive Branch Road/1790 N straight ahead). CONTINUE AHEAD onto Tamms-Olive Branch Road, heading east toward Tamms.
0.2	20.0	Cross Jim Branch of Sandy Creek. T-intersection from the left (McDaniel School Road/1130 E and Tamms-Olive Branch Road/1790 N). CONTINUE AHEAD.
0.5	20.5	Outcrop on both sides of the road. Exposure of Devonian age Clear Creek Chert. A fault is located on the eastern end of the exposure. This fault is part of the Commerce Fault Zone.
0.4	20.9	Angled intersection from the right (Old Diswood Road/1210 E). CONTINUE AHEAD.
0.9	21.8	Crossroad intersection (Steel Road/1300 E and Tamms-Olive Branch Road/1825 N). CONTINUE AHEAD.
0.8	22.6	Enter Tamms, population 724.

Tamms was formerly known as Idlewild. A post office was established at Idlewild on April 23, 1883; the town name was changed to Tamms on March 9, 1900. The four sections of land that are now known as Tamms came into possession of Captain William Kenny of Virginia by right of patent August 1, 1838. The land was given by the United States under President Martin Van Buren. The transfer was part of the Old Soldier Reservation, an arrangement by which land was given to veterans who served in the army prior to 1787. William Kenny never settled the land, however, and from 1838 to 1861 this wild land set idle; thus, the name Idlewild.

Early settlement of southern Illinois land was originally set up as part of the Old Soldier Reservation, established by Congress in 1787. Southern Illinois at an early date was known as Illinois Soldiers Reservation.

In 1861, the land (called North and South Idlewild) was sold to William E. Massey and John Abercrombie. Abercrombie sold his section in 1888 to Theodore Tamm, who had just arrived in the area. Tamm became owner of the Chester and Keller Manufacturing Company. Oscar Tamm, son of Theodore, donated the land in 1899 to the Chicago and Eastern Illinois (C & EI) Railroad. In 1904, Oscar Tamm deeded 81 acres to the Mobile and Ohio Railroad, and a train yard was built. In 1899, a depot was constructed to allow the clerk, or a person standing in the depot, to watch both the Chicago and Eastern Illinois (C & EI) and the Gulf Mobile and Ohio (GM & O) railroads, which crossed at an acute angle. The Gulf Mobile and Ohio Railroad operated until 1975.

0.1	22.7	Crossroad intersection (South Railroad Street). TURN LEFT.

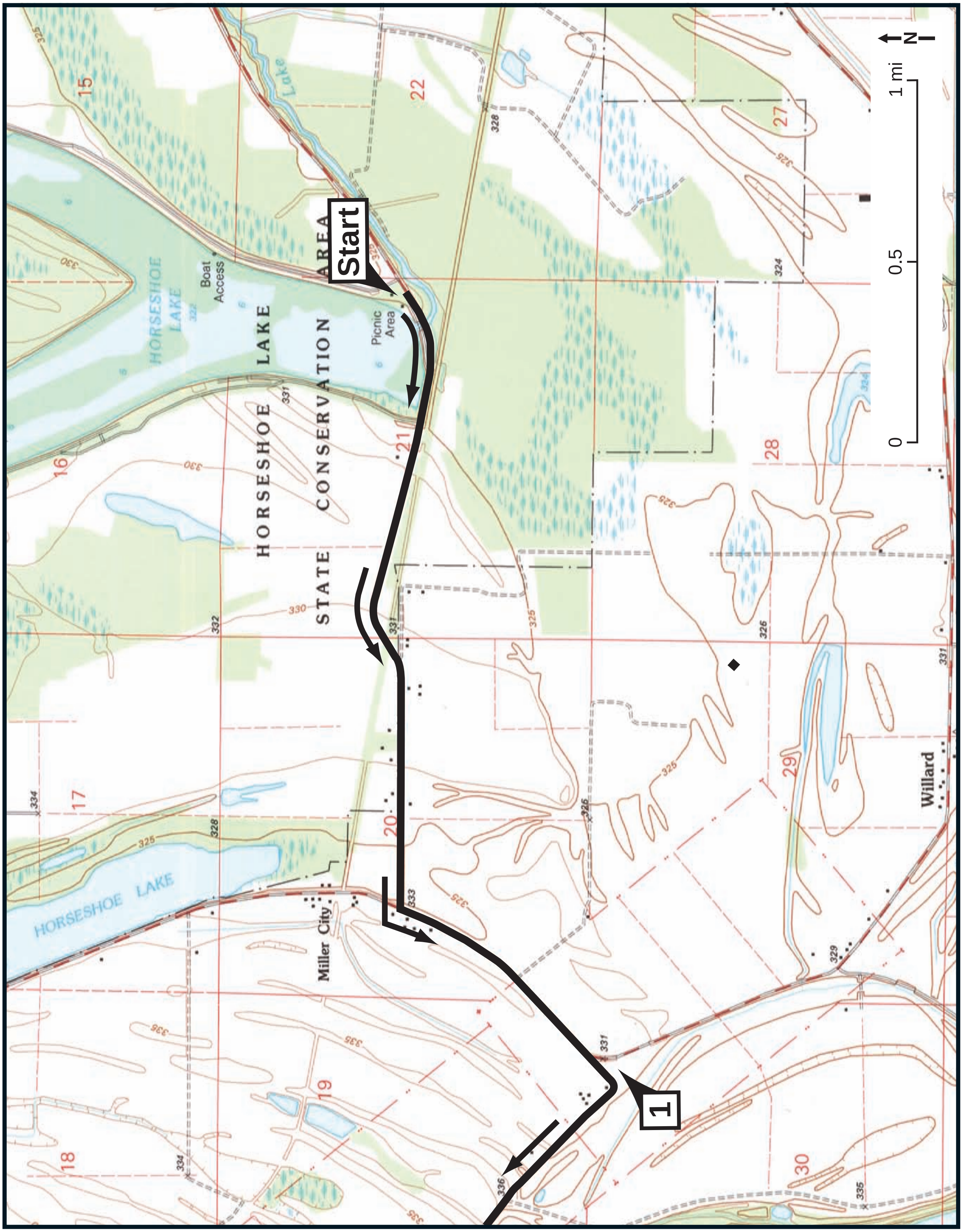
The Tamms UNIMIN processing plant is located south of the intersection. On the right, after the turn, is the historical Tamms Railroad Station. This uniquely designed curved depot has been restored and is on the *National Register of Historic Places*. The depot currently serves as a museum and the Tamms City Hall.

0.4	23.1	Concrete foundation on the left. Former site of a paint manufacturing plant. The paint manufacturing process used local silica in the production of paint. The amount of silica in paint controls the degree or amount of luster (paint with a flat finish has little added silica, and paint with a glossy finish has more).
1.3	24.4	STOP (two-way). Crossroad intersection (Super Max Road/1975 N and Old Elco Road/1380 E). TURN LEFT. Note: Railroad Street becomes Old Elco Road north of this intersection.
0.2	24.6	Main road curves to the left. T-intersection from the right (entrance to Tatumville Novaculite Gravel Quarry). TURN RIGHT. The main road leads to the Illinois Department of Corrections, Tamms Super Maximum facility. The Mill Creek 7.5-minute Quadrangle identifies this junction as Tatumville.

STOP 8. Tatumville Novaculite Gravel Quarry Lower Devonian Grassy Knob Chert. Located north of Tamms at Tatumville (E½ NW¼ Sec. 36, T14S, R2W, 3rd P.M., Mill Creek 7.5-minute Quadrangle, Alexander County).

0.0	24.6	To return home, exit the quarry and retrace your route to the intersection of Super Max Road.
0.25	24.85	Intersection (Super Max Road/1975 N). TURN LEFT.
0.1	24.95	Crossroad intersection (Super Max Road/1975 N and Old Elco Road/1380 E). CONTINUE AHEAD.
0.55	25.5	Cross Jackson Creek, and prepare to stop.
0.2	25.7	STOP (one-way). T-intersection (Super Max Road/1975 N and Illinois Route 127). TURN RIGHT onto Illinois Route 127 to Cairo 20 miles to the south or TURN LEFT onto Illinois Route 127 to Jonesboro 12 miles to the north.

HAVE A SAFE JOURNEY HOME!


Start
1
HORSESHOE LAKE STATE CONSERVATION AREA
HORSESHOE LAKE
Boat Access
Picnic Area
Lake
Miller City
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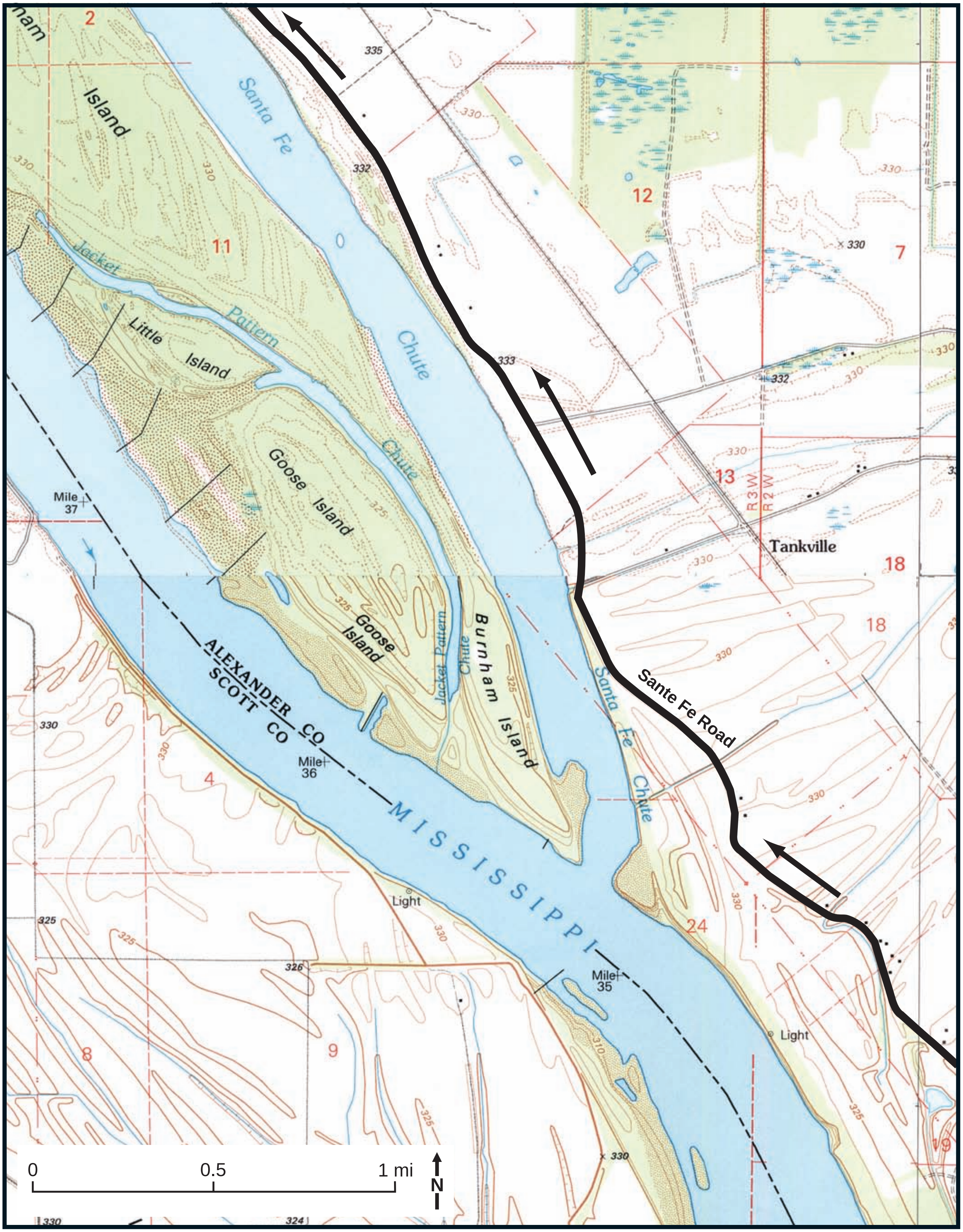
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Santa Fe
Chute
Jacket Pattern
Little Island
Goose Island
Burnham Island
Jacket Pattern Chute
ALEXANDER CO
SCOTT CO
MISSISSIPPI
Santa Fe Chute
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Tankville
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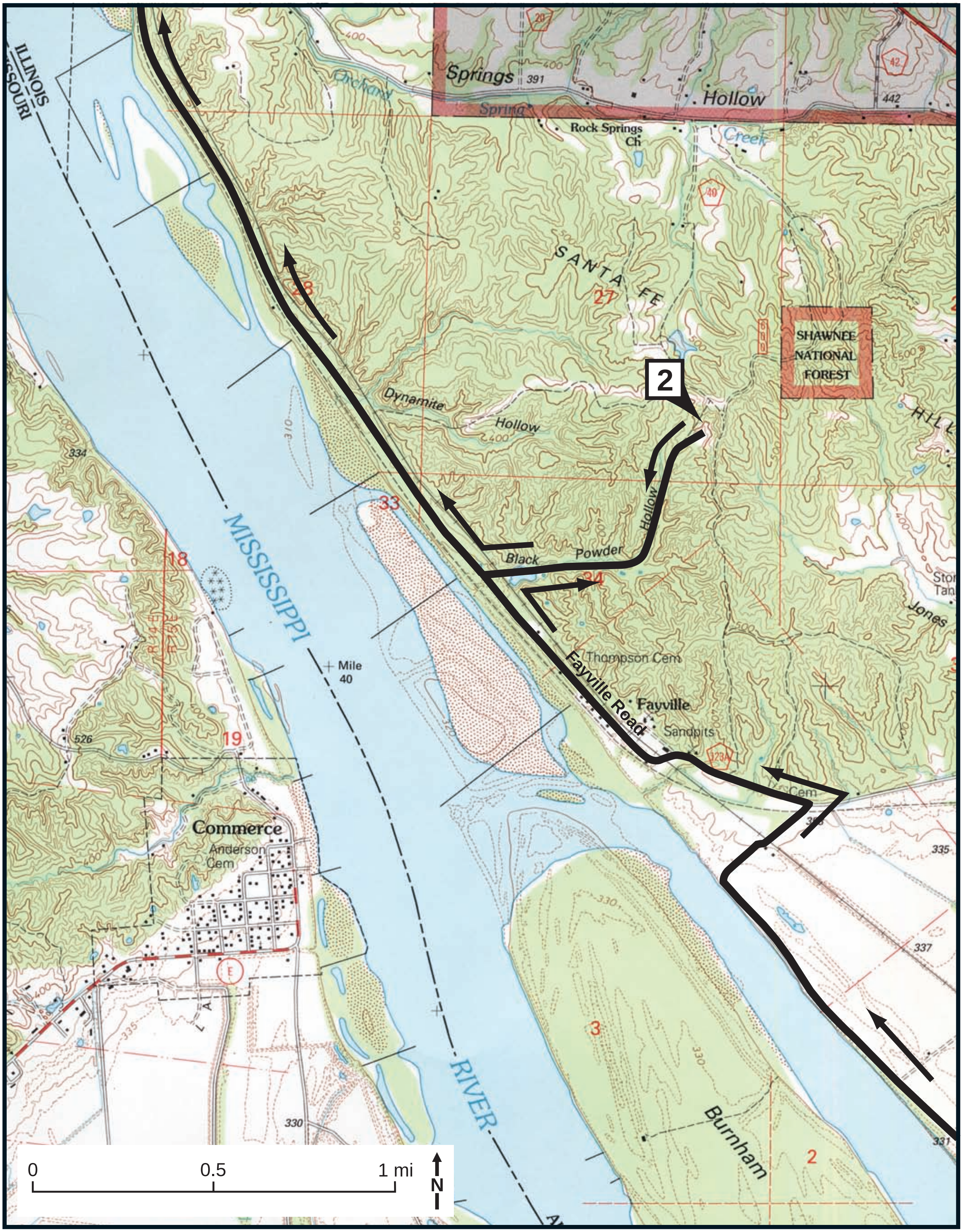

