Geol Survey

A GUIDE TO THE GEOLOGY OF THE WOLF LAKE AREA, UNION AND JACKSON COUNTIES

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Field Trip, 1988D November 5, 1988
Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Champaign, IL 61820

WOLF LAKE GEOLOGICAL FIELD TRIP

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GEOLOGICAL SCIENCE FIELD TRIPS are free tours conducted by the Educational Extension Unit of the Illinois State Geological Survey to acquaint the public with the geology, landscape, and mineral resources of Illinois. Each is an all-day excursion through one or several counties in Illinois; frequent stops are made for explorations, explanations, and collection of rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers in preparing earth science units. Grade school students are welcome, but each must be accompanied by a parent. High school science classes should be supervised by at least one adult for each ten students. A list of previous field trip guide leaflets is available for planning class tours and private outings.

November 5, 1988

WOLF LAKE AREA

THE GEOLOGIC FRAMEWORK

The Wolf Lake field trip area, which is located in scenic extreme southwestern Illinois in-and-adjacent to the broad Mississippi Valley, embraces an area of diverse topography, relief, structure, and geologic history. The surface configuration (topography) of the different parts of the area is largely controlled by the attitude (position) and the physical character of the underlying rocks. Physiographically this area lies along the boundary between the Shawnee Hills Section of the Interior Low Plateaus Province (east and north) and the Salem Plateau Section of the Ozark Plateaus Province (west) (fig.1).

The Shawnee Hills, also known as the "Illinois Ozarks," encompasses a region extending northward from the overlapping Coastal Plain sediments in extreme southern Illinois to slightly north of the southern limit of Illinoian glaciation and westward to the Salem Plateau Section. This region, which is situated along the southern rim of the Illinois Basin (figs. 2 and 3), is a complex dissected upland that is underlain by Pennsylvanian and Mississippian bedrock strata of varied lithology (fig. 4). The northern part of the section is comprised of the Pennsylvanian escarpment, a steep, south-facing, asymmetric ridge or cuesta ("kwesta") composed largely of resistant sandstones. This ridge extends southeastward for more than 70 miles (116 kilometers (km)) from the Big Muddy River to the confluence of the Saline and Ohio Rivers. The southern part of the section is a dissected plateau largely underlain by Chesterian (Mississippian) strata.

The Salem Plateau Section forms the eastern edge of the Ozark Dome, an extensive upland in southern Missouri and northern Arkansas (fig. 2). That part of the section developed here is composed of maturely dissected, partially truncated cuestas which dip to the east and northeast. The whole of the Salem Plateau in the field trip area is mainly underlain by a thick succession of deeply weathered Devonian chert and siliceous limestone formations. Uplands are well dissected with steep slopes and numerous narrow, deep ravines having steep gradients. The drainage pattern of the section here is radial or dendritic. The topography is much more rugged than in the Shawnee Hills Section. The Ste. Genevieve Fault Zone marks the Ozark Plateaus Province-Interior Low Plateaus Provice boundary in Illinois.

The highest point in the Wolf Lake field trip area is Bald Knob, about two miles southwest of Alto Pass. The elevation of this knob is slightly more than 1,020 feet mean-sea level (m.s.l.). Approximately 1.1 mile southeast is a road corner (field trip mileage 9.7+) where the elevation is 410 feet m.s.l. The surface relief of an area is the difference in elevation between its highest and lowest points. The local relief in the Bald Knob vicinity, therefore, is more than 610 feet. On the Ware 7.5-minute Quadrangle, in the southern-most tier of maps used in this field trip, Swiftsure Towhead is situated along the southern edge of the map in the Mississippi River 12.5 miles south-southwest of Bald Knob. The towhead has an elevation of less than 330 feet m.s.l. which shows that the overall total relief for the area is more than 690 feet.

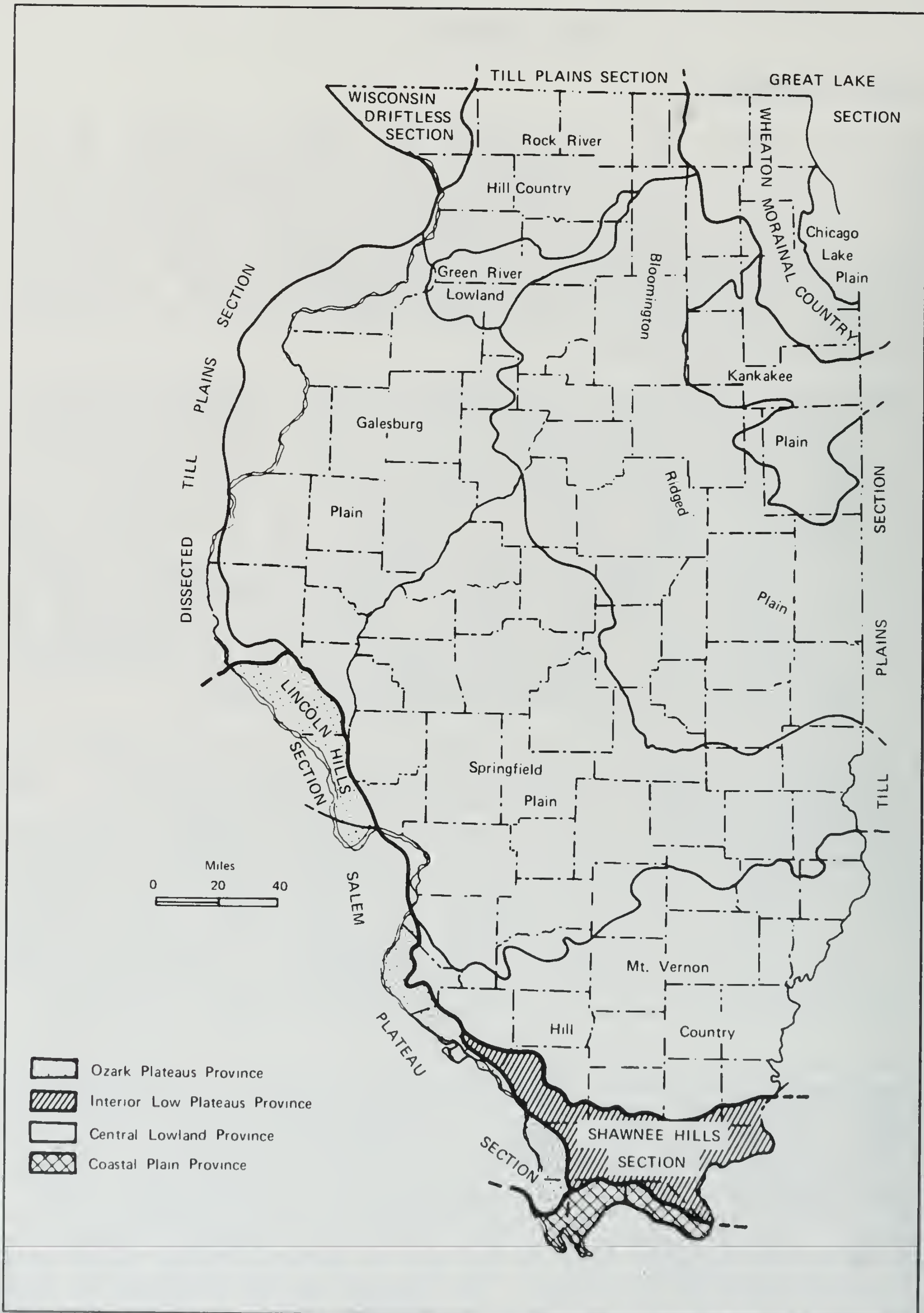


Figure 1 Physiographic divisions of Illinois

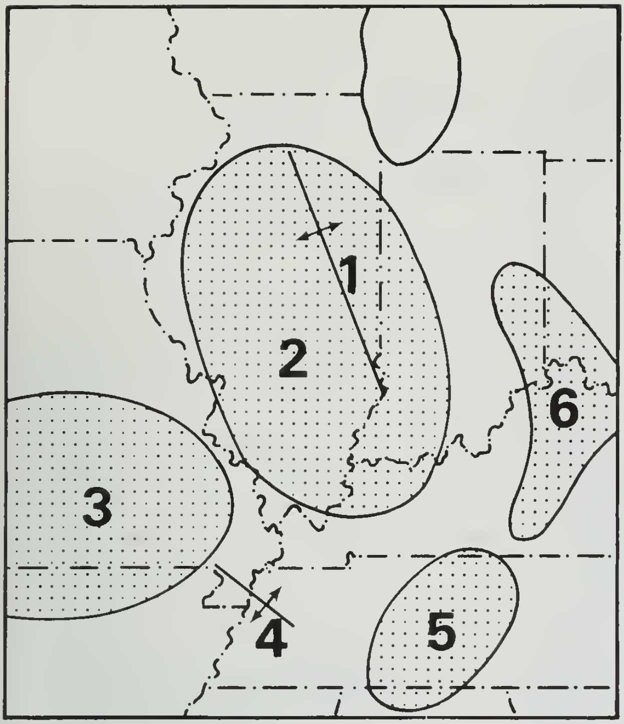


Figure 2 The location of some of the major structures in the Illinois region: (1) La Salle Anticlinal Belt, (2) Illinois Bain, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, and (6) Cincinnati Arch.