ILLINOIS
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Springs
Hollow
Spring
Creek
Orchard
Rock Springs Ch
SANTA FE
HILL
SHAWNEE NATIONAL FOREST
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Dynamite
Hollow
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Powder
MISSISSIPPI
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Fayville Road
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Sandpits
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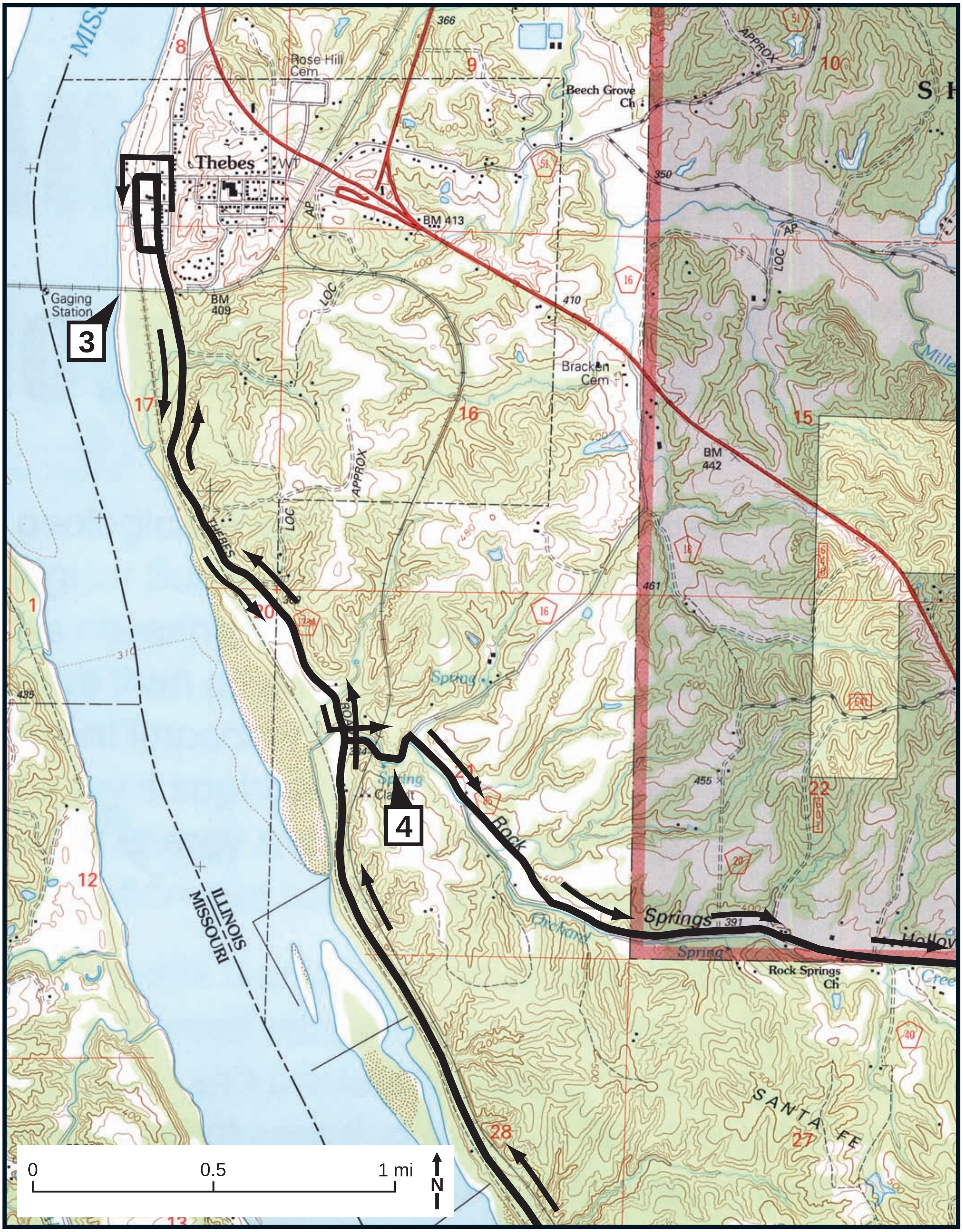
Thebes
Rose Hill Cem
Beech Grove Ch
Gaging Station
BM 409
BM 413
BM 442
Bracken Cem
Rock Springs Ch
Springs
Spring
Rock
Orchard
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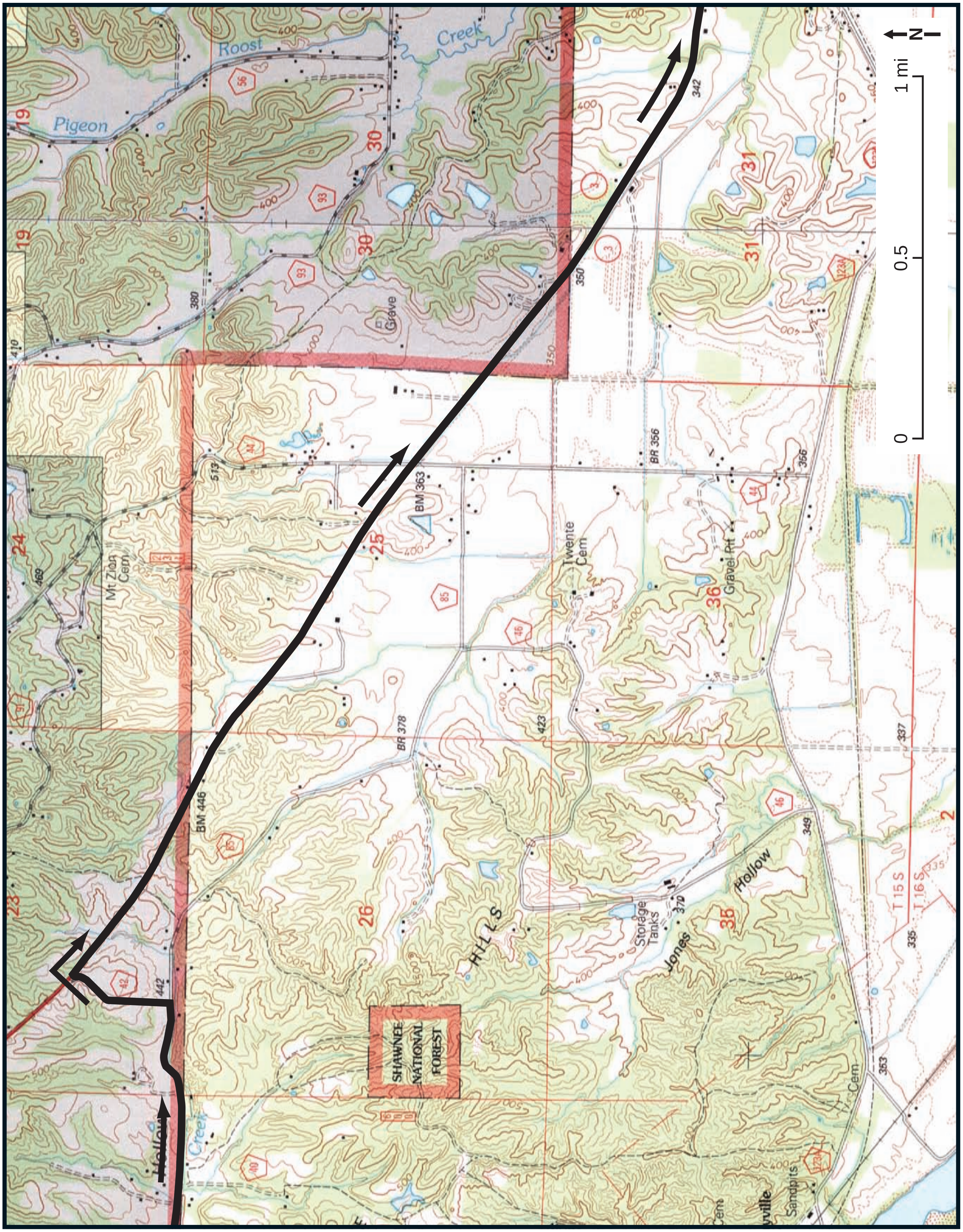
Pigeon
Roost
Creek
Grave
Mt Zion Cem
Twente Cem
Gravel Pit
Storage Tanks
Jones
Hollow
HILLS
SHAWNEE NATIONAL FOREST
BM 446
BM 363
BR 378
BR 356
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Olive Branch
Cem
BM
340
31
32
33
HLSCA
LAKE
Black
Creek
BR 328
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6
4
HORSESHOE
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HORSESHOE LAKE
STATE CONSERVATION AREA
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Boat
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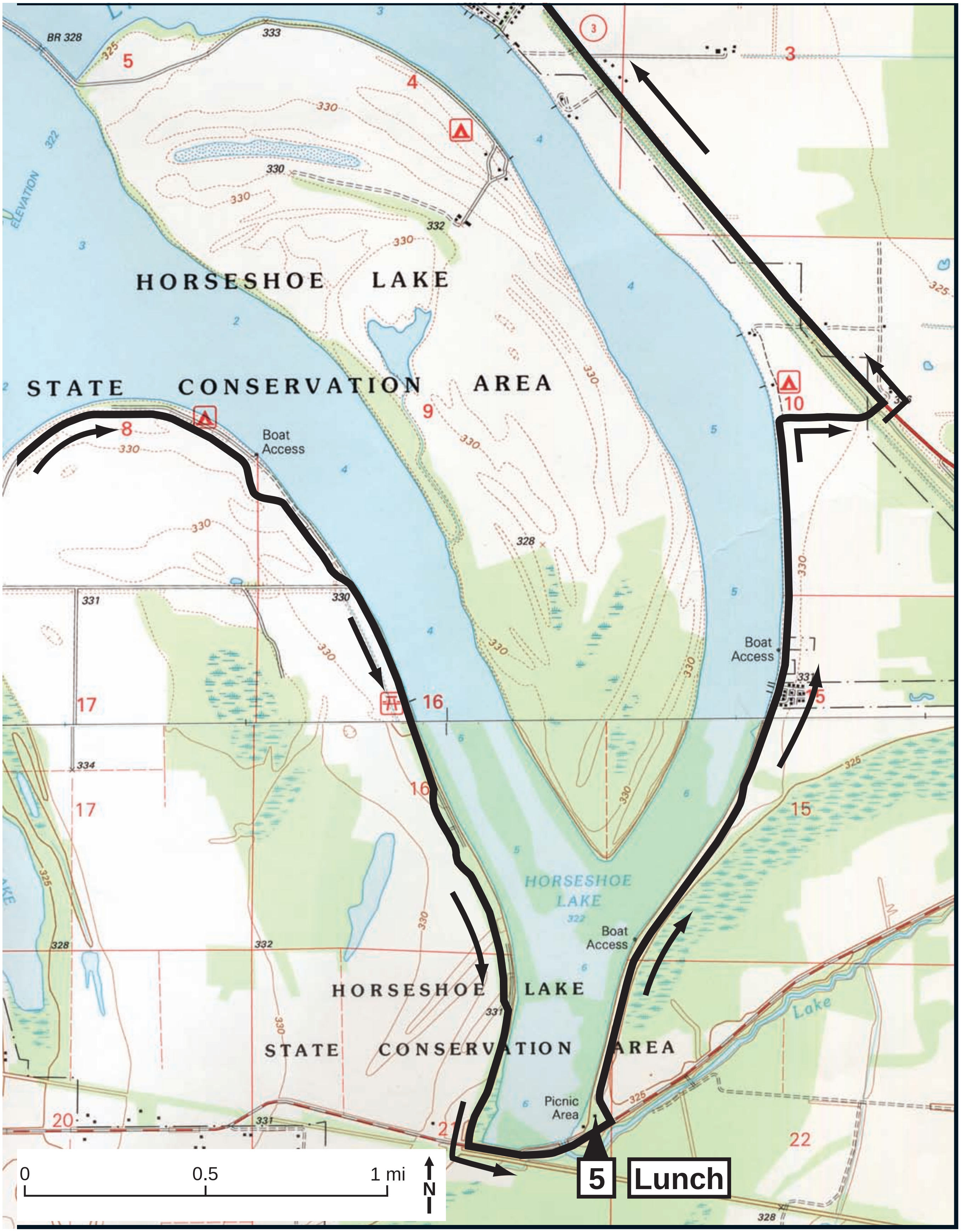
HORSESHOE LAKE
STATE CONSERVATION AREA
Boat
Access
Picnic
Area
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LAKE
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Lunch
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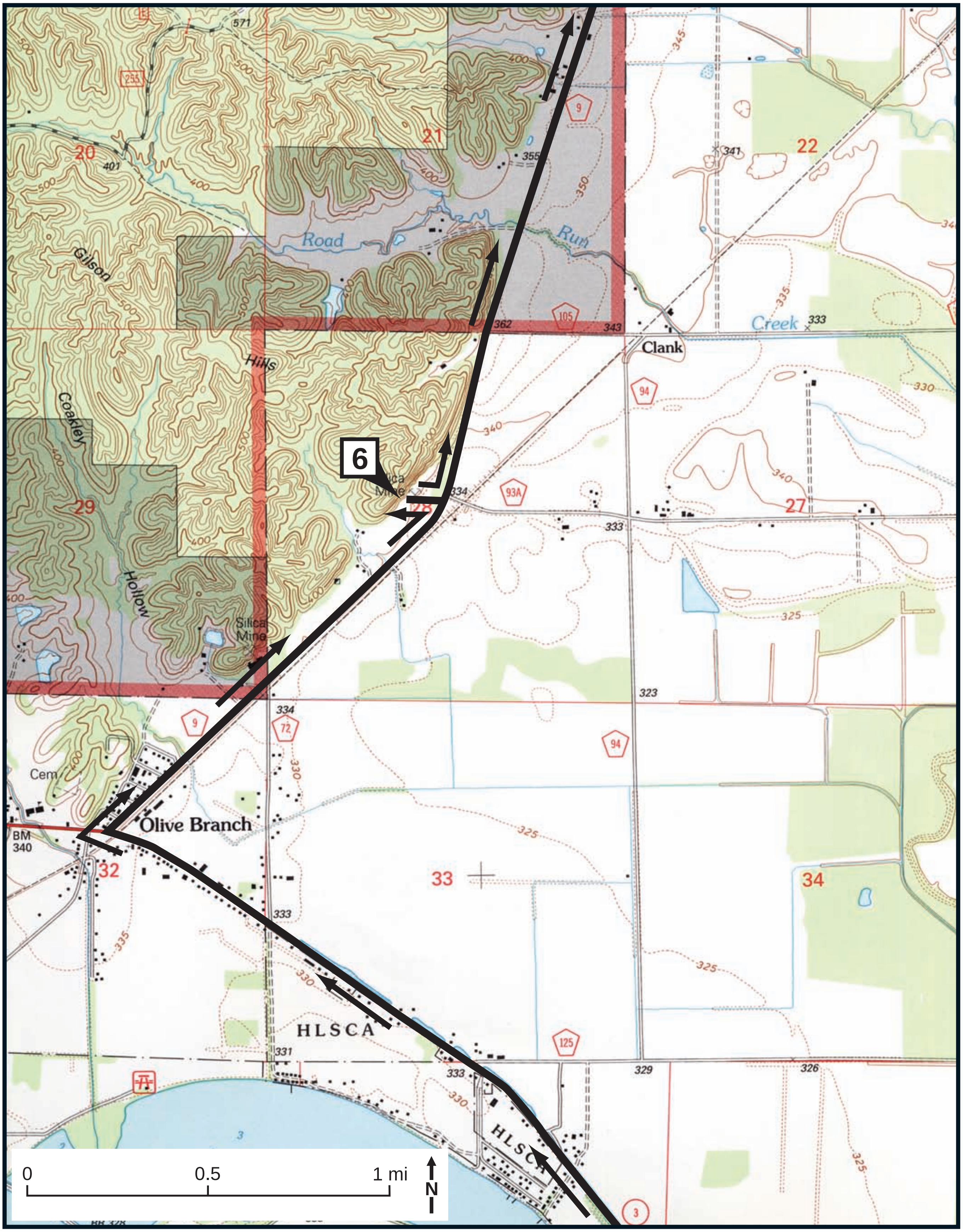
6
Olive Branch
Clank
Road
Run
Creek
Gilson
Hills
Coakley
Hollow
Silica Mine
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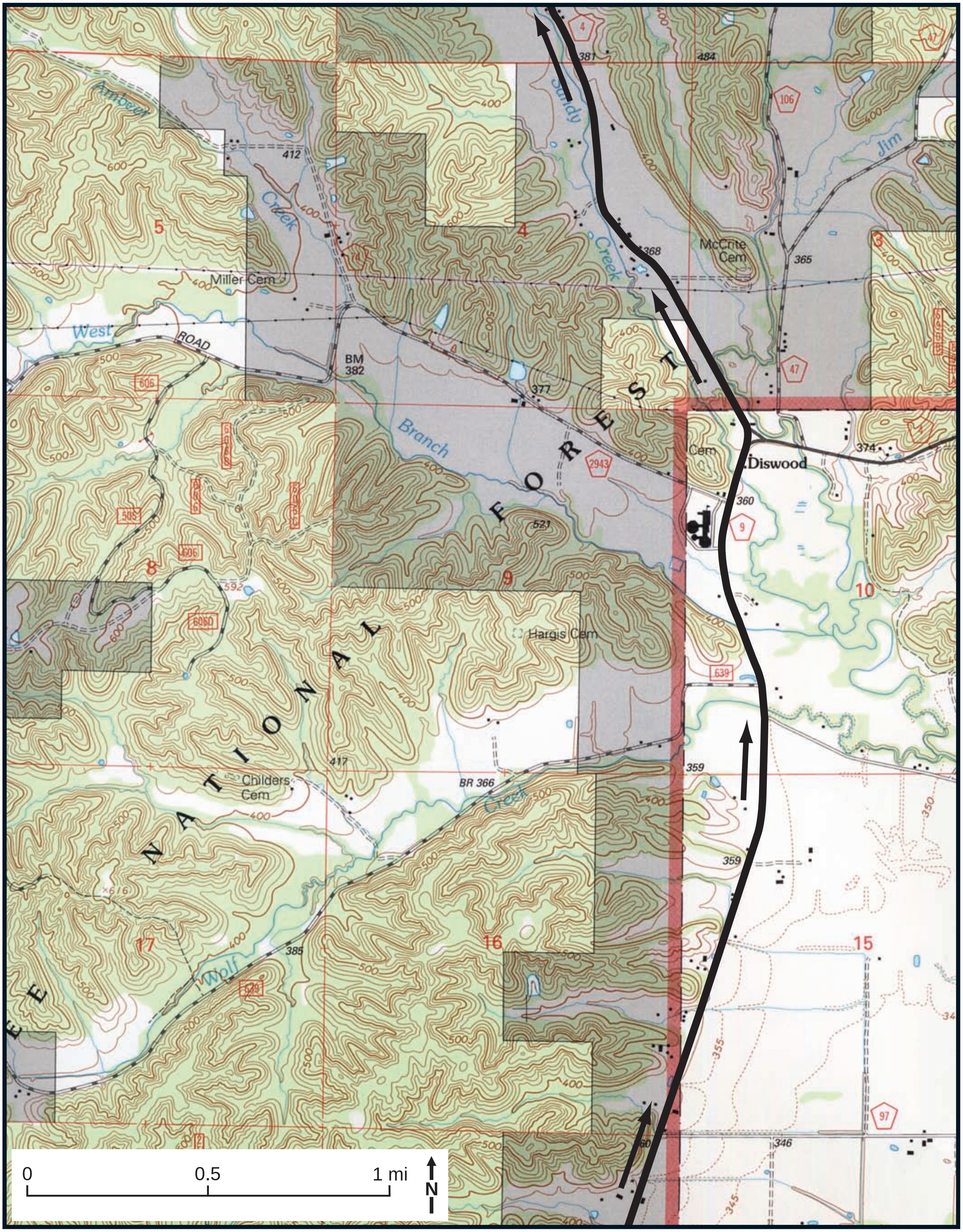
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Sandy
Creek
Jim
Creek
Miller Cem
McCrite
Cem
West
ROAD
BM
382
Branch
F O R E S T
N A T I O N A L
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Diswood
Hargis Cem
Childers
Cem
BR 366
Creek
Wolf
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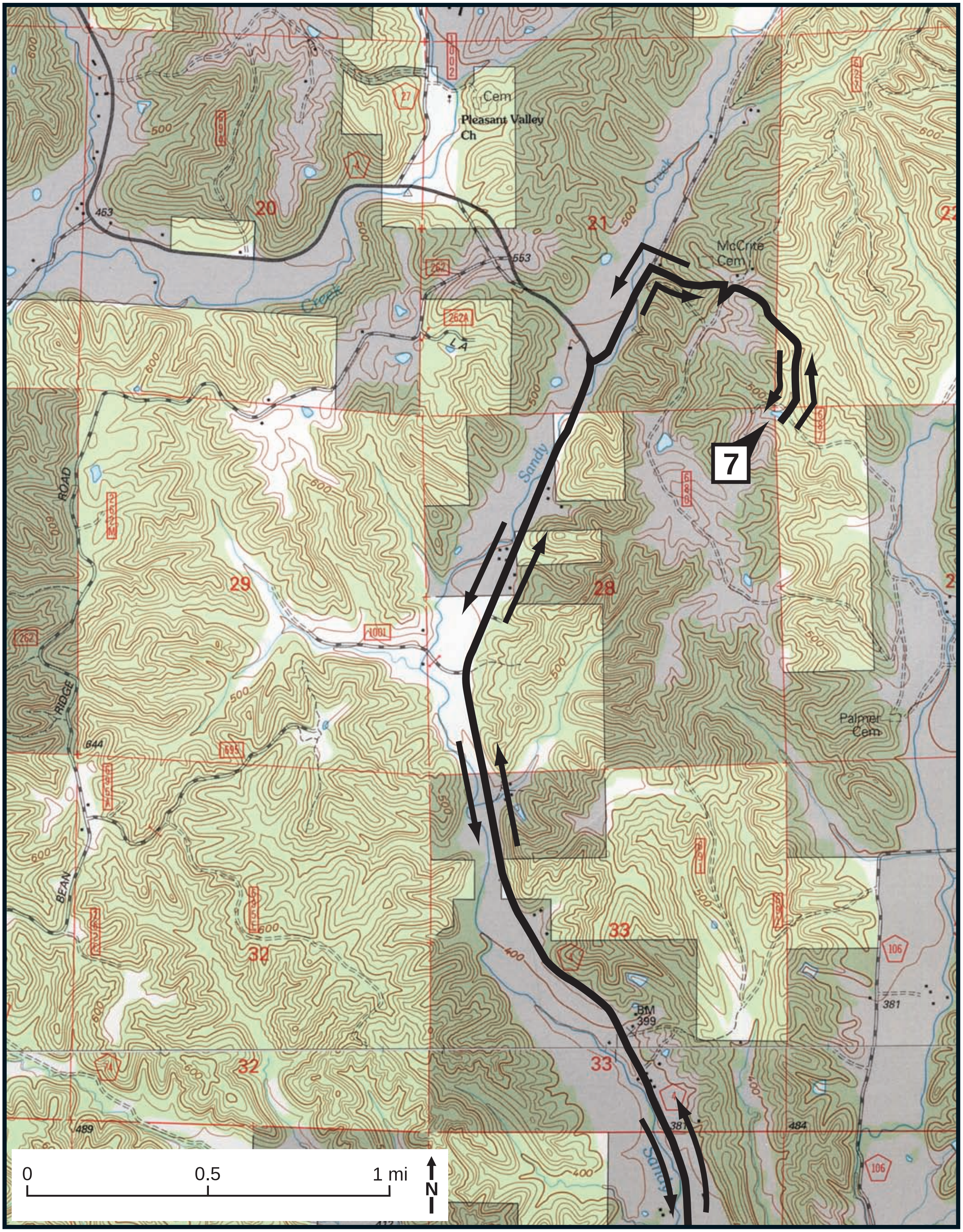

Cem
Pleasant Valley Ch
McCrite Cem
Palmer Cem
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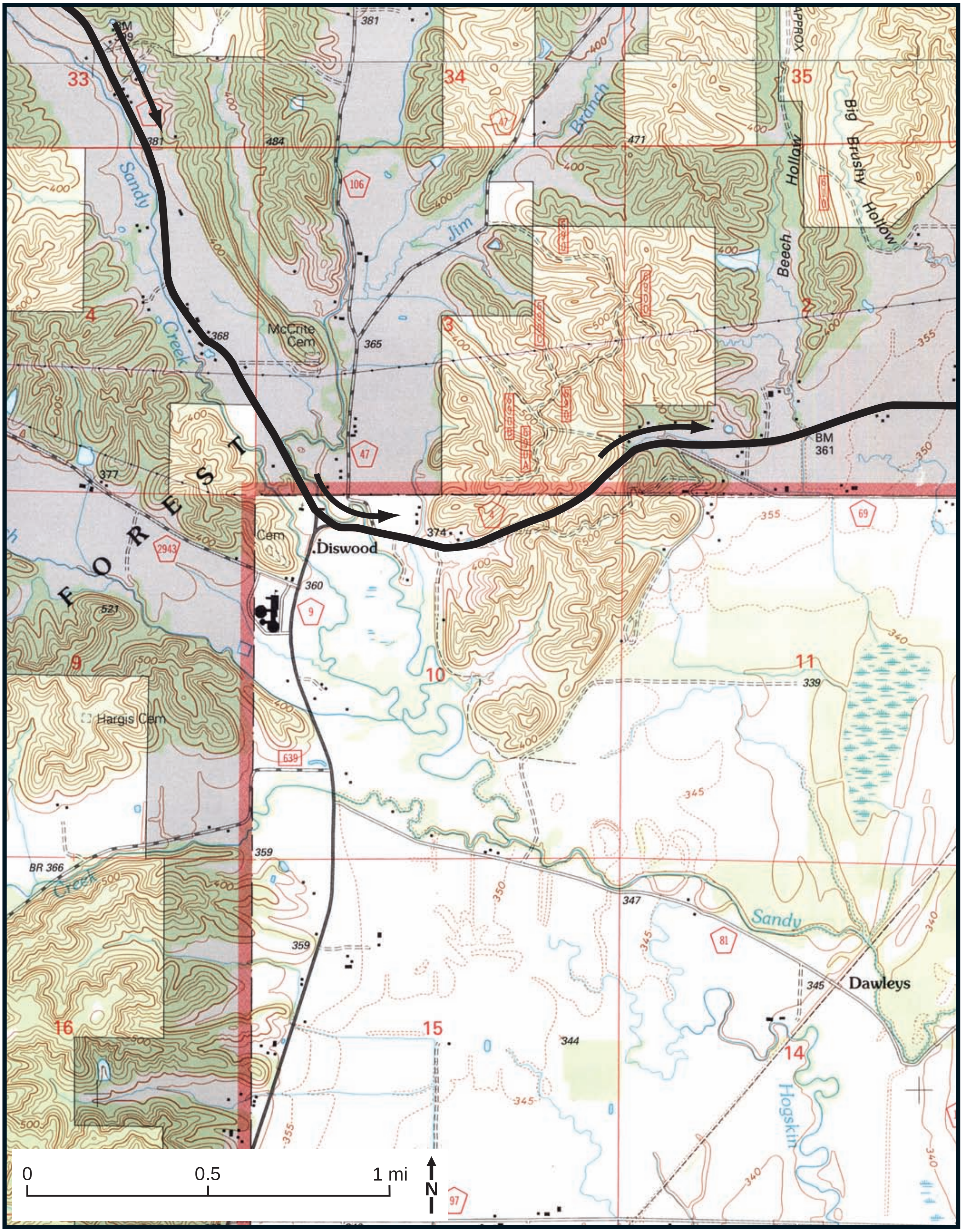
Sandy Creek
Jim Branch
Beech Hollow
Big Brushy Hollow
McCrite Cem
FOREST
Cem
Diswood
Hargis Cem
Sandy
Dawleys
Hogskin
BR 366
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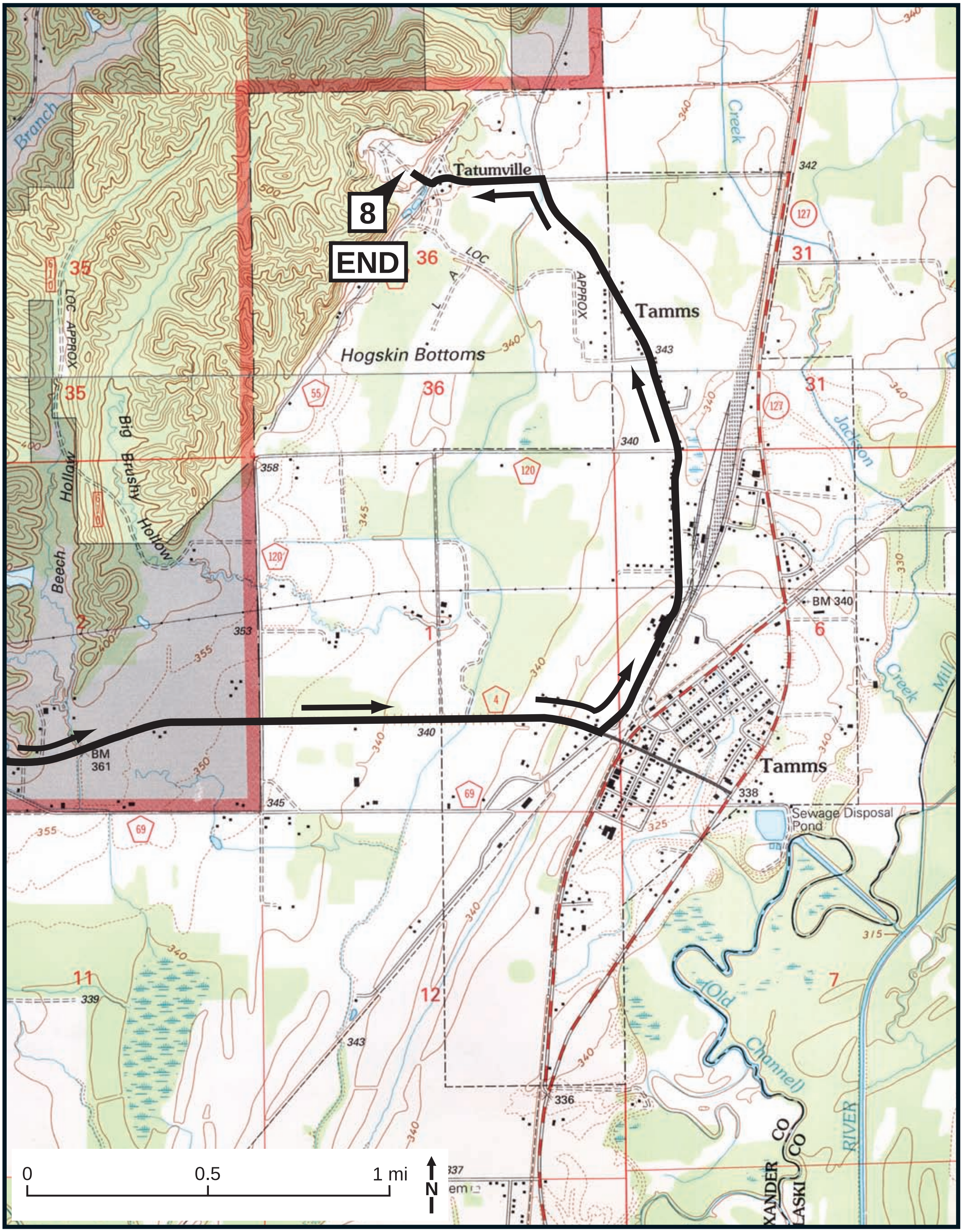
8
END
Tatumville
Tamms
Hogskin Bottoms
Big Brushy Hollow
Beech Hollow
Branch
Creek
Jackson Creek
Mill
(Old Channel)
RIVER
Sewage Disposal Pond
BM 340
BM 361
LOC APPROX
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0.5
1 mi
N

STOP DESCRIPTIONS

START. Horseshoe Lake State Conservation Area We will start at the spillway shelter and picnic area at Horseshoe Lake State Conservation Area (NE¼SE¼NE¼, Sec. 21, T16S, R2W, 3rd P.M., Cache 7.5-minute Quadrangle, Alexander County).

As you explore the Horseshoe Lake State Conservation Area, you may be reminded of the Deep South. The lake resembles a shallow Louisiana bayou with its wading herons and its large stands of bald cypress, swamp cottonwoods, tupelo gums, and wild lotus (fig. 6).

The 10,200-acre area includes the shallow 2,400-acre Horseshoe Lake with its 20 miles of shoreline (fig. 7) and spectacular scenery. Flora and fauna normally found in swampland much further south thrive in this setting. Visitors during fall and winter see large populations of waterfowl and bald eagles. Spring and summer guests can enjoy the vibrant colors of the foliage. Some of the most beautiful blooms are found on red buckeye shrubs in April and wild lotus in June. Native southern hardwood forests are abundant, and two large, undisturbed tracts have been dedicated as Illinois Nature Preserves. These preserves are open to visitors, but are also used for scientific research and education. The geology of Horseshoe Lake is discussed at Stop 5.