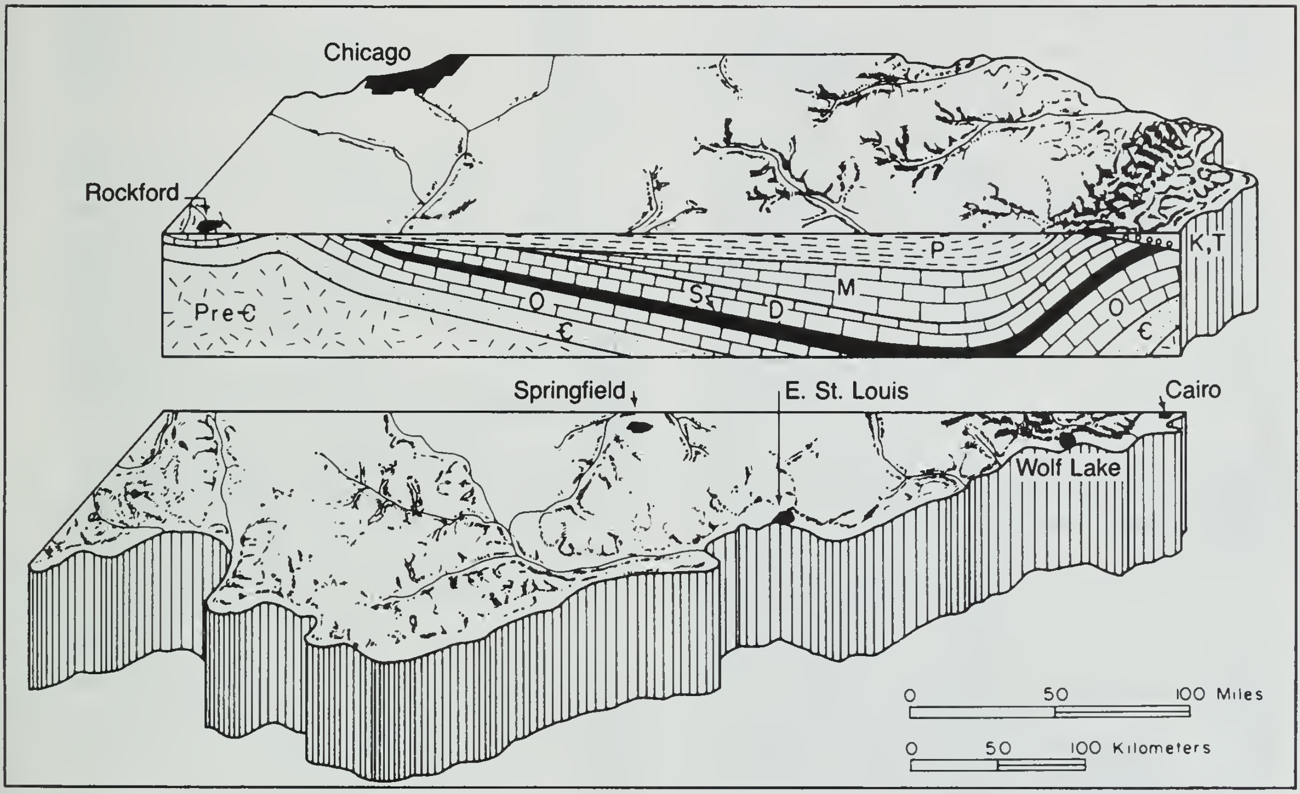
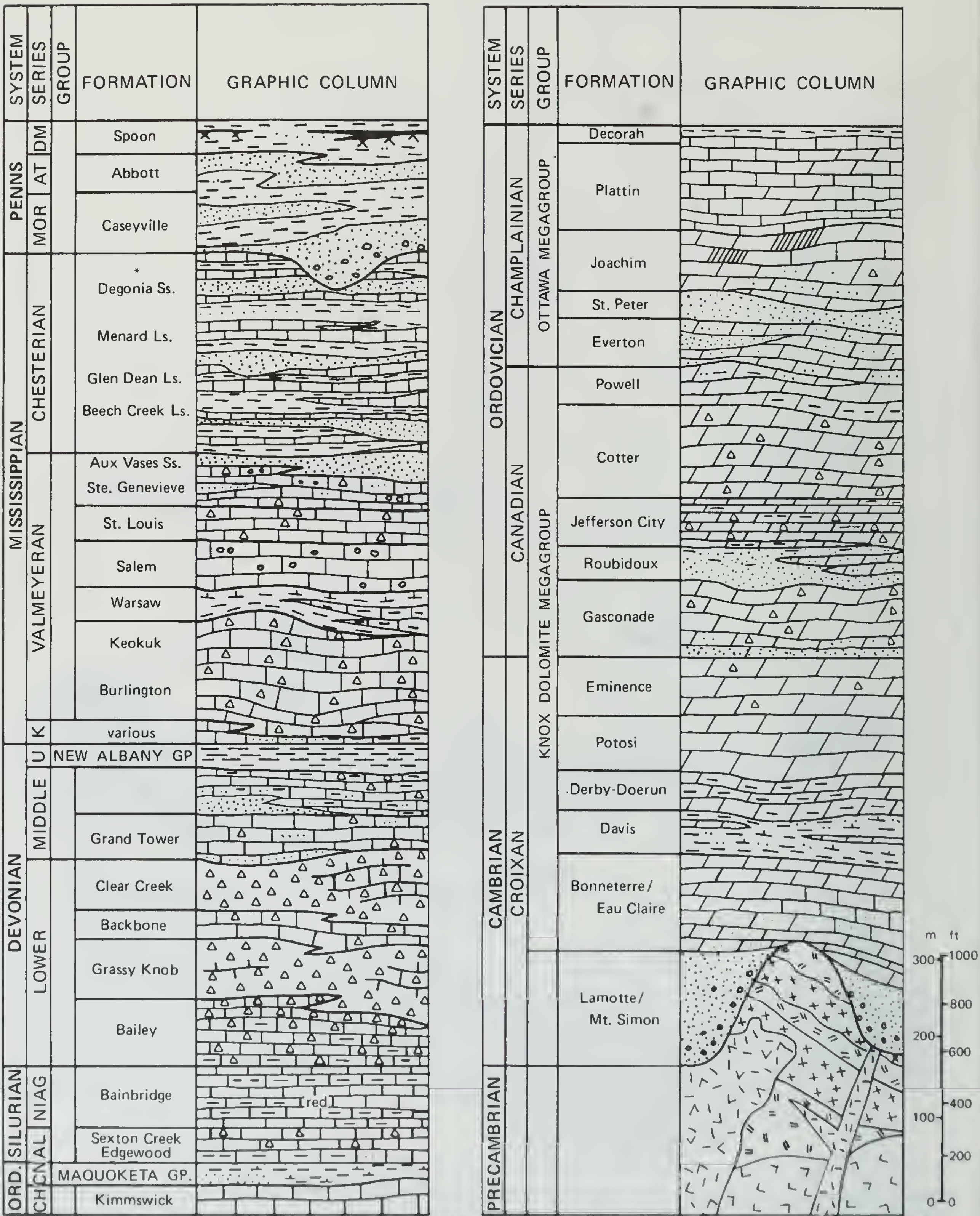


Figure 3 Stylized north-south cross section shows the structure of the Illinois Basin. In order to show detail, the thickness of the sedimentary rocks has been greatly exaggerated and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-C) granites.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

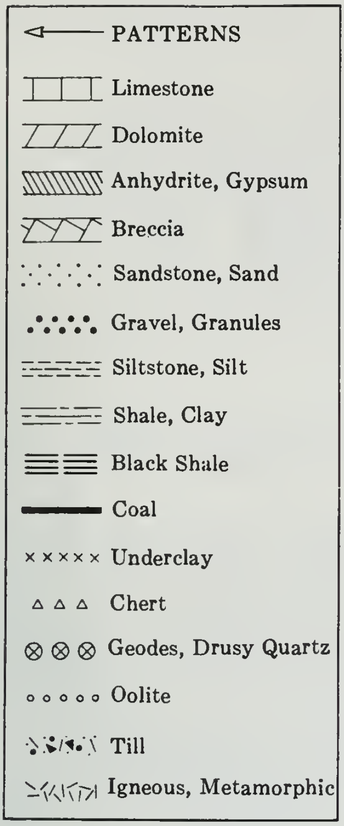


*only selected Chesterian formations are identified

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

ISGS 1985

Figure 4 Generalized stratigraphic section along Ste. Genevieve Fault Zone. In Illinois and Missouri (from Nelson and Lumm, 1985).



The Illinois Basin is a large bedrock structure containing a thick sequence of Paleozoic sedimentary rocks which have been warped into a great spoon-shaped depression, 250-300 miles in diameter, that covers most of Illinois and adjacent parts of Indiana and Kentucky (figs. 2 and 3 and attached Geologic Map of Illinois). The deepest part of the basin in Illinois is in northeastern Pope County, about 50 miles east-northeast of the Wolf Lake area. In that part of the basin, deep oil-test wells indicate that Paleozoic strata may exceed 17,000 feet.

These strata were deposited in the ancient shallow seas that periodically covered Illinois and the Midwest during the Paleozoic Era from Cambrian time, about 570 million years ago, until at least the close of the Pennsylvanian Period, about 280 million years ago. It seems likely that an undetermined thickness of younger Pennsylvanian, and perhaps even strata of the Permian System (the youngest Paleozoic rocks) were deposited 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 (figs. 3 and 4).

The Wolf Lake field trip area is situated near the extreme southwestern margin of the Illinois Basin where it is underlain by about 7,500 feet of Paleozoic rocks ranging in age from Cambrian up to Lower Pennsylvanian. Only Paleozoic rocks of Devonian, Mississippian, and Pennsylvanian age are exposed in this field trip area (fig. 4).

STRUCTURE OF THE PALEOZOIC ROCKS

Regionally the Paleozoic strata are tilted downward about two degrees or so to the north and east into the Illinois Basin (fig. 2). The Wolf Lake area is located in one of the parts of southern Illinois where faulting of Paleozoic strata has been extensive (fig. 5) and, as a consequence, stratigraphic relationships of the various rock units are complicated.