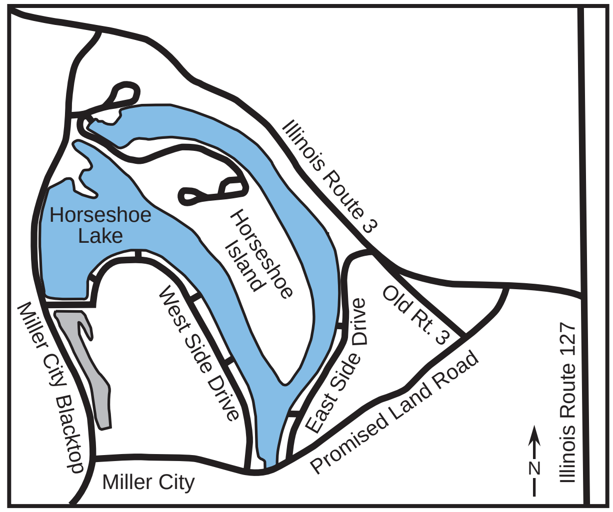


Figure 7 Horseshoe Lake State Conservation Area.

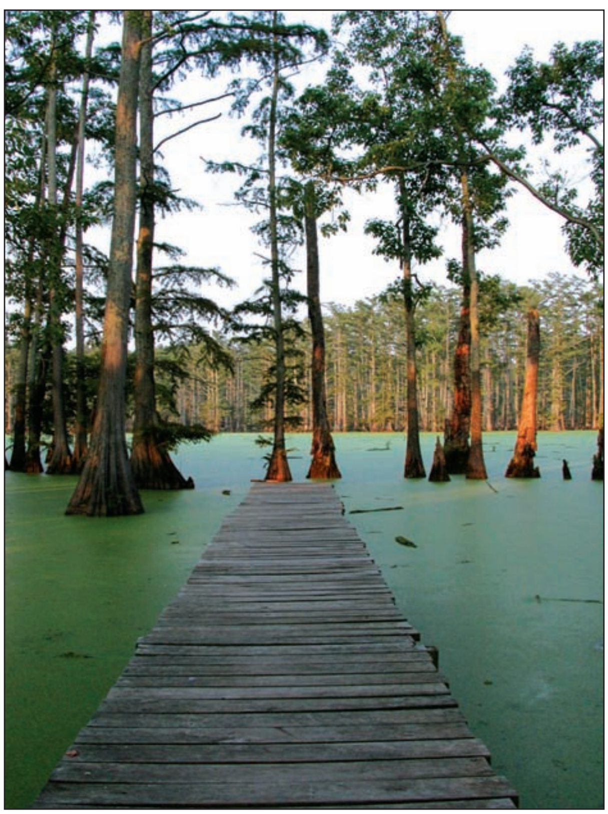


Figure 6 Bald cypress trees at Horseshoe Lake State Conservation Area in Alexander County (photograph by Wayne T. Frankie).

The first 49 acres of the conservation area were purchased by the Illinois Department of Conservation (now the Illinois Department of Natural Resources) in 1927 for development as a Canada goose sanctuary. Additional tracts of land, including Horseshoe Island, continued to be purchased to create the conservation area that greets visitors today.

Canada geese began wintering at the site in 1928. The original 1,000 birds increased to a population of more than 40,000 by 1944, but were reduced to 22,000 by 1947. Today, more than 250,000 Canada geese winter at the site, thanks to improved refuge management and harvest controls.

Horseshoe Lake

Since 1930, when a fixed concrete spillway was constructed, the lake has maintained an average depth of four feet. Water from the spillway flows into Lake Creek, which empties into the Cache River. Horseshoe Lake was inundated by floodwaters from the Mississippi River during the Great Flood of 1993. During March 2008, Horseshoe Lake was once again inundated by floodwaters, this time from the backing up of the Cache River. During this flooding, a large number of Asian carp (an invasive species) were seen migrating over the spillway.

STOP 1. Santa Fe Levee and The Great Flood of 1993—15 Years Later (NW¼NE¼NE¼, Sec. 30, T16S, R2W, 3rd P.M., Cache 7.5-minute Quadrangle, Alexander County). On the day of the field trip, we will park along the road.

Several names have been used to identify the levee south of Miller City, including the Fayville Levee, the Len Small Levee, and the Miller City Levee. I have used name Santa Fe Levee in this guidebook since the name has a more definitive geographic reference. The Santa Fe Chute parallels the levee, and the Santa Fe Road runs along the top of the levee.

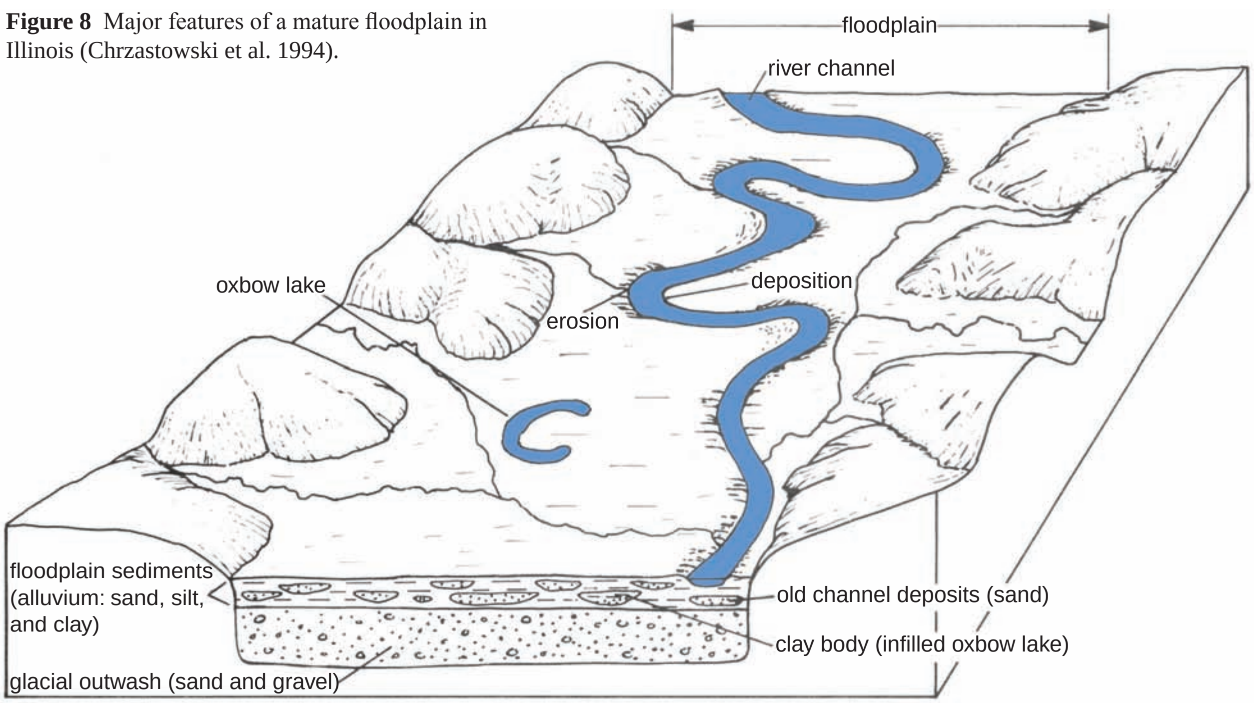
The Santa Fe Levee near Miller City in Alexander County was breeched during the flood of 1993. Thousands of acres of farmland and many homes in the area were flooded. Following the flood, the sand deposited over the floodplain covering the fertile farmland was bulldozed into large piles and/or pushed into the scour channels. Several of these large sand piles are visible south of Miller City. The large scour lake at the base of the levee at this stop is not shown on the Cache 7.5-minute Quadrangle. During the levee break, the Mississippi River cut a scour channel more than 80 feet deep in this area.

The following description, with few modifications, is from *The Great Flood of 1993,* ISGS Special Report 2, by M. J. Chrzastowski et al. (1994):

The Beginning of a Meander Cutoff Near Miller City

When meandering rivers flood, the floodwater may cut a new channel into the floodplain at a place where the river has the potential to shorten the distance it must travel, thus increasing the slope of the river. This process requires a sufficient volume of floodwater and a sufficient amount of time. The cutoff is most likely to occur near the neck of an oxbow meander where the outside bend of one meander loop is close to the outside bend of the next loop downstream. The resulting cutoff meander may still contain a small part of the river's flow, or the meander may be completely closed off by sediment deposition at its two ends, forming an oxbow lake (fig. 8). Such is the case of Horseshoe Lake, which formed approximately 4,000 years ago.

Figure 8 Major features of a mature floodplain in Illinois (Chrzastowski et al. 1994).



The process by which meander cutoffs develop was dramatically demonstrated during the 1993 flood. The Mississippi River nearly cut a new channel across Dogtooth Bend (Dogtooth Island) in southern Illinois south of Miller City (fig. 9). In this area, the Mississippi River floodplain covers a wide area and merges with the Ohio River floodplain. Many topographic features (related to geomorphology) on the floodplain near Miller City indicate that changes in channel positions and meander cutoffs have been frequent in the past. The floodplain includes Horseshoe Lake, an oxbow lake that formed by flooding approximately 4,000 years ago.

The meander cutoff began to form on July 15, 1993, when a breach occurred in the Len Small deflection levee (an appendage of the Santa Fe levee) about 1.5 miles southwest of Miller City. The breach was at about river mile 34, which is 34 miles upstream from the confluence of the Mississippi and Ohio Rivers. The area south of Miller City was flooded, and, because of the gradient, much of the water flowed southeastward for about 6 miles from the breach in the levee to rejoin the main river channel at about river mile 15 (fig. 9). It seemed that approximately 19 miles of river channel was about to be cut off and replaced by a new channel only 6 miles long. The course of the Mississippi River would be shortened by 13 miles. The distance for river traffic would also be shortened, but the slope along the new channel would, most likely, have been too steep for safe passage of tugs and barges (fig. 10). A new lock and dam might even have been needed for this river segment.

At the flood peak in this area on August 7, 1993, approximately 25% of the flood discharge from the Mississippi River was flowing across the floodplain along

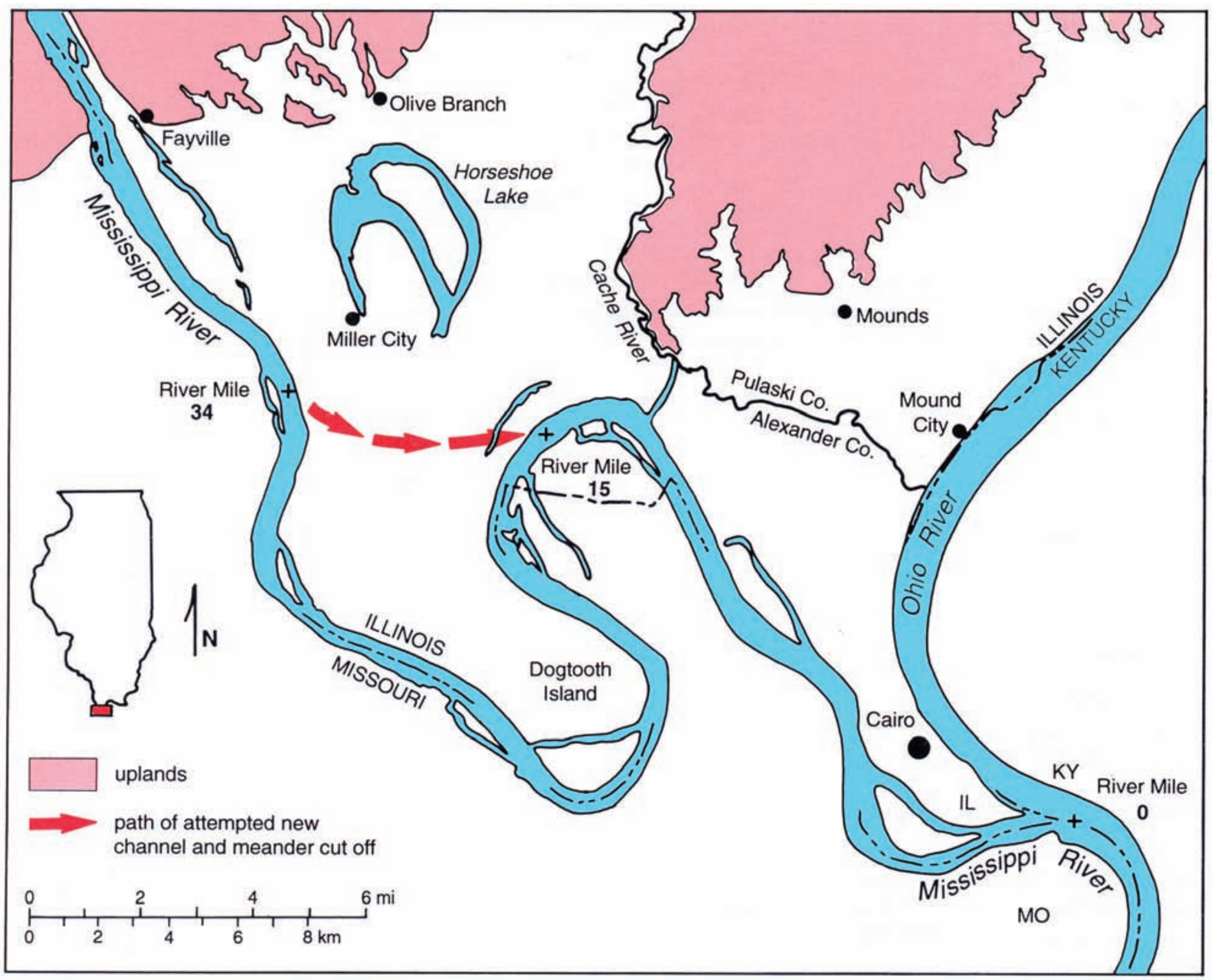


Figure 9 Route of potential meander cutoff by Mississippi River from the Santa Fe/Fayville Levee break. The Mississippi River nearly cut a new channel and formed a cutoff meander between river miles 34 and 15 (Chrzastowski et al. 1994).

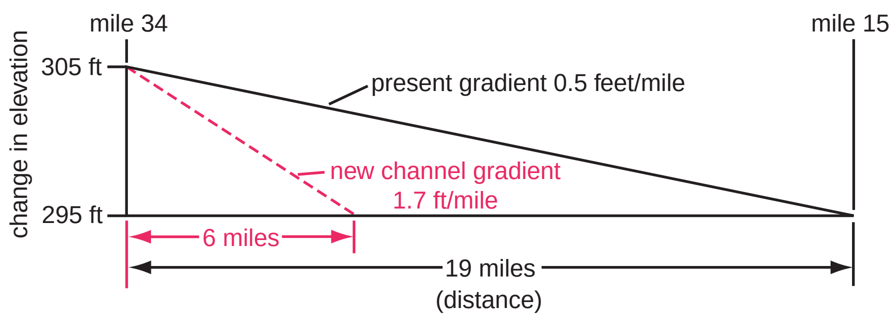


Figure 10 Comparison of current slope of the Mississippi River between river miles 34 and 15 and the possible slope created by the potential meander cutoff.

this potential channel. An irregular channel, ranging from 60 to 80 feet deep and extending 1 to 2 miles downstream from the levee break, was eroded into the floodplain. The eastern portion of the channel development stopped along a road running at right angles to the channel. The compacted roadbed, the paved road surface, and trees along the road apparently formed a barrier to further channel erosion. In this case, a man-made feature intercepted the natural processes developing within the meander cutoff. In other cases, the process may have been retarded by erosion resistant sediment, such as a buried clay deposit, within the floodplain.

The first stage of the meander cutoff near Miller City is a prime example of the type of channel change that commonly occurred during floods along the river before structures such as dikes and levees were built to maintain the channel's position. Such channel changes are part of the natural geomorphic processes of floodplain evolution as the river continually seeks the most efficient route, or path of least resistance, to the sea.

Possibly the most striking example in Illinois of a meander cutoff during historical time occurred at Kaskaskia Island when pioneers established the original settlement of Kaskaskia (and former state capitol) between the Mississippi River, which flowed in a wide arc in a channel (now called "Old River") around what is now the north, west, and south sides of the island and the old channel of the Kaskaskia River on the east side of the island (fig. 11). During a flood of the Mississippi River in 1881, the meander was cut off when the Mississippi River changed course and began to flow through the old channel of the Kaskaskia River on the east side of the island. Because the boundary between Illinois and Missouri was established before the channel shift, Kaskaskia Island, now west of the Mississippi River, remains a part of Illinois, accessible by land only from Missouri.