The major structural feature in the region is the Ste. Genevieve Fault Zone which begins in Franklin County, Missouri, about 50 miles (80 km) southwest of St. Louis, and extends southeastward across the northeastern flank of the Ozark Dome (figs. 2 and 5) into Illinois where it dies out in Union County, a distance of about 120 miles (190 km). The Ste. Genevieve Fault Zone marks in part the boundary between the Ozark Dome and the Illinois Basin. Nelson and Lumm (1985) report as much as 3,000 feet (900 m) of downward displacement to the northeast along a sharp monoclinal flexure or fold (strata dip or flex from the horizontal in one direction only). This flexure is cut by one or more high-angle reverse faults (fig. 6). Smaller high-angle normal and reverse faults are found on both sides of the main zone. At both ends, the Ste. Genevieve Fault Zone dies out into a monocline.

The main fault of the Ste. Genevieve Fault Zone in Illinois is the Rattlesnake Ferry Fault, which actually is a faulted flexure or monocline. Vertical displacement along this structure locally exceeds 3,000 feet, with a maximum of 1,200 to 1,400 due to faulting; the remainder is the result of monoclinal flexure. Strata are downthrown to the northeast side. Exposures

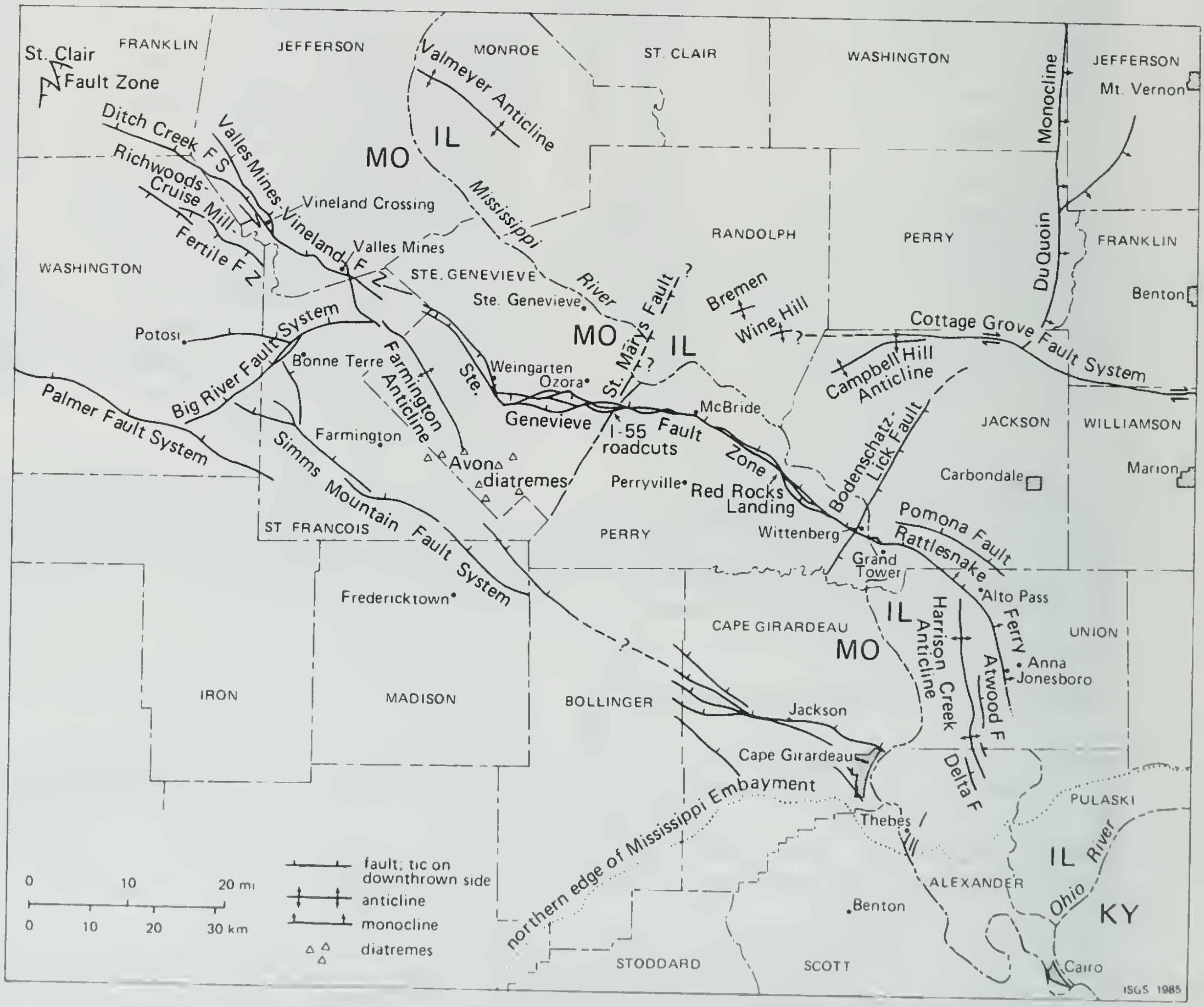


Figure 5 Ste. Genevieve Fault Zone and associated structures in Illinois and Missouri (from Nelson and Lumm, 1985).

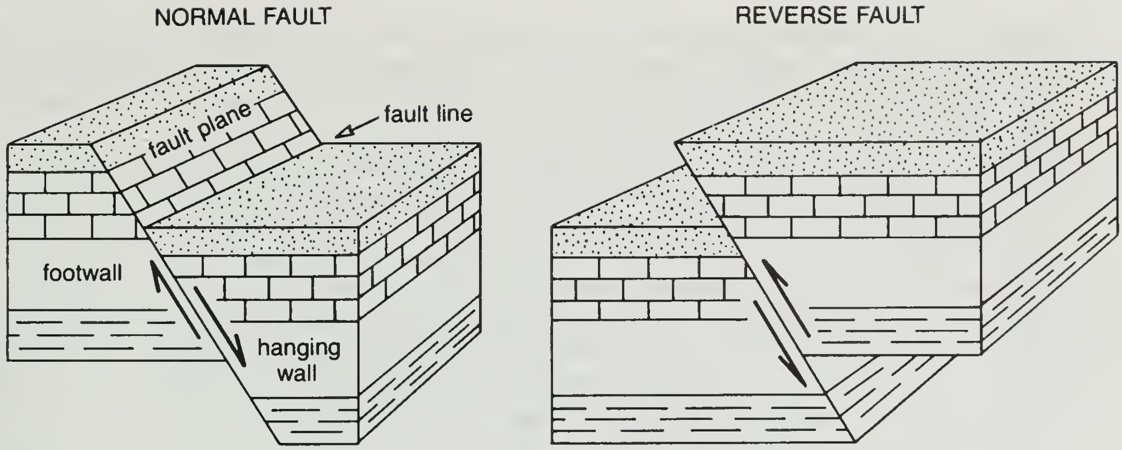


Figure 6 Diagrammatic illustrations of fault types represented in the field trip area.

along this fault show Lower Devonian Clear Creek Chert thrust up against Lower Mississippian Ste. Genevieve Limestone. The Rattlesnake Ferry Fault is not a single fault, but consists of a disturbed zone ranging from about 100 feet to nearly 1.5 miles wide. Although the fault plane is not actually exposed, its approximate position can be found in various exposures near the Big Muddy River and by looking at the Alto Pass 15-minute Quadrangle map to see the striking difference between the topography developed on the Mississippian and Pennsylvanian rocks northeast of the fault and that developed on the Devonian Clear Creek Chert on the southwest side where a more closely-spaced stream pattern has developed.

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

The Harrison Creek Anticline is another structural feature of the field trip area and occurs west of the southern part of the Rattlesnake Ferry monocline. The Harrison Creek is a broad, gentle fold that trends generally southward for about 17 miles (27 km) from the south side of Bald Knob into northern Alexander County. Although the anticline is known mainly from surface exposures, it is poorly defined because the lower Devonian cherts, which lack marker beds and rarely form exposures, comprise the bedrock along much of its extent. The anticline is best exposed along Harrison Creek (for which it is named) about 11 miles (18 km) south of Bald Knob. There it has a maximum structural relief of 300 to 400 feet (90 to 120 m). The anticline is asymmetrical with the east limb locally having dips of 10° to 12° in contrast to 5° to 6° dips along the west flank.

PLEISTOCENE HISTORY

The extensive continental glaciers which covered northern North America and large areas of Illinois and the Midwest during the Pleistocene Epoch, barely missed the Wolf Lake field trip area. During that time of geologic history, nearly 275,000 years ago, commonly referred to as "The Great Ice Age," Illinoian glaciers advanced to within less than 10 miles of the north and northeastern parts of the field trip area. This glacier, which flowed slowly southward into Johnson County (20 miles east of the field trip area), reached farther south than any of the North American continental glaciers (see appendix for "PLEISTOCENE GLACIATIONS IN ILLINOIS"). Although glacial till deposited directly by the ice is not found here, other materials called "outwash" composed of silt, sand, and gravel, were deposited by sediment-laden meltwater streams pouring away from the ice fronts during both advance and waning of the thick masses of ice. Major river valleys, such as the Mississippi Valley, were the main channels for the escaping meltwaters and thus were greatly widened and deepened during times of greatest flood. During times of decreased meltwater flow, the valleys became filled and choked with outwash called "valley trains" far beyond the ice margins. Outwash deposits in the Mississippi Valley here are well in excess of 200 feet thick. About 13,000 years ago, near the end of the last glacial stage in Illinois (the Wisconsinan), a great meltwater flood poured down the major river valleys and caused major changes in their channels. The changes affecting the Mississippi River will be discussed at later stops along the route.

Deposits of wind-blown silt called "loess" (pronounced "luss") are also the result of glaciation in Illinois. Although the Wisconsinan glacier only advanced to within approximately 120 miles (190 km) north-northeast of here, loess from its outwash plains and valley trains was carried by the wind across the uplands. Although thicknesses as great as 50 feet (15 m) are known along the Mississippi Valley locally, in this area the loess is somewhat more than 15 feet (5 m) thick. Loess deposits of both Illinoian and Wisconsinan ages are present in the area.

MINERAL PRODUCTION

The Survey's report of mineral production in Illinois during 1985, the last date for which complete statistics are currently available, summarized the output and value of minerals produced, minerals processed in Illinois, and mineral products manufactured but not necessarily mined in Illinois. The monetary value of these categories is as follows:

1. Extracted	$3,012.1 million
2. Processed	540.4 million
3. Manufactured	205.3 million
Total	$3,757.8 million

Major mineral commodity ranking according to value was: (1) coal, (2) oil, (3) stone, (4) sand and gravel, and (5) clays. The mineral fuels--coal, crude oil, and natural gas--constituted nearly 89 percent of the total value extracted or $2,680, 769,000. Industrial and construction materials--crushed and broken stone, sand and gravel, clay, and tripoli were valued at $301,210,000 or 10 percent. The metals (lead, zinc, and silver), peat, barite, and gemstones accounted for the remaining one percent or $30,120,000. Mineral production was reported from 98 of Illinois' 102 counties.

Nationally, Illinois ranked 17th in non-fuel mineral production value. It remained the leading U.S. producer of fluorspar, industrial sand, and tripoli, and the major manufacturer of iron-oxide pigments. In peat, the state ranked 4th, but it dropped to 9th place in output of stone and sand and gravel.

Union County ranked 52nd among the mineral producing counties. Stone was the only mineral commodity produced during 1985. Actual production tonnages and values are withheld to avoid disclosing individual company data.

Jackson County ranked 15th based on the value of its mineral production. Minerals extracted in order of value were coal, stone, crude oil, and sand and gravel. Actual production figures have also been withheld for Jackson County to avoid disclosing individual company data.

GROUNDWATER

Groundwater is a mineral resource which may be essential for orderly economic and community development. About 49 percent of the state's more than 11 million population depends on groundwater for a water supply. Illinois potable groundwater is tapped at depths as great as 2,300 feet at the industrial city of Aurora in the north, to less than 50 feet for the Anna-Jonesboro municipal supply, downstate near Ware in Union County. In Jackson and Union Counties and throughout Illinois, groundwater is obtained from porous and permeable underground zones called aquifers which contain varying amounts of potable water. Aquifers may consist of water-saturated glacially-derived sand and gravel, stream alluvium and porous or creviced limestone, dolomite, or sandstone. The source of most of the potable water in Jackson and Union Counties is precipitation which occurs in the form of rain, hail or snow, about 40 times each year. Precipitation is lost through evaporation, transpiration, and runoff, with a final part migrating downward into aquifers. Wells tapping these aquifers in the field trip area range from less than 50 to as much as 600 feet deep.

Groundwater conditions for large-scale industrial and municipal well-development from sand and gravel aquifers in the Mississippi River bottomland and in the lowland of the Big Muddy River are favorable. Productive water-bearing zones in these deposits range from 50 to over 150 feet thick. Sand and gravel deposits present in the glacial drift in the upland areas of Jackson and Union Counties are scattered and may dewater during dry periods.

Groundwater from bedrock aquifers suitable for domestic and farm supplies can be obtained with little difficulty from Pennsylvanian, Mississippian and Devonian rock systems. The bedrock in Jackson and Union Counties becomes progressively younger in age eastward, away from the Mississippi River. Groundwater in older bedrock units is usually favorable for development several miles east of the overlying younger bedrock system. (Much of the following municipal supply data is from personal communication, D. Woller, Illinois State Water Survey.

JACKSON COUNTY

Public water supplies are present at Campbell Hill, Gorham and Grand Tower. The village of Campbell Hill (389 population) installed a public water system in 1949 and is currently supplied by the Kinkaid-Reeds Creek Intercity Water System. Campbell Hill Well No. 1, which is available for emergency use, was completed in 1946 to a depth of 442 feet in Pennsylvanian sandstone. The well is rated at 50 gpm (gallons per minute). At Gorham (381) the public water system was installed in 1956. Pumpage for the system from a sand and gravel well 142 feet deep, ranges between 100-200 gpm (39-63,000 gpd (gallons per day)). The city of Grand Tower (748) installed a public water supply in 1951. Pumpage from two sand and gravel wells, which average 155 feet deep, ranges between 100-150 gpm (51-65,000 gpd).

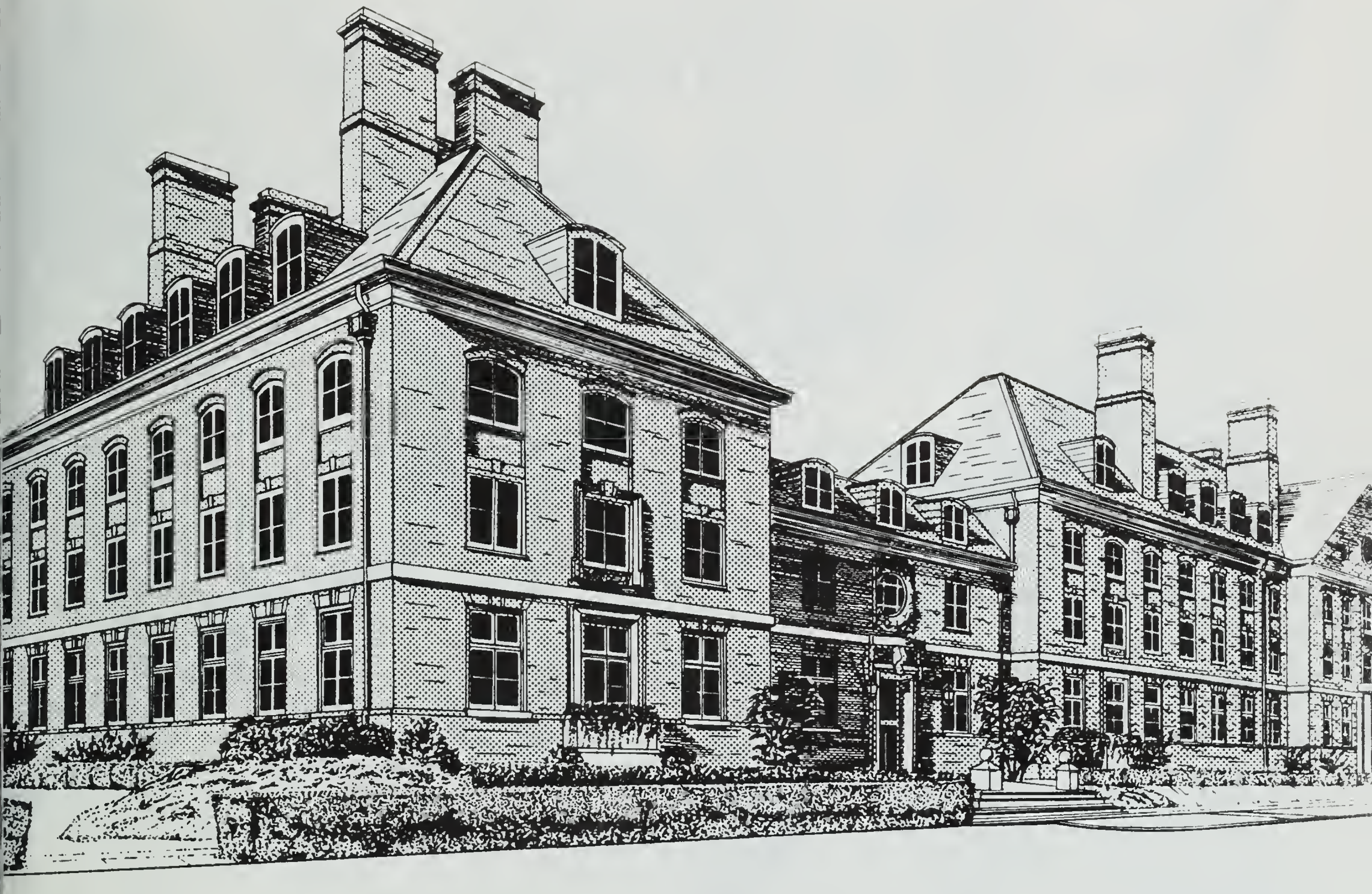
UNION COUNTY

Public water supplies have been developed for Anna, Anna-Jonesboro Water Commission, and Cobden. The city of Anna (5,408) installed a public water supply in 1912. In 1970 the city was connected to the Anna-Jonesboro Water Commission system. The Ice House well at Anna which pumps 300 gpm was completed in 1929 to a depth of 650 feet in lower Mississippian limestone and is now used for a standby. Another well, on the Holshouser property, (250 gpm) is 1,031 feet deep and is open in the Mississippian limestone. Another standby well on the Peak property reportedly pumps 80-200 gpm and is finished in Mississippian limestone at a depth of 1,038 feet. The Anna-Jonesboro Water Commission installed a public water supply in 1970. Three wells completed in sand and gravel that average 81 feet deep are situated in the lowland near the west side of Clear Creek levee, and are pumped between 375-740 gpm. (1.1-1.3 million gpd) to Anna, Anna Mental Health Center, Jonesboro and the Shawnee Valley Public Water District. A fourth well recently completed to a depth of 33 feet about one mile northeast of the three principal wells will eventually provide an additional 400 gpm for the Water Commission. The village of Cobden (571) installed a public water supply in 1935. Two Mississippian Cypress Sandstone wells, 226 feet and 253 feet deep, respectively, are pumped between 150-185 gpm (average 140,000 gpd).