Floodplain Sediments and Their Distribution

River meandering, sediment erosion and deposition, and other geologic processes that form floodplains also control what type of sediments can be found on a floodplain and how they are distributed. Sand and gravel are common in channel deposits; silt and clay are common in overbank deposits between old channels and in backwater swamp deposits. Clay deposits are common in the upper part of sediments in-filling old channels that have become oxbow lakes. Another important geologic control is the areal distribution of these sediments—in other words, how and where they are distributed across the floodplain controls how susceptible different areas of the floodplain are to erosion. Whether the type of sediment consists of porous sand or relatively impermeable clay also determines whether water can infiltrate the sediments below and/or within the levees. Once infiltrated, levees are weakened and more likely to fail.

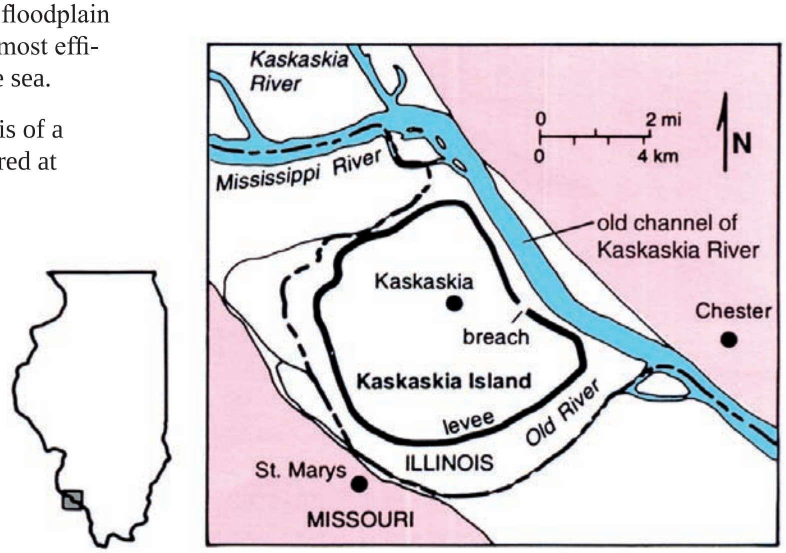


Figure 11 Historic 1881 meander cutoff creating Kaskaskia Island (Chrzastowski et al. 1994).

Overview of Levee Construction and Failure

Levees are linear, earthen mounds of two general types, depending on what they protect. Agricultural levees protect farmlands; urban levees are higher and broader structures that protect cities. Levees along the floodplains in Illinois are primarily agricultural.

Levees are typically constructed of sediments that have been dredged from the river channels or excavated from the floodplains. Properly compacted clay is ideal for levee construction because it resists erosion and forms a relatively impermeable barrier to the infiltration of flood water. In contrast, sand allows infiltration, which can weaken the levee and lead to structural failure. Sand is also easily eroded from the levee.

Four causes of levee failure (fig. 12) are summarized below.

Surface erosion The surface of the levee is eroded by floodwater lapping against it or by precipitation, as during a heavy rainfall, when drops of water pelt the surface and dislodge particles of sediment.

Levee seepage The levee is internally weakened as it becomes saturated by water seeping through permeable layers within the levee, or by the process called piping, by which water carries sediment through animal burrows or along the openings made by plant roots, particularly tree roots. This is why the levees are mowed and trees are not allowed to grow on levees.

Underseepage The ground under the levee is weakened as water moves through porous sand layers beneath the levee and pipes sediment away. Because of the loss of support, the levee may subside or collapse.

Overtopping A levee can also be weakened by overtopping, which simply means that water floods over the levee. Overtopping is not a type of levee failure, but a case of flood height exceeding the design height of the levee. Once overtopping begins, however, the flow of floodwater usually breaches the levee (fig. 13).

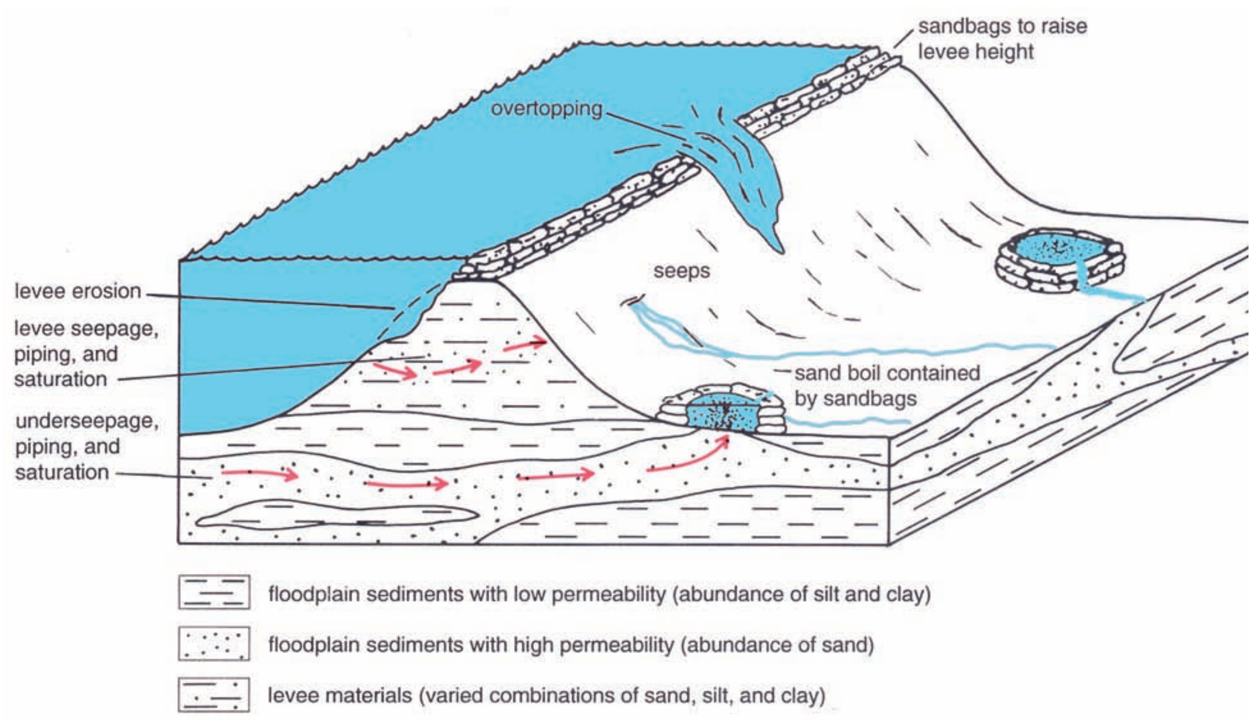


Figure 12 Overtopping, seeps, and piping move water over, through, or under a levee during a flood (U.S. Army Corps of Engineers 1978).

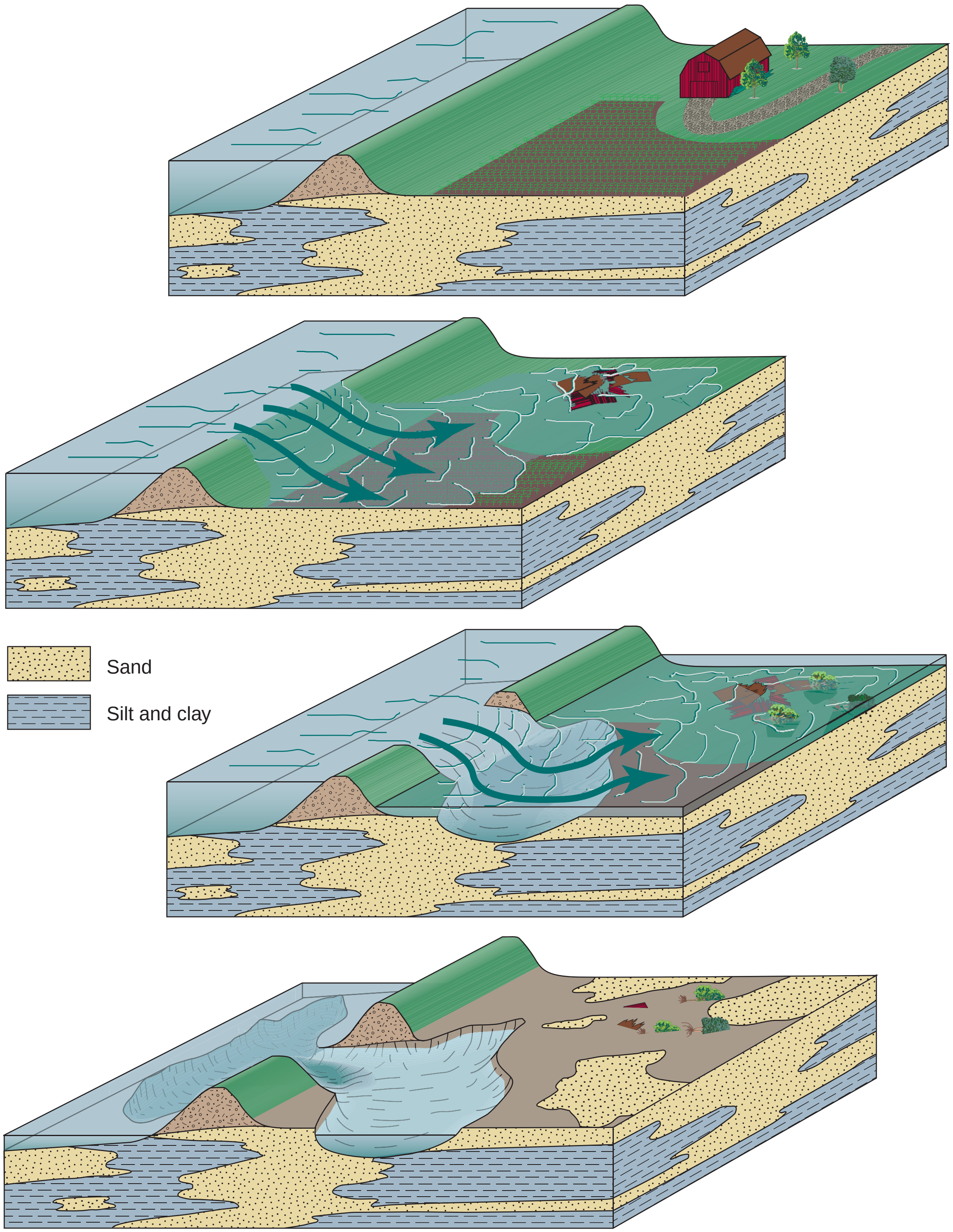


Figure 13 Levee failure by overtopping and the stages in development of a typical scour hole common to most levee breaches. Depth of the scour holes can be 50 to 80 feet below the original floodplain surface (Chrzastowski et al. 1994).

STOP 2. Black Powder Hollow Sand and Gravel Pit (W½SE¼SE¼, Sec. 27, T15S, R3W, 3rd P.M., Thebes 7.5-minute Quadrangle, Alexander County).

At this stop we will examine a pit where sand and gravel is being mined for local uses (fig. 14).

The geologic section (fig. 1) exposed in this pit includes Pleistocene loess (windblown silt) overlying the Tertiary age Wilcox Group (Eocene) gravel. The gravel at this pit rests upon the Cretaceous McNairy Formation. The McNairy is up to 450 feet thick in southern Illinois and is completely eroded north of the Cache Valley.

Figure 14 Exposure of Tertiary age Wilcox Group sand and gravel pit in Black Powder Hollow (photograph by W.T. Frankie).

The McNairy Formation is overlain by a thick section of Tertiary sand and gravel. These units occur within a graben formed between the Commerce Fault and the 40-Mile Fault (fig. 15). The McNairy is composed primarily of very fine-grained, micaceous quartz sandstone. It also has clay beds and laminated sand and clay facies. The sand is white to gray, contains reddish brown sandstone lenses, and is extremely friable.

The overlying Tertiary gravels belong to the Wilcox Group (Eocene). The uppermost sands and gravels may belong to the Mounds Gravel (Pliocene to Early Pleistocene). The Wilcox is composed of coarse quartz sands, colorful clays, and gravels. Sands occur in various shades of red, orange, yellow, and gray stained by iron oxide. Sands range from coarse to fine grained and are typically cross-bedded. The gravel consists of rounded, clear to milky quartz granules and pebbles, black chert pebbles, banded-iron polished pebbles, and agate pebbles. The clay of the Wilcox commonly occurs as gray lenses within the sands. However, variegated yellow-red-pink and purple clay lenses (as seen at this stop) occur as well.

The youngest gravel on top of this exposure may be equivalent to the Mounds Gravel. It is a rounded chert gravel that has a light brown patina and can contain fossil invertebrates from Ordovician through Mississippian age. The gravel mainly differs from the underlying gravels in its monochrome stain. The Tertiary gravels are thicker at this location because of active tectonics, which created accommodation space within the Black Powder Hollow Graben

The Mounds Gravel is widely present and exposed in numerous gravel pits and road cuts in the area south of the Cache Valley. The Mounds is up to 40 feet thick in some areas but more often is less than 20 feet thick. The formation is characterized by mostly medium to dark brown chert pebbles with a glossy surface in a matrix of coarse red sand to pebbly sand. Many of these pebbles are partly rounded to well-rounded and average 2 to 3 inches in diameter, but are sometimes even larger. Quartz pebbles that are well-rounded but

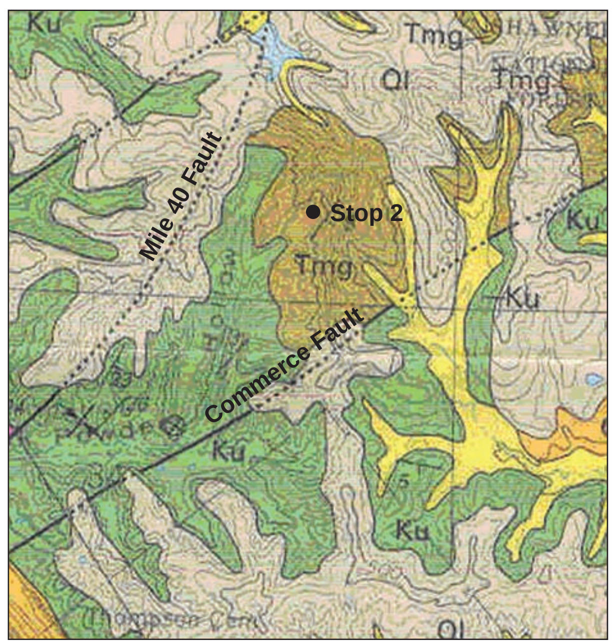


Figure 15 Geologic map of area surrounding Black Powder Hollow. Ku,Cretaceous deposits; Ql, Quaternary loess deposits, Tmg, Tertiary gravels (modified from Harrison 1999).

typically smaller are also common. Cross-bedding and heavy-mineral content indicate (Willman et al. 1975) that the Mounds Gravel in southern Illinois was largely deposited by streams flowing from the east or southeast, likely down the Tennessee River valley on the east side of the Mississippi Embayment.

The Mounds erodes the underlying, older Tertiary and Cretaceous sediments in the region. In turn, the Mounds has been highly dissected and weathered before deposition of the oldest Pleistocene deposit in the area (windblown deposits of Illinois Episode Loveland Silt). In most cases, these deposits are thought to be Pliocene in age, however, there is evidence that deposits of the Mounds in the lower terrace surfaces may have been reworked from higher levels during the early Pleistocene. The Mounds does not contain the igneous and carbonate rocks or heavy minerals characteristic of the glacial deposits of the Upper Mississippi and Ohio Valleys.

Some of the gravels found near the Mississippi River at the head of and on the west side of the Mississippi Embayment contain igneous rocks, chert, agate, and purple quartzite pebbles that are characteristic of the Lake Superior region. The gravel within Black Powder Hollow has been mapped as Mounds Gravel. However, because of the difference in the composition of the clasts within this deposit, the source area for this gravel is most likely from the Upper Mississippi and Missouri Valleys and not from the Tennessee River Valley. Therefore, we have tentatively assigned this gravel to the Tertiary age Wilcox Group (Eocene).

The sediments and fossils in the McNairy Formation indicate that sea level rose during Cretaceous time and that ocean waters spread inland across the Gulf Coastal Plain and Mississippi Embayment, extending into southern Illinois. How far this marine transgression extended into southern Illinois is unknown because of later erosion of those sediments north of the Cache River valley. The Mississippi Embayment is a structural trough in the form of a wedge-shaped inland extension of the Gulf Coastal Plain (thinning to the north and thickening towards the south) and is both a physiographic and structural feature. The northern limit of the Mississippi Embayment is marked mostly by the erosional limit of the Cretaceous and Tertiary age deposits. These Cretaceous and Tertiary deposits represent the ancient shoreline, open to marine sedimentation, when waters of the Gulf of Mexico reached inland to the southern tip of Illinois.