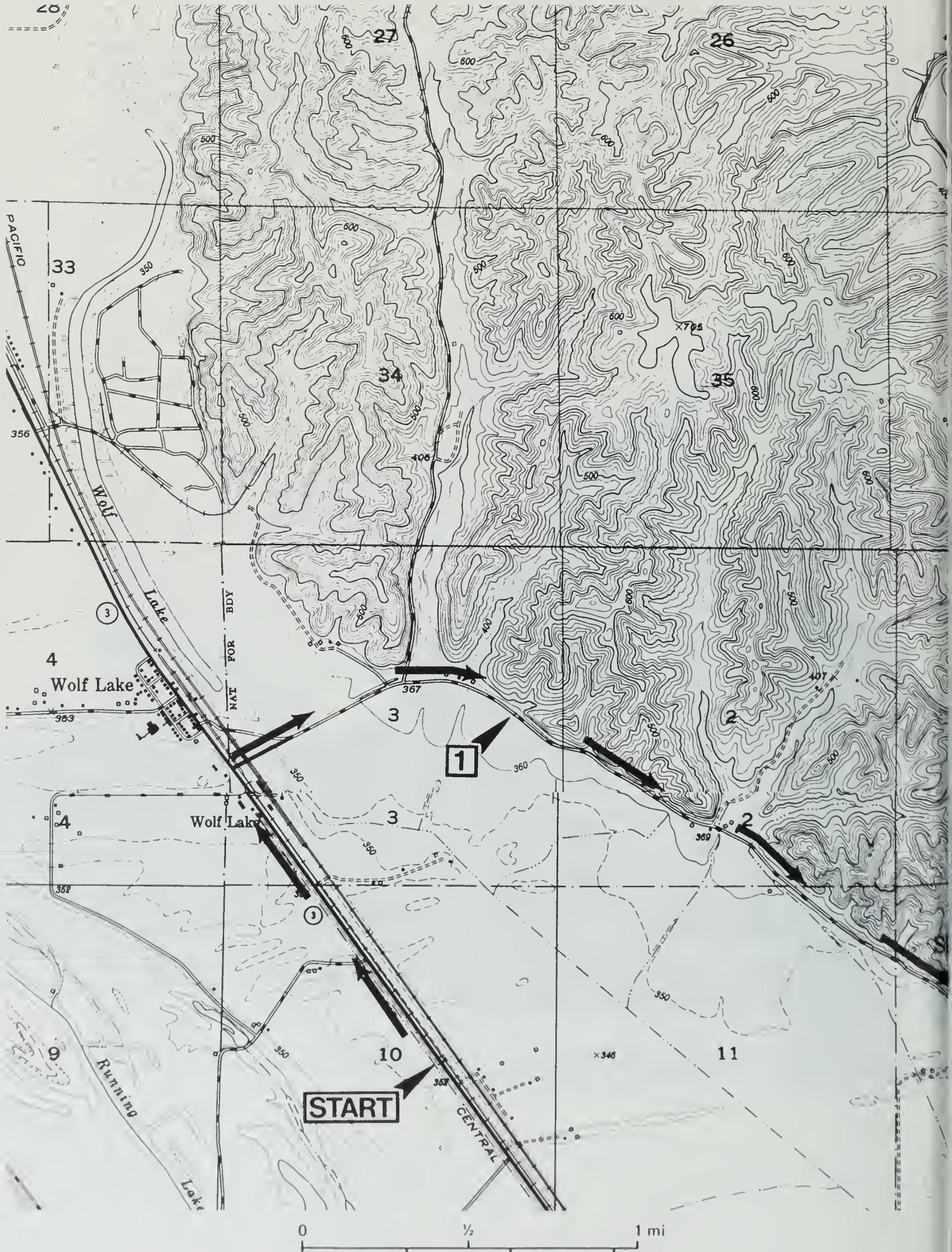
GUIDE TO THE ROUTE

NOTE: The number in parentheses following the topographic map name, (37089D4), is the code assigned to that map as part of the National Mapping Program. The state is divided into 1^{o} blocks of latitude and longitude. The first pair of numbers refers to the latitude of the southeast corner of the block and the next three numbers designate the longtitude. The blocks are divided into 64 7.5-minute quadrangles; the letter refers to the east-west row from the bottom and the last digit refers to the north-south row from the right.

Line up facing northeast on the south drive of Shawnee High School (N 1/2 NW 1/4 SE 1/4 Sec. 10, T. 12 S., R. 3 W., 3rd P.M., Union County; Ware 7.5-minute Quadrangle (37089D4)). Mileage figures begin at the STOP sign at the intersection of the south driveway and State Route (SR) 3.



LLINOIS STATE GEOLOGICAL SURVEY



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Miles to Next Point	Miles from Start	
0.0	0.0	**Turn left** (north) on SR3.
0.9	0.9	**CAUTION:** Enter hamlet of Wolf Lake and prepare to turn right.
0.1+	1.0+	**Turn right** (east) on Macadam.
0.05-	1.05+	**CAUTION:** Guarded Union Pacific (UP) RR crossing (3 tracks-2 main/1 siding) **Continue ahead** (easterly).
0.5+	1.55+	T-road from left to LaRue-Pine Hills ecological area. **Continue ahead** (easterly).
0.35	1.9	**PARK** along the right side as far off the road as you can safely. **CAUTION:** FAST TRAFFIC!

STOP 1. View and collection of Lower Devonian Grassy Knob Chert at pit on the northeast side of the road (SE 1/4 SW 1/4 SE 1/4 NE 1/4 Sec. 3, T. 12 S., R. 3 W., 3rd P.M., Union County; Wolf Lake 7.5-minute Quadrangle (37089E4)).

The Grassy Knob Chert is named for exposures on Grassy Knob, a prominent high area on the east Mississippi Valley wall overlooking the Big Muddy River in Jackson County, about 7 miles north of here. This formation, which is exposed in and adjacent to the Mississippi River bluffs in Jackson, Union, and Alexander Counties, also is encountered in the subsurface throughout the deep part of the Illinois Basin to the east. Thickness ranges from about 200 feet in the outcrop area to about 300 feet in the Illinois Basin.

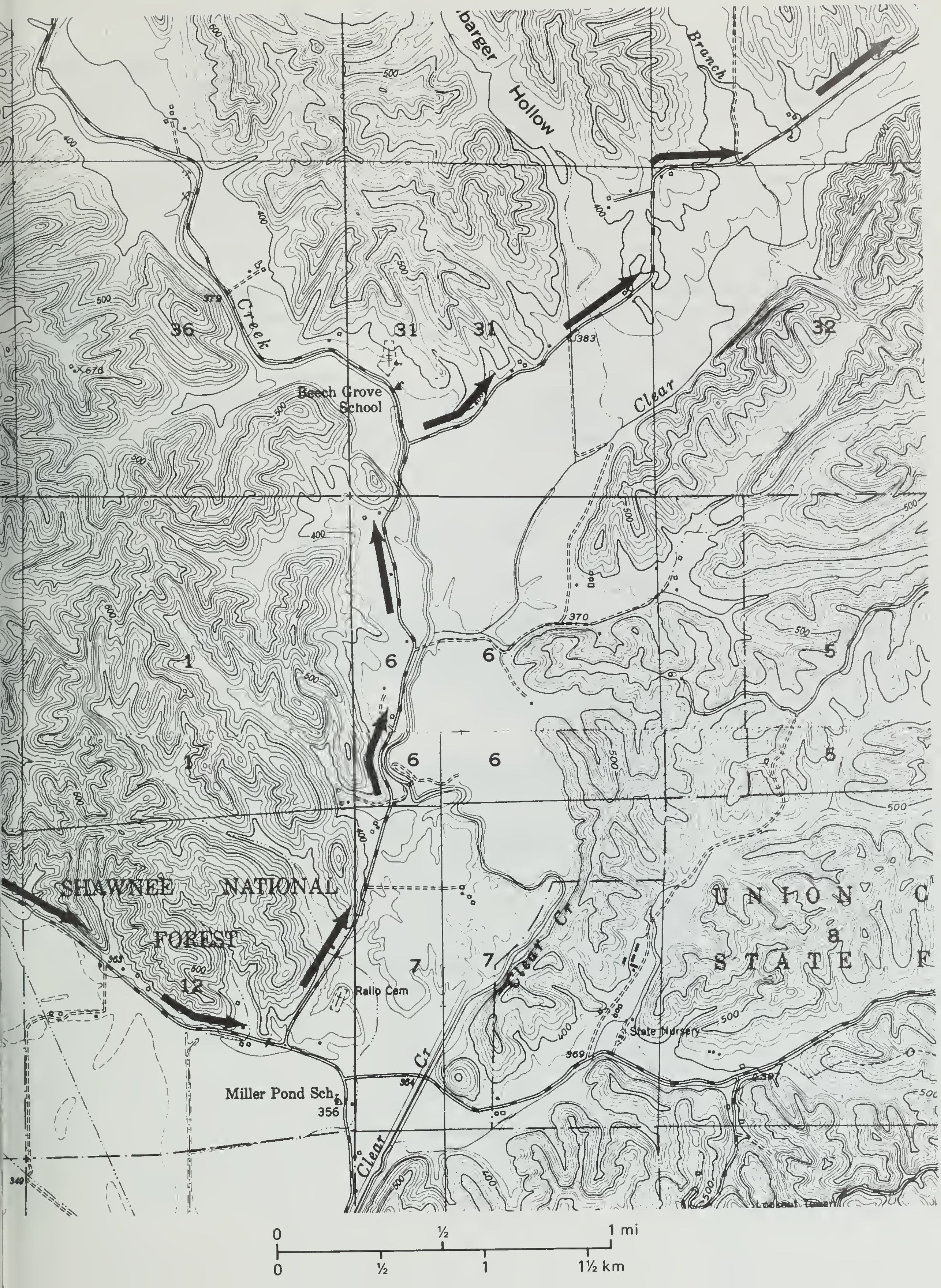
In southern Jackson County, the Grassy Knob is chert in the lower two-thirds of the formation and alternating layers of dolomitic limestone and chert in the remainder. In Union County, according to Lamar (1953), exposures of the middle part of the formation are chert, as much as 80 feet thick. In Alexander County, the lower part of the formation is considerably weathered where exposed, but probably was interbedded limestone and chert where fresh.

The chert is tan with some iron staining on the surface. Part way up the slope is a light gray area that is composed of tripolitic material. That is, the material is a mixture of white to light-gray angular fragments (breccia) of chert held together by a soft, friable, white siliceous material (microcrystalline quartz or tripoli). The dark gray material on some surfaces penetrates the matrix frequently. This darker material is a siliceous gray clay residue left behind when the carbonate of the dolomitic limestone was leached away. Similar material has been observed elsewhere on stylolite surfaces in this formation. The Grassy Knob does not appear to change in character away from the outcrop area much, except that it may be somewhat less siliceous. This led Lamar (1953) to hypothesize that the chert and other siliceous materials were primary in origin, or that widespread silicification has occurred since deposition, or both.

Once the formation was stripped of its protective cover and brought within the weathering zone, groundwater had free access to it. The relatively insoluble chert was little affected at first, but the more calcareous beds were leached of their carbonates. This eventually left a series of chert strata interbedded with the soft clayey or siliceous residues of the wholly or partially leached calcareous beds, which in some places contained residual chert nodules. This resulted in settling in the weathered portion of the formation, causing the chert beds to fracture. This increased the porosity of the chert beds and permitted groundwater to circulate more easily. Once the carbonates were essentially leached away, free groundwater circulation ensued over a long time period, causing the major chemical disintegration of the cherty layers.

Fossils appear to be scarce in this area, but are more common in Alexander County where molds of trilobites and brachiopods have been found. In Alexander County, where current tripoli mining and processing occurs, microcrystalline silica is produced in varying degrees of fineness and is used for the following purposes: paint fillers, wood filler, concrete admixture, foundry partings and facings, ceramic products, buffing compounds, fine abrasive in polishing and scouring compounds, and as a polishing agent. A very fine-sized grade is known as "white rouge" which is used for polishing optical lenses (Lamar, 1953).

Miles to Next Point	**Miles from Start**	
0.0	1.9+	Leave Stop 1 and **Continue ahead** (southeasterly). Note the broad Mississippi Valley to the right.
2.2+	4.15	Prepare to turn left
0.05+	4.2+	**Turn left** (northerly) at T-road; sign to Beech Grove Baptist Church.
0.1-	4.3	We are crossing a terrace remnant. The topographic maps in this area show the terrace remnants quite well. You will note that there are several land surfaces of about the same elevation in the area to the east and northeast.
0.35	4.65	Around this curve is a view of the Bald Knob cross.
0.35	5.0	**CAUTION:** Bridge--**continue ahead.**
0.15	5.15	Clear Creek to right.
0.7+	5.85	**CAUTION:** Culvert--low sides not marked.
0.1+	6.0	**CAUTION:** One lane bridge over Hutchins Creek..
0.15	6.15	Y-intersection--Beech Grove Baptist Church to the left. **Turn right** (northeasterly).
0.6+	6.75+	**CAUTION:** Narrow one lane wooden bridge--no side rails.
0.05+	6.8+	**CAUTION:** Another narrow wooden bridge with no side rails.
0.35+	7.2+	**CAUTION:** Narrow one-lane wooden bridge.
0.35+	7.6+	**CAUTION:** Ford Dry Branch--chert gravel bottom. Along the west bank on both sides of the crossing are old car bodies that have been



barger
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Creek
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State Nursery
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356
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		placed to help control erosion of the banks (and to dispose of the cars?).
2.0+	9.6+	**CAUTION:** Narrow bridge--one lane. Continue ahead.
0.1	9.7+	**CAUTION:** T-intersection. **Turn right** (southerly) and cross Clear Creek bridge.
0.45+	10.2+	Park to the right side as far as you can safely. **CAUTION:** Narrow shoulder.

STOP 2. Exposure of Devonian Grand Tower Limestone, Dutch Creek Sandstone, and Clear Creek Chert (fig. 7) in roadcuts along northeast side of road (NW 1/4 NW 1/4 NW 1/4 Sec. 27, T. 11 S., R. 2 W., 3rd P.M., Union County; Cobden 7.5-minute Quadrangle (37089E3)).

This stop is on the southwest (upthrown) side of the Rattlesnake Ferry Fault in the outcrop belt of the Devonian rocks. The thickest outcropping section of Devonian strata in Illinois, to a total of almost 1,500 feet, occurs in

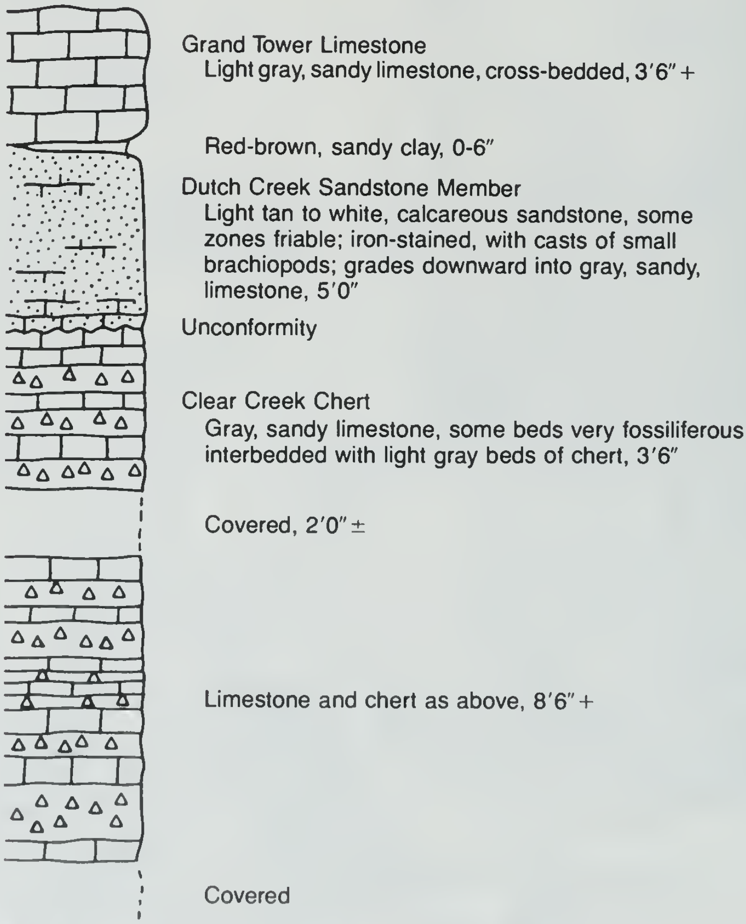


Figure 7 Devonian section exposed along roadcut at Stop 2.

the Alto Pass area in southern Jackson, western Union, and northern Alexander Counties. Where not overlain by younger rocks, the Devonian formations are deeply weathered and altered by silicification. Most of the exposed formations consist of a monotonous succession of silicified limestone and novaculitic chert.