Previous research on the Cretaceous-Paleocene strata in southern Illinois have included two potassium-argon dates on the pelletal glauconite found above and below the Cretaceous-Tertiary boundary. The uppermost Owl Creek Formation (Cretaceous) was dated at 65.7 ± 1.4 million years before present (BP), and the lowermost Clayton Formation (Paleocene) was dated at 60.6 ± 1.3 million years BP (Reed et al. 1977).

STOP 3. Kimmswick Limestone and Thebes Railroad Bridge (SW¼NW¼NE¼, Sec. 17, T15S, R3W, 3rd P.M., Thebes 7.5-minute Quadrangle, Alexander County).

Stop 3 provides the opportunity to discuss at least three important topics: the strata (rock layers) exposed along the river, the geologic history of the Mississippi River, and the construction of the Thebes Railroad Bridge.

Kimmswick Limestone

The Ordovician age Kimmswick Limestone is exposed along the Mississippi River near Thebes. The Kimmswick Limestone is a light gray to brownish gray, medium- to coarse-grained, high-calcium grainstone. Thin intervals of dark gray, finer-grained wackstone occur occasionally near the top. This unit contains abundant fossil fragments, dominantly crinoids, and common argillaceous partings and styolites; the upper part contains black to brown chert nodules. The Cape Limestone overlies the Kimmswick Limestone. The high-calcium content of the Kimmswick Limestone in this area is currently being investigated as a potential source of high-calcium lime for use in coal-fired power plants scrubbers to reduce emissions. The interaction between the Kimmswick Limestone and the Mississippi River has created a unique erosional surface in the Kimmswick, including solution cavities, numerous potholes of varying sizes, and unusual, if not beautiful, large mushroom-like pillars (fig. 16).

Thebes Gap

Crowley's Ridge begins south of Cape Girardeau near Commerce, Missouri. This ridge trends to the southwest and then makes a large arc, coming back to the Mississippi River near Helena, Arkansas. During the last period of glaciation, some 15,000 years ago, massive buildup and melting of the glaciers resulted in great floodwaters beyond modern imagination that flowed down the

Figure 16 Exposure of Ordovician age Kimmswick Limestone along the Mississippi River at Thebes, Illinois. The historic Thebes Railroad Bridge is shown in the background (photograph by W.T. Frankie).

Ohio and Mississippi Rivers as marginal ice streams. The Mississippi River at one time turned sharply west, just south of Cape Girardeau, Missouri, and flowed on the west side of Crowley's Ridge. The old route of the Mississippi River generally followed the course of what is now the St. Francis River. The present channel of the Mississippi River flowing through the Thebes Gap developed some time between 10,000 and 20,000 years ago. Earthquakes along the Commerce Fault Zone may have helped open the present channel. Following the last ice melt, the Ohio joined the Mississippi River just south of the Thebes Gap. The narrow band of uplands known as Crowley's Ridge is the only remaining remnant of this story.

The Mighty Mississippi

"Old Man River," the mighty Mississippi River, begins its life rippling between stepping stones at the outlet of Lake Itasca in northern Minnesota. Lake Itasca is the uppermost collection basin where the river begins its 2,500-mile journey southward to the Gulf of Mexico. The Mississippi borders the entire western side of Illinois, beginning at East Dubuque and ending at Cairo at the river's confluence with the Ohio River.

The Mississippi River System includes all main channels and tributaries of the Mississippi, Illinois, Missouri, and Ohio Rivers. The Mississippi River itself is open to river commerce for more than 1,830 miles—from Minneapolis, Minnesota, to the mouth of the river at Southwest Pass, Louisiana. More than 540 million tons of more than 100 different commodities are transported on the Mississippi River System. Some of the more common commodities for export include corn, wheat, soybeans, lignite, bituminous, and anthracite coals, grain mill products, and basic chemicals and products. Imports include aluminum ore concentrates, crude petroleum, and sugar, along with iron and steel plates and sheets.

For comparison, the cargo capacity of one barge is 1,500 tons, which is equal to 15 jumbo hopper railcars with a capacity of 100 tons each or 58 large semi-trucks with a capacity of 25 tons each. A typical tow consists of 15 barges, which can carry 22,500 tons, the equivalent capacity of 870 trucks or 2.25 unit trains. A unit train consists of 100 jumbo hopper cars, each with a capacity of 100 tons. A single tow is 0.25 miles in length, 2.25 unit trains are 2.75 miles long, and 870 trucks (assuming 150 feet between trucks) would be 34.5 miles long.

Ohio River—Tributary to the Mississippi River

The Ohio River basin comprises 204,000 square miles. The 981-mile-long river carries the largest volume of water of any of the Mississippi River tributaries. Starting in northeastern New York, the Ohio is formed by the junction of the Allegheny and Monongahela Rivers at Pittsburgh, Pennsylvania, and empties into the Mississippi River at Cairo. Over 239 million tons of commodities, valued at nearly $45 billion, are transported by barge annually on the Ohio River.

Thebes Bridge

Construction on the Thebes Bridge started on July 8, 1902, and was completed on April 18, 1905. Designed by the famous architect Ralf Mojeski, the bridge was at the time of completion the world's longest cantilever-type bridge to be erected over such a huge body of water. Unfortunately, 25 men lost their lives during construction. To test the bridge's strength, 25 locomotives were coupled together and run to the center of the bridge where they were stopped suddenly in order to put a great amount of stress on the structure. The bridge was built by the Southern Illinois and Missouri Bridge Company at a cost of $4,000,000.

The bridge is a double-track cantilever-type structure. It contains five spans. The main cantilever span over the channel is 671 feet long, and the other spans are 521 feet long. The western approach consists of six 65-foot arches and one 100-foot concrete arch; the eastern approach consists of five 65-foot concrete arches. The entire length is 3,910 feet. Construction materials used included 945,000 cubic feet of concrete and 27 million pounds of steel for the superstructure. The piers within the Mississippi River were armored using Indiana oolitic limestone. The limestone blocks were hewn by hand in order to give the bridge a natural look against the bluffs.

Each of the spans is 65 feet above normal high water and 108 feet above low-water stage. The distance from the extreme bottom of the channel pier, which rests on bedrock, to the top of the top chord is 231 feet. High water during field work for this trip precluded close examination of the piers in the water. The color of the blocks and the proximity of the location to Grafton, Illinois, suggest the possibility that the stone blocks used in the piers may have come from Grafton, where Silurian age dolomite was quarried. A large amount of dynamite was used in blasting through the bedrock for the piers. The dynamite most likely was purchased from the Aetna Powder Company at Fayville.

STOP 4. Girardeau Limestone at Rock Springs Hollow (SW¼SE¼NW¼, Sec. 21, T15S, R3W, 3rd P.M., Thebes 7.5-minute Quadrangle, Alexander County).

There is a series of small waterfalls and primary joints that trend northeast along the major structural fabric in the rocks at this stop (fig. 17). The first rock unit observed is a dense dark gray to gray, lime mudstone (sublithographic) that contains dark gray chert and displays wavy to irregular bedding. Individual limestone beds range from two to six inches thick separated by tan, gray, to greenish gray shale. The shale becomes thinner and less abundant upward. Well-preserved Ordovician fossils can be found just below the shale on

Figure 17 Exposure of Upper Ordovician age Girardeau Limestone within Orchard Creek, Rock Springs Hollow Section (photograph by W.T. Frankie).

the top of the limestone beds. The formation is called the Girardeau Limestone; it is a dense micrite that when struck displays conchoidal and splintery fracture. The Girardeau has variable thickness from 0 to 40 feet. It is a part of the Upper Ordovician Cincinnatian Series.

Fossils that have been found here include *Tentaculites*, encrinurid trilobites, crinoid heads and columns, starfish, rugose corals, bryozoans, and brachiopods. All of the fossils are somewhat rare but show exceptional preservation.

At this location, the Girardeau Limestone is wedged between two northeast-trending faults, one to the east of this stop and a second to the west (fig. 18). The second fault is called the Rock Springs Fault. It is a part of a graben, where overlying rocks are dropped down relative to the underlying rocks. The Girardeau Limestone strikes north-northeast and dips about 5 degrees to the southeast. As you walk along the stream to the west (downstream), near the abandoned Missouri Pacific Rail Road bridge, the Girardeau outcrop abruptly ends and is juxtaposed with Silurian Sexton Creek, Bainbridge, and Devonian Bailey Formations at the Rock Springs Fault.

The formation next to the Girardeau along the Rock Springs Fault is the cherty, gray lime mudstone (sublithographic) belonging to the Sexton Creek Formation. The Bainbridge, a gray lime mudstone with reddish fossils is west of the Sexton Creek. Some pink-gray limestone facies are also seen in this formation. The Bainbridge occurs west of the Sexton Creek within this downdropped fault block, or graben, west of the Rock Springs Fault. The Sexton Creek also contains the colonial, tabulate coral, *Favosites.* Finally, the Bailey Limestone is also present on the west side of the Rock Springs Fault. Figure 18 shows a plan view of the geology along Rock Springs Hollow. The Bailey straddles the Silurian and Devonian boundary. The Bailey Limestone is a thin-bedded, argillaceous limestone

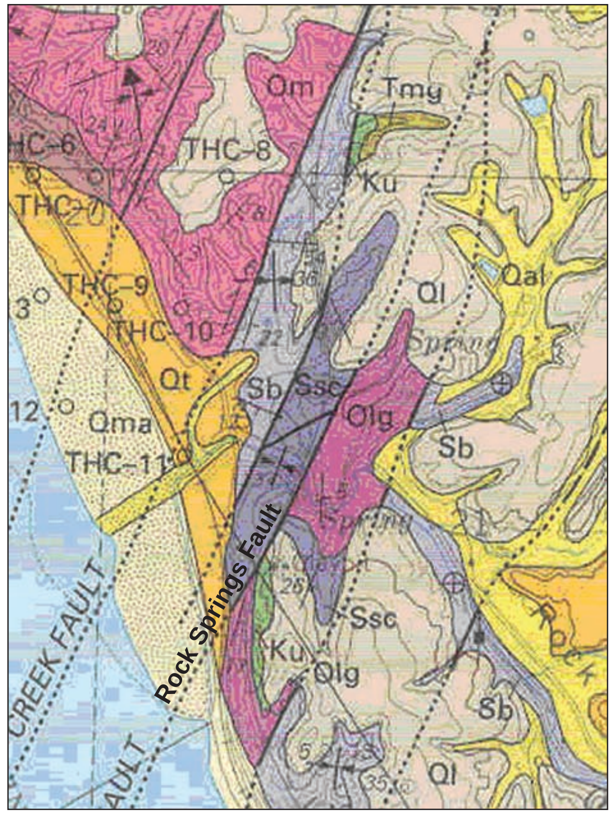


Figure 18 Geologic map of area surrounding Rock Springs Hollow. Ql, Quaternary loess deposits; Qal and Qma, Quaternary alluvium deposits; Qt, Quaternary terrace deposits; Tmg, Tertiary gravels; Ku, Cretaceous deposits; Sb, Silurian, Bainbridge Formation, Ssc, Silurian, Sexton Creek limestone; Olg, Ordovician, Girardeau Limestone; Om, Ordovician, Maquoketa Group (Harrison 1999).

that contains tan to greenish chert nodules and is rarely fossiliferous.

A mammoth tusk was excavated by workers in the Civilian Conservation Core (CCC) in the 1930s near Rock Springs. The tusk is housed in the Thebes Courthouse.

STOP 5. Horseshoe Lake State Conservation Area - Lunch (NE¼SE¼NE¼, Sec. 21, T16S, R2W, 3rd P.M., Cache 7.5-minute Quadrangle, Alexander County).

Horseshoe Lake, originally a large oxbow meander in the Mississippi River, was formed when the Mississippi River changed its course. This large abandoned meander formed an oxbow lake within the Mississippi River floodplain. Because of the vast number of trees that covered most of this area, early historians referred to this area as the “Great Forest.” The first Native Americans to inhabit this area were mound builders. Lake Milligan Mound (reported to be the third largest mound in the United States) is located 3 miles south of Horseshoe Lake, within Dogtooth Bend (Dogtooth Island). Several smaller mounds are located around Horseshoe Lake.

The following summary of the archaeology and history of Horseshoe Lake was modified from a paper by Koldehoff and Wagner (2002).

Horseshoe Lake is the most prominent hydrologic feature in the complex area of floodplains and swamps between the converging channels of the Mississippi, Ohio, and Cache Rivers at the southern tip of Illinois. This oxbow lake, formed around 6,000 years BP, is an unusual feature in geomorphic terms in that it still exists as a definable lake and associated swamp. Most comparably aged features in active floodplains along the Mississippi have been infilled and have ceased to exist.

Seismic History

Settling and compaction of alluvium occur during major earthquake shaking and can produce profound changes in the nature of rivers and their floodplains. Paleoseismic studies indicate the there have been at least three large earthquakes on the New Madrid Fault System before the historic 1811–1812 events: these are dated as 1450 A.D. (±150 years), 900 A.D. (±100 years), and 2,350 ± 200 years BP. Data also indicate a smaller earthquake occurred around 300 A.D. (± 200 years) The U.S. Geological Survey calculates that a magnitude 7 earthquake on the New Madrid Fault System has a recurrence interval of about 500 years (Skip Nelson, personal communication 2008).

Horseshoe Lake may have formed in response to a large New Madrid-type earthquake. During the New Madrid Earthquake of 1811–1812, Reelfoot Lake in Tennessee was formed in response to subsidence and to a dramatic shift in course of the Mississippi River.

The Prehistoric Record of Horseshoe Lake

A record of human habitation ranges from the mid-Archaic cultural period, prior to 3,000 B.C., through the Mississippian cultural period (900 A.D. to 1500 A.D.). The importance of the lake area to local groups varied dramatically through time, being greater during the Archaic (8000 B.C. to 500 B.C.) and Woodland (500 B.C. to 900 A.D.) cultural periods and declining noticeably during the Mississippian cultural period, when settlement was concentrated around the large mound center in the Dogtooth Bend meander to the southeast.

Horseshoe Lake was formed around 6,000 years ago and remains a scar on the Mississippi floodplain. A generalized model of the life cycle of Horseshoe Lake (an oxbow lake) can be divided into three stages with estimated date ranges: (1) the lake stage, 6,000 to 3,000 years ago; (2) the swampy lake stage, 3,000 to1,000 years ago; and (3) the swamp stage, 1,000 years ago to 1929. These cycles are based on fundamental principles of wetland ecology, plant succession, and landscape. The swampy lake stage was the most productive in terms of human subsistence potential, and the most productive part of the lake during this stage was the interface between open water and the swampy ends of the lake's arms, which tend to fill with sediment and swamp more rapidly than the rest of the lake.

Geomorphology: The Evolution of Horseshoe Lake

In 1928, when the State of Illinois constructed a temporary dam at the south end of the lake, Horseshoe Lake ceased to be a natural feature. Before this construction, Horseshoe Lake was more swamp than lake, typically drying up in the summer. The areas of open water that currently exist are not natural features but are the result of logging early in the twentieth century and the artificial lake levels. The transformation of an oxbow lake into a swamp is a natural and inevitable process.

The life cycle of abandoned Mississippi River channels begins when a meander loop is cut off from the main channel and an oxbow lake is formed (fig. 8). The cycle ends when the oxbow lake is filled with sediment and is completely transformed into a swamp or marsh, which eventually becomes dry land or is eroded by an advancing meander loop. The duration of a complete life cycle is highly variable because of local circumstances but probably involves at least several hundred years and can be as long as several thousand years.

After its cutoff, the Mississippi River migrated to the west, never to return except during floods, as in 1993.

Biotic Landscape

Once covered by rich bottomland forest interspersed with cypress swamps, the areas surrounding Horseshoe Lake are today largely denuded, drained, and cultivated, as is much of the surrounding bottomlands of the Mississippi and Cache Rivers. Much of this area, including Horseshoe Lake, was logged early in the twentieth century. Currently, the lake is ringed by bald cypress and tupelo gum trees, occasionally in thick stands that reach from shoreline to shoreline. Merging with this zone but on higher ground along the lake bank are remnant slivers of bottomland forest.

The landscape prior to European settlement was densely forested, and the distribution of plant species was closely tied to soil moisture, as dictated by annual flooding and the depth of the water table. Cypress tupelo swamps covered the lowest areas. Willows, cottonwoods, and maples were common along the banks and sandbars of the Mississippi River and other waterways.

These species, with ashes and elms, grew in and along swales and other low spots with sugarberry and sycamore. Natural levees, point bar ridges, and other drier landforms supported mature growth, including various species of oak and hickory. These and similar species were common in the adjacent uplands, particularly in stream valleys and moist ravines. Numerous vines and understory plants thrived in all of these forested settings. Floating, submerged, and emergent plants grew in and along lakes, swamps, and streams. Many insect, mollusk, fish, amphibian, reptile, bird, and mammal species inhabited these ecosystems: some were permanent residents; others were periodic or seasonal visitors. Historic accounts, such as that of Worthen (1882) reveal that migratory waterfowl—ducks, geese, and swans—were especially plentiful:

> The bottom lands are generally flat, and are interspersed with Cypress ponds and marshes, and a portion of them are too wet for cultivation without a thorough system of drainage, and are subject to annual inundations from the floods of the adjacent rivers. The most elevated portion of these lands, however, has a light, rich, sandy soil, and is susceptible of a high state of cultivation. They are heavily timbered with white oak, swamp white oak, bur oak, Spanish oak, yellow poplar (tulip tree), shellbark and pig nut hickory, ash beech, and white and sugar maple, all of which are found on the highest bottoms, and indicate a soil sufficiently dry for cultivation. The swampy lands are characterized by the growth of the cypress, sweet gum, pecan, tupelo gum, cottonwood, willow, etc.

STOP 6. Olive Branch-Sandy Ridge Novaculite Quarry (S½SW¼NW¼, Sec. 28, T15S, R2W, 3rd P.M., Tamms 7.5-minute Quadrangle, Alexander County)

The strata exposed within the quarry belong to the Lower Devonian Grassy Knob Chert (see detailed description, Stop 8). Pleistocene age, loess deposits overlie the chert (fig. 19). The loess contains an abundance of calcareous (calcium carbonate) concretions. Geologists call these concretions *loess kindchen* (translated: "children of the loess"). These compound nodules or concretions often resemble a doll, potato, or a child's head. Generally hollow, some may contain a loose stone. These concretions have also been called loess dolls, loess nodules, and loess puppets. Occasionally, the loess deposits contain fossil snails. Although no fossil snails were observed at this stop, they have been observed in the loess deposits at Stop 8.

A fault is located on the top bench at the northwest corner of the quarry. This fault is associated with the Commerce Fault Zone. This strike-slip fault trends northwest-southwest, with movement to the southwest in relation to movement on the northwest side of the fault.

Looking to the east from the upper bench in the quarry provides a great view of the ancient Ohio River Valley and floodplain. The Cache River, which flows within the ancient Ohio River Valley, is located to the east.

History of the Ohio River and the Cache Valley

The Cache Valley is one of the most impressive physiographic features in Illinois (fig. 20). It stretches east to west from the Ohio River to the Mississippi River. The Cache Valley is an abandoned main channel and floodplain of an ancient major drainage system and is one of the best exposed and most widely recognized landforms in Illinois.

Figure 19 Exposure of Lower Devonian age Grassy Knob Chert Formation at Olive Branch-Sandy Ridge novaculite quarry (photograph by W. T. Frankie).

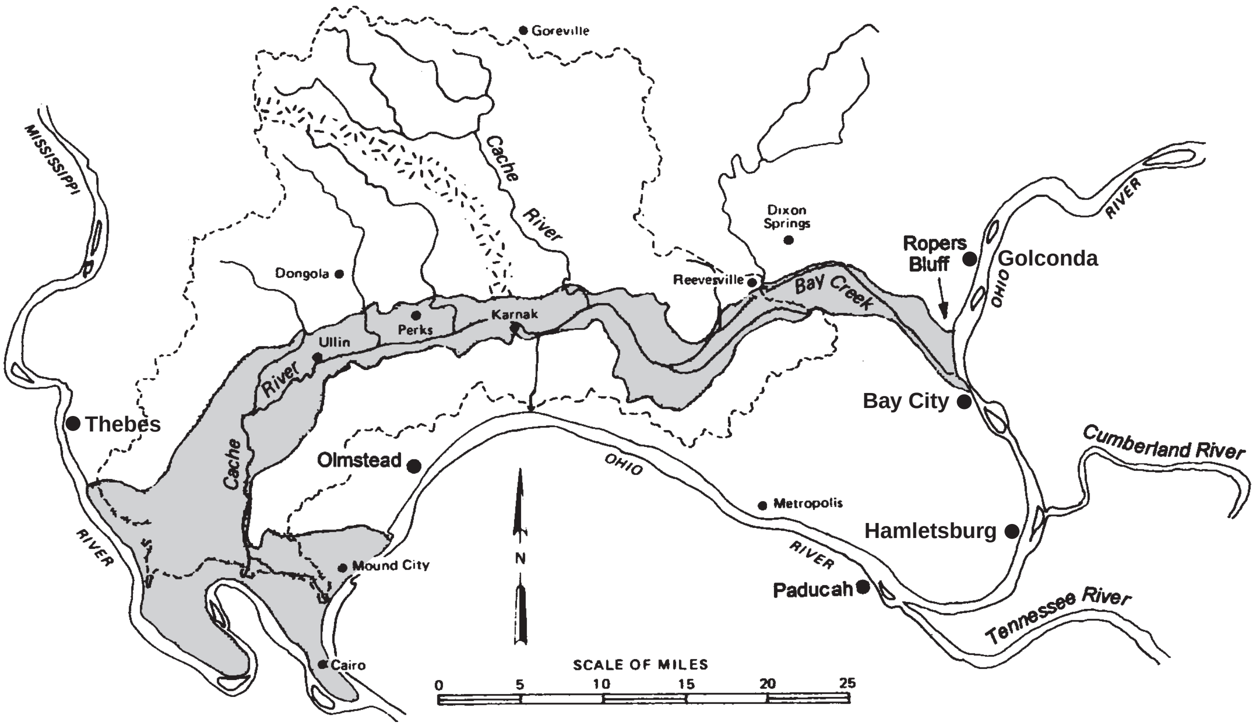


Figure 20 The Cache Valley (Frankie et al. 1997, 2003).

Physiographically, the Cache Valley forms the northernmost edge of the Coastal Plain Province (the Mississippi Embayment) (fig. 5). Here the Embayment abuts the Shawnee Hills Section of the Interior Low Plateaus Province. The valley extends nearly 45 miles westward from its sharp angular junction with the Ohio River at Ropers Bluff (about 5 miles south of Golconda) to an area north of Cairo where the floodplains of the ancient Ohio and Mississippi Rivers converge.

The Cache Valley is a broad, flat-bottomed valley, ranging in width from 1.5 to 4 miles and averaging about 3 miles. The north valley walls are 150 to 250 feet high. Generally the valley follows the contact between the Cretaceous and Paleozoic rocks across southern Illinois. Therefore, the north wall of the valley, which is cut in hard Paleozoic rock, is marked by cliffs and steep hills, whereas its south wall, cut through soft, unconsolidated Cretaceous and Tertiary sediments, is marked by gentle slopes.

Bay Creek, in the east end of the Cache Valley, flows eastward into the Ohio River above Bay City. The Cache River flows west into the Ohio just above Cairo. Both streams are small and sluggish. The Cache Valley has very little slope and has been channelized in places by man-made ditches. Seasonal floods from the Ohio River back up into the Cache Valley and cover the floodplains of the streams. Hundred-year floods cover the slightly higher parts of the valley floor above these floodplains.

Regional Setting

The general pattern of drainage across Illinois and the central United States was set millions of years ago (long before the Pleistocene glaciation), when this region was a lowland between the Appalachian and Rocky Mountains. For eons, rivers from the north, east, and west met in this low-lying region of Illinois to begin their to flow southward to the sea. Prior to the end of the Pleistocene Epoch, only a few thousand years ago, the courses of many of the ancient large rivers in the central United States did not follow present-day drainage lines.

The Pleistocene glaciation changed ancient drainage courses of the Mississippi and Ohio Rivers. One glacier after another released immense quantities of meltwater, which buried and diverted river valleys and eroded new channels across the region. The last glaciation led to the creation of the present-day drainage system.

Origin of the Cache Valley

The origin of the Cache Valley and its history have remained matters for research and discussion for more than 65 years. The Cache Valley continues to be a topic of interest and a challenging puzzle to solve for many geologists. Most agree that the valley served as the channel for the ancient Ohio River before the river was diverted into the modern Ohio Valley. Figure 20 shows the present drainage in extreme southern Illinois.

Most geologists think that the Ohio River flowed through the Cache Valley until it was diverted at some time during the Pleistocene Epoch. The most acceptable theory behind the cause of the diversion has been that glacial outwash and meltwater filled the valley during glaciation and raised the river level until it overtopped a low divide, where it flowed south toward the ancient Cumberland and Tennessee Rivers and abandoned the Cache Valley.

There are several lines of evidence and reasoning used to support these conclusions.

- The streams now flowing in the Cache Valley and the present-day floods from the Ohio River could not have cut the Cache Valley. The streams are too small, high backwater floods are too infrequent, and both are too sluggish to cut a valley as deep and wide as the Cache.

- The Cache Valley appears to be an extension of the Ohio Valley. It is connected to and in line with the Kentucky reach of the Ohio River above Bay City (fig. 20) and is a more direct course westward than the present Ohio River channel.

- Valleys of the ancient Cumberland and Tennessee Rivers and their tributaries could have served as channels for a diversion of the ancient Ohio River from the Cache Valley into the present Ohio Valley to the south.

- The deep filling of stream-laid clay, silt, and sand beds in the large river valleys indicates enormous volumes of glacial meltwater and outwash that would have been sufficient to fill in the old channels and raise the rivers over low divides into their present courses. The floor of the Cache Valley, for instance, is filled in 140 to 180 feet above the original valley floor cut in bedrock.

Current View

The current and most acceptable conclusions on the development of the Cache Valley are summarized here. The valley walls are cut into resistant Paleozoic rocks in the eastern one-quarter and along the entire north side of the valley and occasionally follow fault zones. Where resistant Paleozoic strata are exposed, the north valley walls are much steeper, 150 to 250 feet high, and better defined than the south side, where all but the eastern one-quarter has been eroded in softer, relatively unconsolidated Cretaceous and Tertiary sediments. The eastern part of the valley is now occupied by Bay Creek, and the western part is occupied by the Cache River; both are underfit streams too small to have eroded such an enormous valley. In the subsurface, the deepest part of the valley is incised into Paleozoic strata throughout its extent.

The earliest fluvial system to occupy the position of the Cache Valley is unknown, but it is reasonable to suspect that its beginning dates back to the Paleozoic/Mesozoic erosional unconformity. During part of that time, the Little Bear Soil was developed, and the Cretaceous Tuscaloosa Formation gravel was deposited in the vicinity of the Cache Valley. The deposition of the Tuscaloosa chert gravel and the overlying fluvial-deltaic McNairy Formation reflects the northward extension of the Mississippi Embayment into southernmost Illinois (fig. 2).

During the early part of the late Cretaceous, the northern part of the Mississippi Embayment was on the north flank of an upland known as the Pascola Arch (fig. 2) with possibly as much as 500 feet of relief. Streams heading in the upland flowed northeast and east across the embayment into a trunk stream that drained southward around the eastern periphery of the Pascola Arch. The Tuscaloosa gravel was deposited in part by this fluvial system. It is not known, for certain, if any part of these early streams occupied the position of the Cache Valley because no deposits of the Tuscaloosa have been identified in the Cache Valley. However, the strong curvilinear alignment of the Cache Valley along the northeastern edge of the Mississippi Embayment and the position of the Cumberland and Tennessee River valleys suggest that its early origin may be related to the Cretaceous age fluvial system.

In the middle of Tertiary time, the elevation of the northeastern part of the Mississippi Embayment, including most of the area of the Cache Valley, was relatively near sea level, and the surrounding Paleozoic bedrock regions were also low and of subdued relief.

During the Pliocene, eperiogenic uplift initiated a new erosion cycle. Chert-rich residuum was eroded from the Paleozoic uplands and deposited (as Mounds Gravel) in the form of alluvial fans in the northeastern Mississippi Embayment by high-velocity braided streams. The ancestral Tennessee and Cumberland were the dominant rivers along the east side of the Embayment, building their alluvial fans from the southeast toward the northwest where the Cumberland was joined by the relatively small, preglacial Ohio River near the present upstream (east) end of the Cache Valley.

These low-gradient alluvial fans apparently filled the northeastern part of the low-lying Embayment and overlapped onto the east flank of the Paleozoic uplands. The fans were deposited on an erosional surface that is now at an elevation of 450 to 500 feet above mean sea level in the Embayment area and extends upward to 600 to 650 feet on the upland rim areas. Erosion has subsequently dissected the fans and underlying deposits. Northward progradation of these alluvial fans may well have forced the main Cumberland-Ohio and probably the Tennessee River channels northward into the position of the Cache Valley. Erosion and redistribution of the chert gravels began in the late Pliocene and probably continued into the early Pleistocene. Deep entrenchment of the major valleys in the midcontinent may well have begun with the onset of the Pliocene.

There are few, if any, deposits in the Cache Valley and vicinity to provide evidence of the effect of the pre-Illinois Episode glaciations and the following interglacial episode on the area. Although the Cache Valley area was not glaciated, the later Illinois Episode ice did extend southward to within about 25 miles of the Cache Valley. Deep weathering and erosion appear to have progressed at variable rates during the early Pleistocene in this area. Early Pleistocene glaciation blocked other drainage systems from Indiana to Pennsylvania and eventually diverted them into the Ohio. This large increase in the size of its drainage basin, coupled with the addition of vast quantities of meltwater, converted the Ohio into a major river. This conversion, accompanied by eustatic lowering of sea level during each pre-Illinois glacial episode (at least two) and probably by epeirogenic uplift, ultimately resulted in the deep entrenchment of the ancestral Ohio River channel into bedrock beneath the Cache Valley. Thus, it seems most plausible that during the early Pleistocene, the Ohio, Cumberland, and Tennessee Rivers did meet near the sharp bend between Golconda and Bay City, Illinois, to flow westward, carving and entrenching the Cache Valley.

The absence of an equally deep channel in the present Ohio River valley between Paducah and Olmsted is strong evidence that, before the Illinois Episode, the Ohio River did not flow through its present channel, but rather through the Cache Valley. It appears more likely that the present course of the Ohio River formed during the late Wisconsin Episode. During a period of extremely high meltwater volume and alluviation of the valleys, a large slackwater lake formed in the Tennessee River valley, backing up a tributary of the Tennessee toward Metropolis, Illinois. A low divide separating this northeast-flowing drainage from another steep-gradient system flowing southwestward was eventually topped and rapidly cut down by the steep-gradient stream. The volume of meltwater was large enough and was sustained long enough to establish a permanent channel southwestward to a juncture with the Mississippi River. Both the Cache Valley channel and the new Ohio River channel were probably used by the Ohio on into the Holocene, especially during times of exceptionally high flooding. However, by studying slackwater lake deposits associated with the Cache Valley, Graham (1985) determined that the diversion of the Ohio was essentially completed by about 8,200 radiocarbon years BP. Backwaters of the Ohio most recently spilled through the Cache Valley during the record flood of 1937.

In summary, the geologic history of the formation of the deeply entrenched Cache Valley extends back to the Cretaceous Period and is related to the origin of the northern part of the Mississippi Embayment. A stream flowing northeast and east may have occupied all or a part of the location of the Cache Valley during uplift and subsequent erosion of the Pascola Arch. Alternating subsidence and uplift in the Embayment resulted in the deposition of shallow marine and fluvial-deltaic sediments in most of the area of the Cache Valley, followed by periods of erosion. Chert gravel deposition during the late Tertiary filled the northeastern portion of the Mississippi Embayment, concentrating the major west- to southwest-draining rivers of the time into the present location of the Cache Valley. The major deep entrenchment of the valley occurred during the Illinois Episode. With each glacial cycle, the Cache Valley was alternately scoured out and refilled with sediment to varying heights and thicknesses. The shallow sediments underlying the Cache Valley are mostly late Wisconsin and Holocene in age (12,600 to 8,200 years ago), bracketing the time of the diversion of the Ohio, Cumberland, and Tennessee Rivers from the Cache Valley into the present Ohio Valley.

STOP 7. Birk-McCrite Quarry UNIMIN Specialty Minerals, Inc., Lower Devonian Clear Creek Chert. Located northwest of Tamms (SE¼SE¼, Sec. 21 and NE¼NE¼NE¼, Sec. 28, T14S, R2W, 3rd P.M., Mill Creek 7.5-minute Quadrangle, Alexander County). On the day of the field trip, we will park along the road. Follow the directions of ISGS staff.