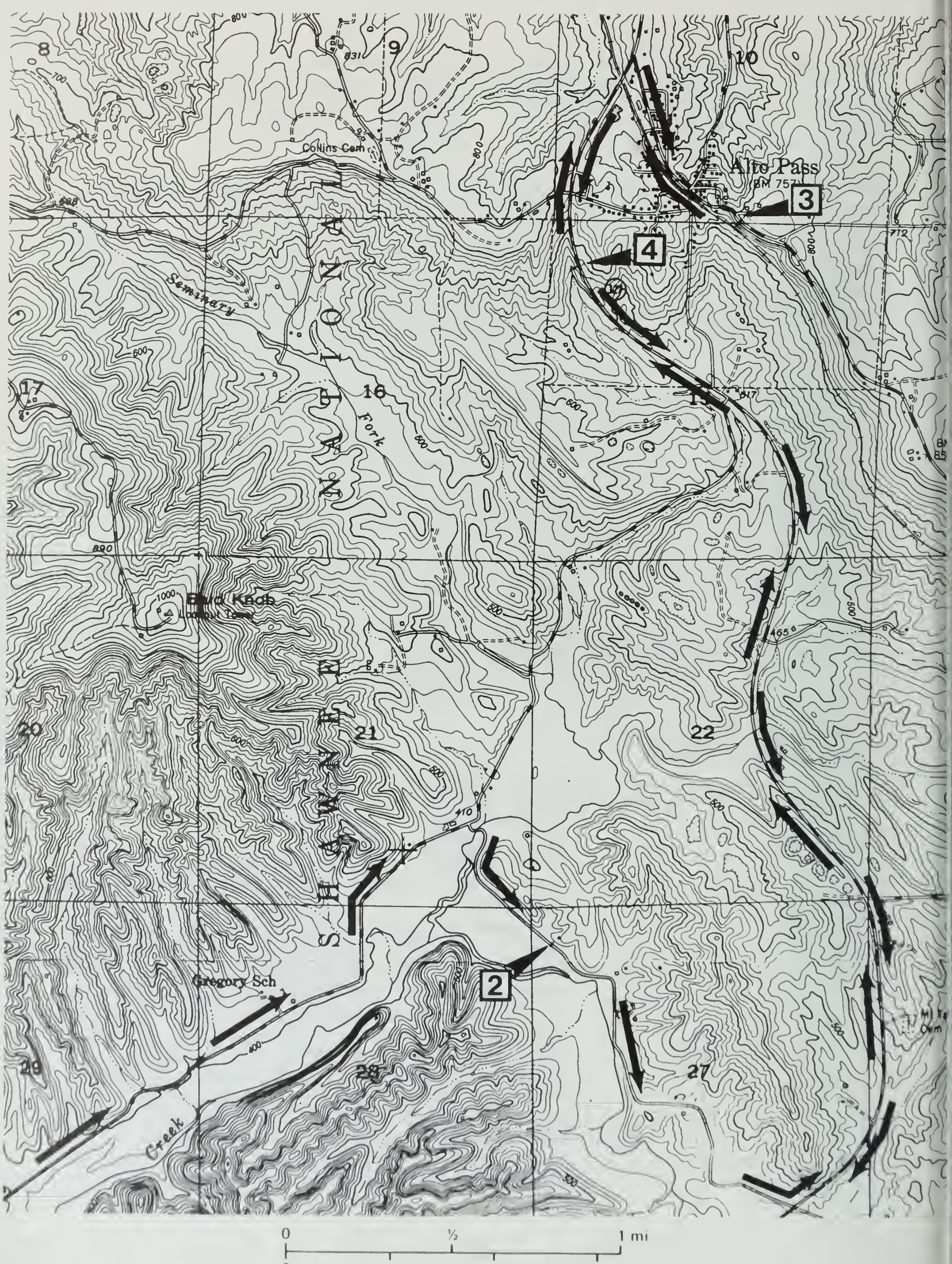
The Devonian strata contain an unusual abundance of chert, whose origin is not definitely known. There is no question that the Devonian rocks have been "chertified," and that most of the chert is secondary, but where the silica came from is open to question. Some chert was deposited with the Devonian limestones. However, secondary chert has replaced limestone, and sedimentary structures, fossils, and stylolites are preserved. Over a very long period of time the limestone was gradually replaced by silica that may have been weathered and leached from younger rocks.

The exposure here includes the lower part of the Grand Tower Limestone, the Dutch Creek Sandstone Member of the Grand Tower, and the upper part of the Clear Creek Chert. Of particular interest here is the unconformity between the Grand Tower and the Clear Creek Formations. The unconformity is evidence that an interval of erosion occurred after deposition of the Clear Creek. When the Middle Devonian sea re-advanced across the area (about 350 million years ago), the calcareous quartz sand of the Dutch Creek Member was deposited on this erosion surface.

As the sea deepened and the shore migrated farther away, a gradual change to the depositon of the purer limestone of the Grand Tower took place.

The Clear Creek here consists of an alternation of thin, sandy limestones, and beds of gray, calcareous chert.

Miles to Next Point	Miles from Start	
0.0	10.2+	Leave Stop 2 and **Continue ahead** southeasterly.
1.1+	11.35	STOP (2-WAY): Crossroad. SR 127 and Union 15.42 **CAUTION:** Poor visibility to the left -- about 1/10 of a mile. **Fast Traffic. Turn left** (northerly).
1.4+	12.75+	Sandstone exposed in roadcut on southwest side of SR 127 belongs to the Mississippian (Valmeyeran) Ste. Genevieve Limestone. This sandy phase may indicate a temporary shoaling of the Ste. Genevieve Sea or a sudden influx of sand into the area. The sandstone is light-gray and medium-grained in texture. It exhibits a variety of sedimentary structures, including cross-bedding, ripple marks, drag marks, and flute casts. These features form in a shallow water, high energy environment. The steep dip (15^{0}) here may be the result of slumping due to solution of underlying (Map)



8
9
10
831
Collins Cem
Alto Pass
(BM 757)
3
4
712
Seminary
16
17
15
617
Fork
NATIONAL
SHAWNEE
890
Bald Knob
Lookout Tower
1000
20
21
22
465
2
Gregory Sch
28
27
29
Creek
400
500
600
700
800
0
½
1 mi
0
½
1
1½ km

		limestone, because just over the ridge to the southwest, there are large sinkholes in the lower part of the Ste. Genevieve. However, as this locality is only about half a mile from the Rattlesnake Ferry Fault, the dips might be the result of faulting.
0.75	13.5+	Road cut exposes Mississippian (Chesterian) Waltersburg Sandstone on the left.
1.15	14.65+	Mississippian (Chesterian) Menard Limestone exposed in road cut on the right overlain by Palestine Sandstone to the north. **Continue ahead** (northerly).
0.2+	14.9	Bald Knob road overpass. **Continue ahead** (northerly).
0.35+	15.25+	Abandoned Gulf Mobile & Ohio (GM&O)/Illinois Central Gulf (ICG) RR overpass. Prepare to turn right.
0.05	15.3+	**Turn right** toward Alto Pass.
0.05-	15.35-	STOP (1-WAY) T-road intersection. **Turn right** (southeasterly).
0.3+	15.65+	**CAUTION:** Entering the north side of the Alto Pass business district. **Continue ahead** (southeasterly) and prepare to ascend hill beyond the "End of State Maintenance" sign. The road is very crooked.
0.25	15.95	**Bear right** into the Cliff View Park. **NOTE:** MILEAGE RESUMES FROM THIS POINT.

STOP 3. Lower Pennsylvanian Battery Rock Sandstone and view of the upland landscape in the Alto Pass area (near center S edge SW 1/4 SW 1/4 SE 1/4 Sec. 10, T. 11 S., R. 2 W., 3rd P.M., Union County; Cobden 7.5-minute Quadrangle (37089E3)).

The sandstone exposed in the cliff face is the Battery Rock Sandstone Member of the Pennsylvanian Caseyville Formation. The Battery Rock consists of massive, cross-bedded, medium-grained, slightly micaceous, light-brown sandstone. It is also slightly conglomeratic, containing well-rounded quartz pebbles, especially in the lower part. The sandstone is tightly cemented by silica and iron oxide, so that the Battery Rock is generally a cliff-former. In the Alto Pass area the Battery Rock is from 50 to 100 feet thick, and here about sixty feet is exposed. In the lower part of the cliff, quartz pebbles are absent, and it is possible that the Battery Rock rests directly on the Degonia Sandstone of Mississippian Age.

Outcrop surfaces of the Battery Rock are reddish because of the concentration of a thin layer of iron oxide. There are also bands and small concretionary structures, composed of iron oxide-cemented sandstone, which stand out in relief on outcrop surfaces. These features have formed by differential cementation by the iron oxide, which moved through the sandstone in solution and became concentrated in bands. This type of cementation by iron oxide is common in the Pennsylvanian sandstones.

The Battery Rock Sandstone is a non-marine, alluvial sand that was deposited by rivers that shifted laterally over a low-lying Pennsylvanian landscape (see appendix for "Depositional History of the Pennsylvanian Rocks in Illinois"). The lower conglomeratic part is an early channel phase which was deposited with angular unconformity on the upper Chesterian formations. The environment was one of high energy and strong currents, which resulted in the deposition of fairly clean, cross-bedded sand. Some zones are more shaly and contain traces of plant remains. These may represent muddy sands that were deposited on floodplains.

The view to right and left of Bald Knob, two miles to the southwest, encompasses the southern part of the Salem Plateau Section, which forms the eastern edge of an extensive upland in southern Missouri and northern Arkansas. The Salem Plateau comprises the major part of the Ozark Dome in southern Missouri. That part of the plateau developed here is composed of maturely dissected, partially truncated cuestas that dip to the east and northeast. The whole of the area is mainly underlain by a thick succession of deeply weathered Mississippian and Devonian chert and cherty limestone formations.

This stop is near the boundary between the Salem Plateau Section and the Shawnee Hills Section. Portions of the latter can be seen toward the far left (southeast). The Salem Plateau is characterized by higher elevations, more rugged hills, and closely-spaced drainage lines. The Shawnee Hills includes a complexly dissected upland that is underlain by Mississippian and Pennsylvanian strata. This is the area popularly called the "Illinois Ozarks."

Bald Knob is the second highest point in southern Illinois with a summit elevation of 1,034 feet m.s.l. Williams Hill in Pope County south-southeast of Harrisburg has a summit elevation of 1,064 feet m.s.l.

The foundation of 730 tons of reinforced concrete for the Bald Knob Cross was emplaced 20 feet down to bedrock in 1952. The cross was completed in 1963 and stands 111 feet high. It is 22 feet square at the base and 16 feet square at the top; the arms extend 63 feet horizontally. The cross weighs a total of 200 tons including its covering. Mississippian Ullin Limestone, a commercial "marble" from southern Illinois, is used to face the lower part of the cross.

The view from the top of Bald Knob is exceptional on a clear day.

Miles to Next Point	Miles from Start	
0.0	15.95	Leave STOP 3. **Re-enter the blacktop and turn left.** Visibility on the right is quite restricted so use extreme caution. Descend steep crooked road into Alto Pass.
0.15+	16.1+	**CAUTION:** Crossroad--entering business district. **Continue ahead.** Retrace route to SR 127.

0.4+	16.55-	**Turn left.**
0.05-	16.55+	STOP (1-WAY): T-Intersection with SR 127. **Turn left** (southwesterly). **Use extreme caution**--Restricted visibility to right; fast traffic.
0.4+	17.0-	Bald Knob road overpass--**continue ahead** (southerly) and prepare to stop.
0.2+	17.2+	PARK well off the pavement on the right shoulder. **CAUTION:** FAST TRAFFIC.