This mine operates in the Lower Devonian Clear Creek Chert (figs. 1 and 21), which likely has been altered (leached of carbonates and silicified) by hot (hydrothermal) waters from an intrusive igneous rock in the Precambrian basement, as indicated by prominent positive magnetic anomalies (Heigold 1976) in the Elco and Wolf Lake areas of these hills (Berg and Masters 1994). Bouguer gravity maps (McGinnis et al. 1976) also support the presence of igneous bodies in the Elco and Wolf Lake areas. The body of igneous rock that these geophysics indicate is thought to be a pluton with an uppermost extent of 5 miles below sea level in the Elco area (McGinnis et. al. 1976).

The resultant microcrystalline silica, or tripoli, is utilized by UNIMIN in a variety of products, for example, as a buffing and polishing compound and as a filler and extender in plastics, paints, and rubber. Iron oxide-stained tripoli is used as an ingredient in portland cement. Tripoli has been mined for more than 80 years from deposits in both Alexander and Union Counties.

Figure 21 Exposure of Lower Devonian age Clear Creek Chert (tripoli) at the Birk-McCrite Quarry. The mine is operated by Unimin Speciality Minerals Inc. (photograph by W.T. Frankie).

Most of the tripoli deposits are found in the Clear Creek, although the alteration has also affected the underlying Grassy Knob Chert and, to a lesser degree, the Baily Limestone. According to Devera et al. (1994), four factors led to the original formation of this tripoli: (1) original biogenic silica in the form of sponge spicules, which are abundant in these lower Devonian host rocks; (2) abundant detrital quartz silt in the host rocks; (3) hydrothermal leaching and concentration of silica; and (4) near-surface weathering in the past (probably minor).

Devera et al. (1994) also noted that the hydrothermal theory of alteration for tripoli formation suggests that metallic ores may be found in deposits near the surface. Local lore has it that lead mining by pioneers occurred along the Delta Fault (just west-northwest of this mine), but this mining cannot be confirmed. However, concentrations of limonite, goethite, and manganese oxides along this fault suggest that metallic ores are present at depth. High concentrations of metals are also known from the Humble Pickle No. 1 oil test hole (Erickson et al. 1987), including the highest values found in over 29 statewide wells for silver, arsenic, and lead; the second-highest molybdenum values for any of these wells; and the third-highest copper value. The silver value was highest, being six times that of any other of these 29 wells.

The Birk-McCrite Quarry is located in an area of small faults striking N15° W to N40° W that are high-angle and normal (Devera et al. 1994) and just to the east of the Delta Fault. This complex of faults (some of which can be seen in this mine) form a small downdropped block of Lower Devonian rocks (known as a graben) (fig. 21). As a result of the downdropping of this graben, the overlying Dutch Creek Sandstone is preserved as a cap overlying the Clear Creek Chert in this area. The Dutch Creek Sandstone contains concentrations of limonite, goethite, and manganese oxides along the erosional contact with the underlying Clear Creek Chert.

Stratigraphic Description of Devonian Rocks

A general stratigraphic description for the Devonian rocks in the area (Devera 1994) is reproduced below. The pit itself is largely in the Clear Creek Chert, although the boundary between the Clear Creek and the underlying Grassy Knob is not clear. Clear Creek is very fossiliferous, and the Grassy Knob is not, and that characteristic makes for the best distinction.

Lower Devonian Dutch Creek Sandstone (10–30 feet thick) Sandstone, white (weathering dark gray), fine- to medium-grained, well-sorted quartz arenite composed of rounded, frosted grains; locally abundant molds of corals, brachiopods, and other fossils. Much of this sandstone is an intraformational breccia cemented with silica and dark brown iron oxides. The lower contact is sharp and at least locally disconformable. Although it has been classified as Middle Devonian, the fossil content of the Dutch Creek more closely resembles that of the Clear Creek below it, and thus this unit may be Lower Devonian in age (Devera, personal communication 2003).

Clear Creek Chert (200–300 feet thick) Chert, microcrystalline silica or tripoli, and minor limestone. Chert (largely silicified limestone) is a dull to semivitreous white with orange- and red-stained zones. Bedding is thin and wavy to tabular; red clay partings are common. The chert is mainly porous to microporous, but some is dense. Brecciated chert occurs locally near the tops of ridges. Ledge-forming chert occurs sporadically in the unit; its occurrence appears to be partially fault-controlled. Chert is gently folded and highly fractured in most places. Microcrystalline silica (such as at this mine) is white to very light gray, orange- and red-stained, and relatively soft and friable; it has indistinct thin layering and some clay partings. Limestone in the Clear Creek when present (likely not here as it was removed in this district by the hydrothermal alteration) is grayish brown, thin-bedded lime mudstone. Fossils are abundant in the upper part of the unit, including trilobites *Dalmanites pratteni, Odontochile* sp., *Leonaspis* sp., *Phacops cristata,* and *Cordania* sp., and the brachiopods *Eodevonaria arcuata, Strophostylus cancellatus,* and *Amphigenia curta* along with abundant spiriferid and strophenmenid brachiopods and pelmatozoans. Ichnofossils include burrows (typically vertical), borings in brachiopod shells, and large domichnia cavities. Gray chert containing abundant spiriferid brachiopods and crinoid columnals at the base of the unit may represent the Backbone Limestone. The lower contact is poorly exposed but appears conformable.

Grassy Knob Chert (200–250 feet thick) Chert and microcrystalline silica (tripoli). Chert is white to very light gray with gray, yellow, and orange stains. Typically, this chert is dense, novaculitic, and medium- to thick-bedded. Fossils are rare and represent the best way to distinguish it from the overlying Clear Creek Chert. Brecciated chert occurs throughout the unit but is most common at the top. Below the upper breccia zone is an interval of very porous, popcorn-textured chert riddled with what appears to be horizontal burrows. The Grassy Knob contains less clay and more styolitic partings than the Clear Creek. The lower contact is gradational. Microcrystalline silica (tripoli) is similar to that in the overlying Clear Creek, but generally occurs in thinner layers and contains a greater proportion of chert.

Bailey Limestone (300–325 feet thick) Limestone, chert, minor shale, and microcrystalline silica (tripoli). Limestone is light brown to light yellowish gray, dolomitic, argillaceous lime mudstone; its thin wavy beds contain abundant gray chert nodules. The upper part of the unit, stained yellow to orange in some areas, includes chert with a “brain” texture interbedded with microcrystalline silica and dense, nodular chert. Sponge spicules increase in abundance upward. Fossils are common in the upper 100 feet; they include the trilobites *Huntonia palacea, Phacops* sp., and *Dalmanites* sp. along with crinoids and the trace fossil *Zoophycos*. The lower part of the unit is relatively unfossiliferous. Near the base is greenish gray cherty limestone and bedded chert with interbeds of green shale. The lower contact is gradational.

STOP 8. Tatumville Novaculite Quarry Lower Devonian Grassy Knob Chert. Located north of Tamms at Tatumville (E½NW¼, Sec. 36, T14S, R2W, 3rd P.M., Mill Creek 7.5-minute Quadrangle, Alexander County)

The gravel from this area has been mined at least since the early 1920s. The 1923 edition of the Jonesboro 15-minute Quadrangle map shows a spur from the Gulf Mobile and Ohio Railroad (GM & O) running to Tatumville, and two mines are located in the area. In 1927, railroad ballast material was taken from this locality by the Gulf, Mobile and Ohio Railroad (now the Illinois Central and Gulf Railroad). The 1947 edition of the Jonesboro 15-minute Quadrangle map shows an active quarry at this stop. The chert from these early mining operations was possibly also used as road aggregate.

In recent years, the chert has been primarily used for road construction purposes, and the broken pieces have sharp edges that are likely useful as aggregate in bituminous paving because they provide resistance to abrasion and scuffing, thus providing a skid-resistant surface.

The mining operation by Markgraf Materials Co. halted sometime after 1981. The property was then sold to an individual from the Marion area who used it for roads on his property. The property was sold in 2007 to Teko materials LLS, and, after some activity, it was sold in 2008 to Bootzie Unicem USA (formerly Lone Star). Bootzie Unicem USA acquired the property as a source of silica in the manufacturing of cement at its Cape Girardeau operation.

The Lower Devonian Grassy Knob Chert is exposed in this quarry (fig. 22). Approximately 185 feet of the formation is exposed in the quarry faces. The Grassy Knob Chert is highly fractured by open joints and contains some conspicuous beds of chert that are more resistant to weathering than most of the exposure. Some thin beds of clay are present. Iron staining occurs close below the soil zone at the top and sides of the quarry face and where the face has been long exposed to weathering. A nearby well indicates that the formation may be somewhat more than 315 feet in thickness here. Locally it is difficult to differentiate the Grassy Knob from formations above and below, but the Grassy Knob is lighter and contains more solid beds of chert than the underlying Baily Limestone Formation. In this quarry, the Grassy Knob Chert is overlain by the Clear Creek Chert, and the contact is difficult to recognize. However, the presence of abundant fossils in the Clear Creek is the best way to determine the break with the Grassy Knob, which is largely unfossiliferous.

The quarry at Tatumville is made up of two Lower Devonian formations: the lower part is the Grassy Knob Chert and the upper part is the Clear Creek Chert. The Grassy Knob Chert is white to very light gray, yellow with orange and red iron oxide stains. Typically, the Grassy Knob Chert is a dense novaculitic chert that is medium- to thick-bedded. Fossils are rare in the Grassy Knob. Brecciated chert occurs throughout the unit but is most common near the top. Below the upper breccia zone is an interval of very porous, popcorn-textured chert riddled with what appears to be horizontal burrows. The Grassy Knob contains less clay and more stylolitic partings than does the overlying Clear Creek Chert. This unit also contains microcrystalline chert,

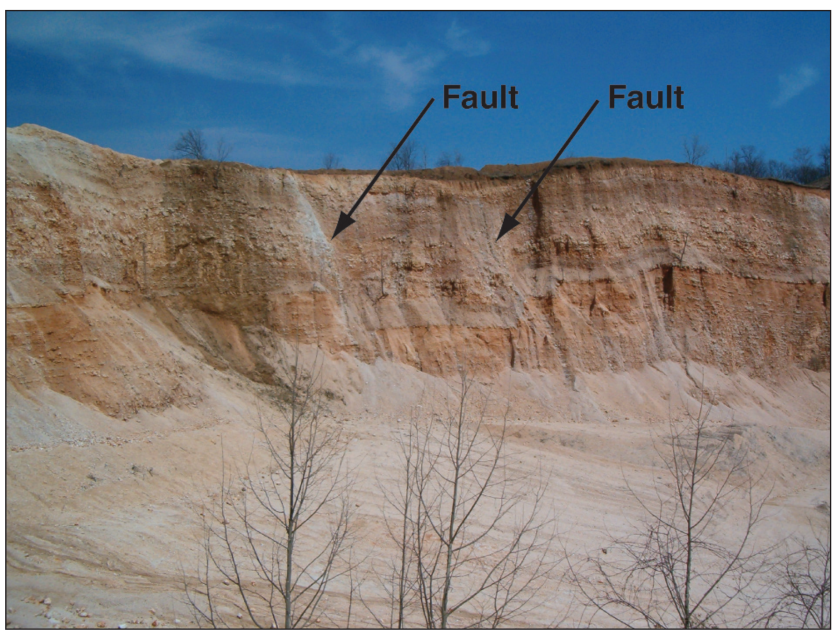


Figure 22 Exposure of Lower Devonian age Grassy Knob Chert Formation at the Tatumville novaculite (silica) quarry (photograph by W. T. Frankie).

which is quartz crystals that range from 5 to 10 µm in length. The base of the Grassy Knob is not present in the quarry but is gradational with the Lower Devonian Bailey Formation, which is also silicified in this area.

The Clear Creek Chert contains bedded chert, microcrystalline silica, and minor amounts of limestone and clay. It is white with orange and red-stained zones. The bedding is thin, wavy to tabular. The texture of the chert ranges from porous to microporous to dense and novaculitic, but the chert is thinner-bedded than the overlying Grassy Knob. Fossils that occur in the Clear Creek include *Odontochile, Leonaspice, Phacops,* and *Cordania* trilobites, which are all rare; also included are the brachiopods *Eodevonaria, Strophostylus,* and *Amphigenia.* Spiriferids are more common.

Lamar (1953) noted that the terms "novaculite" and "novaculite gravel" have been applied to certain southern Illinois materials for a number of years. "Novaculite" is typically applied to dense white or nearly white chert that is found in relatively solid ledges of several feet in thickness without other interbedded materials. "Novaculite gravel" is more loosely applied to a angular chert gravel that is basically found in place with little or no transport. These terms were applied to these deposits because they resemble certain Arkansas novaculites.

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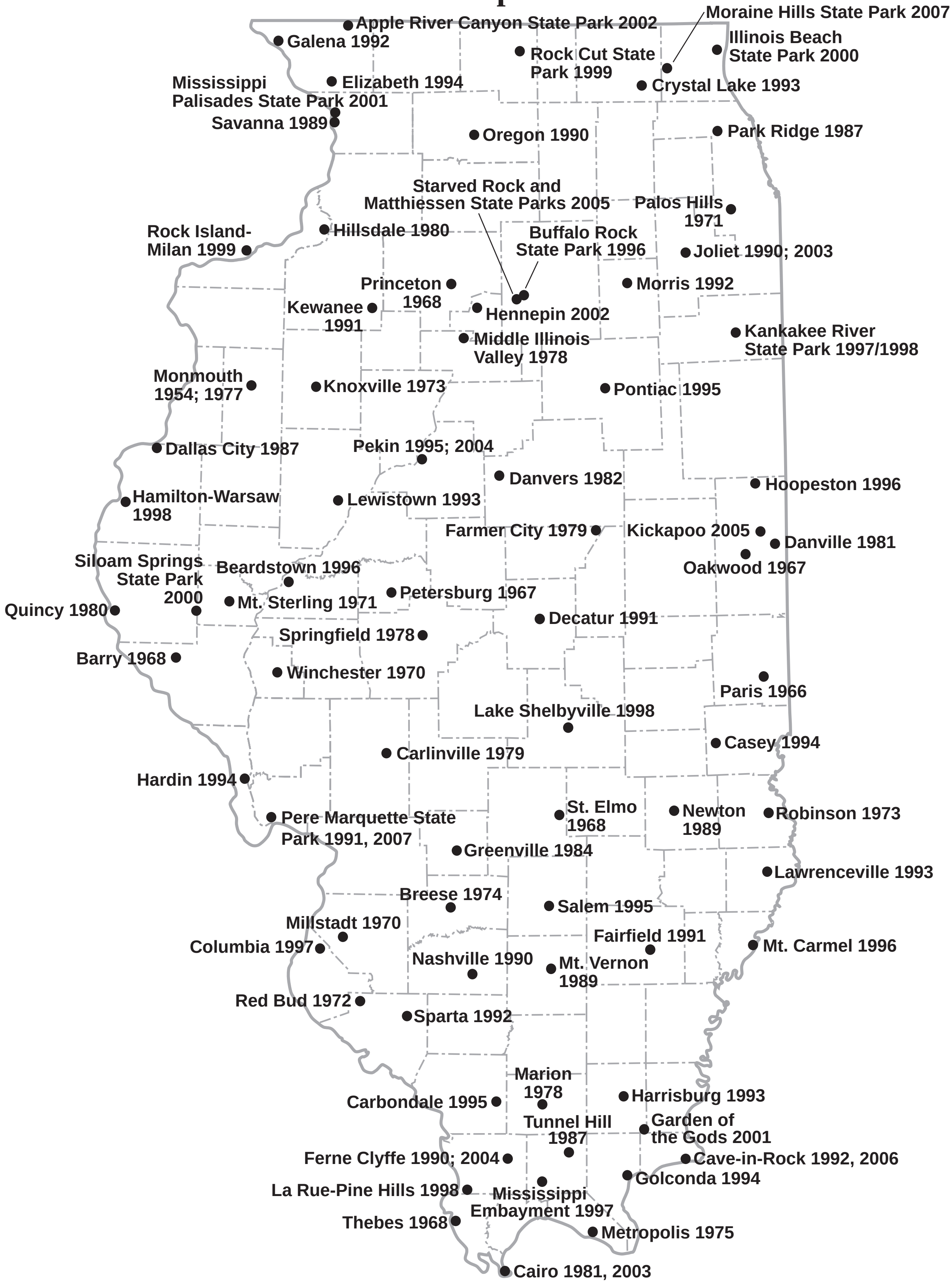

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SHAWNEE NATIONAL FOREST
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Grand Lake
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