STOP 4. Fossil collecting in the Mississippian Menard Limestone on east side of SR 127 (NW 1/4 NW 1/4 NW 1/4 Sec. 15, T. 11 S., R. 2 W., 3rd P.M., Union County; Cobden 7.5-minute Quadrangle (37089E3)).

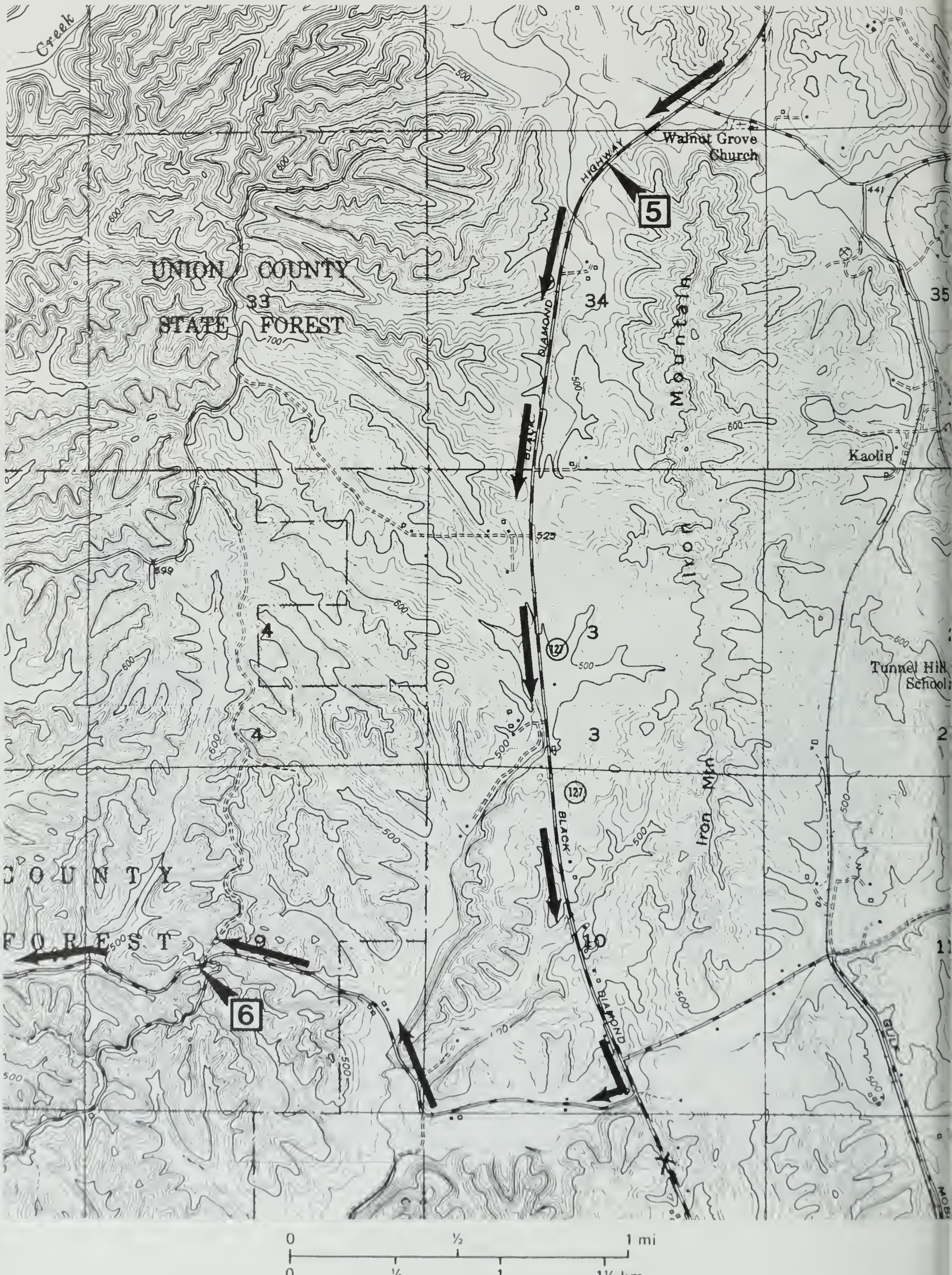
On the left are exposures of Menard Limestone and Palestine Sandstone of the Mississippian Chesterian Series. In the Alto Pass area these units are about 90 feet and 30 feet thick, respectively.

The Menard exposed here consists of massive, dark-gray, fossiliferous, oolitic calcarenite. There are a few gray-green shale beds, which thicken slightly toward the northwest. The upper few feet consist of gray-green shale beds and thin-bedded biocalcarenites. Some of the latter are composed almost entirely of fossils and fossil fragments. Collecting is very good, and most of the fossils illustrated in the plate at the back of the guide leaflet can be found.

The Menard grades upward into shaly sandstone of the lower part of the Palestine, and there is apparently no erosional break between the two formations. North of the ravine on the left, more of the Palestine is exposed above the lower shaly zone. It consists of very pure, limonite-speckled orthoquartzite. The sandstone is cross-bedded and bedding planes are ripple-marked.

The Chesterian formations of southern Illinois are characterized by striking lateral and vertical changes in lithology. These changes reflect the great variability in the environments of deposition on the floor of the shallow Late Mississippian sea. In the Alto Pass area the Chesterian formations are thin, usually only a few tens of feet thick, but they thicken toward the east and southeast. The Alto Pass area, under the influence of the Ozark Dome, did not subside as much as areas farther east in the Illinois Basin, so that less sediment accumulated.

During deposition of most of the Menard Limestone, conditions on the Mississippian sea floor remained fairly constant. Broken fossils and oolites in the massive limestone indicate shallow water, but essentially pure lime sediment with little terrigenous sand and mud was deposited. Shale in the upper part of the Menard indicates that the sea became muddy. Still later, the sea cleared again or became much shallower, and there was an influx of sand to account for the clean quartz sandstone of the Palestine Formation (see appendix for "Mississippian Deposition").



Creek
UNION COUNTY
STATE FOREST
33
34
35
Walnut Grove
Church
HIGHWAY
DIAMOND
BLACK
5
Mountain
Iron
Kaolin
Tunnel Hill
School
3
4
127
Iron Mtn
COUNTY
FOREST
9
10
6
BLACK
DIAMOND
0
½
1 mi
0
½
1
1½ km

Miles to Next Point	Miles from Start	
0.0	17.2+	Leave STOP 4 and **continue ahead** (southerly). **CAUTION:** FAST TRAFFIC when re-entering SR 127.
0.6	17.8+	T-road from right. Gravel operation to the left. **Continue ahead** (southerly) on SR 127.
1.65	19.45+	**NOTE:** Sink holes to right.
0.9+	20.4+	The road cut exposes large pieces of chert on the right. Continue ahead (southwesterly).
0.1+	20.55	15.42/127 Crossroad. **Continue ahead** (southwesterly) on SR 127.
0.15+	20.7+	Cross Clear Creek. Park on right road shoulder as far off pavement as possible. **CAUTION:** FAST TRAFFIC.
0.15	20.85	**STOP 5.**

STOP 5. Middle Devonian Grand Tower Limestone exposed in SR 127 roadcut NW 1/4 NW 1/4 NE 1/4 Sec. 34, T 11 S., R. 2 W., 3rd P.M., Union County; Cobden 7.5-minute Quadrangle (37089E3).

The Grand Tower Limestone is light-gray, coarse-grained, medium to thick bedded, and very fossiliferous here; 12'+.

0.0	20.85+	Leave STOP 5 and **continue ahead** (southerly).
2.7	23.55+	Prepare to turn right at T-road ahead.
0.1+	23.7	**Turn right** (west) toward the Trail of Tears State Forest.
0.85+	24.55+	Cross culvert...**continue ahead** (northwesterly).
0.25+	24.8+	Enter Trail of Tears State Forest.
0.4+	25.2+	**CAUTION:** Gated crossroad. **Continue ahead** (westerly).
0.05-	25.25	Park on road shoulder. **CAUTION:** FAST TRAFFIC.

STOP 6. Small anticline in Lower Devonian Clear Creek Chert in roadcut exposure (NW 1/4 NE 1/4 SW 1/4 Sec. 9, T. 12 S., R. 2 W., 3rd P.M., Union County; Jonesboro 7.5 minute Quadrangle (37089D3)).

The Clear Creek Chert, uppermost of the Lower Devonian formations, is named for nearby Clear Creek along which it is exposed for nearly five miles. Weller (1940) noted that the chert in this predominantly chert formation is white or lighter in color than the chert in the lower formations. The formation does contain some gray, very fine-grained, siliceous limestone beds which are locally separated from the chert beds by stylolites. The proportion of limestone is generally small in most outcrops, but it is larger near the top of the formation and also increases to the north and east in the subsurface. The thickness is difficult to determine because of deep weathering and structure, but it is thought to be at least 300 feet thick in the outcrop area. Bald Knob, which is more than 600 feet high, is thought to be entirely composed of Clear Creek Chert, but the thickness here is complicated by the structure along the Rattlesnake Ferry Fault and monocline.

Solution of the limestone and fracturing of the chert has formed material very similar to that noted at STOP 1 in the Grassy Knob Chert. In some areas of Alexander County to the south, surface chert material looks very similar to this exposure, but once the weathered surface material is removed, the Clear Creek Chert is found to have been altered to the white, microcrystalline silica, tripoli. The Clear Creek Chert is much more fossiliferous than the Grassy Knob Chert, with some beds largely composed of fossil casts.

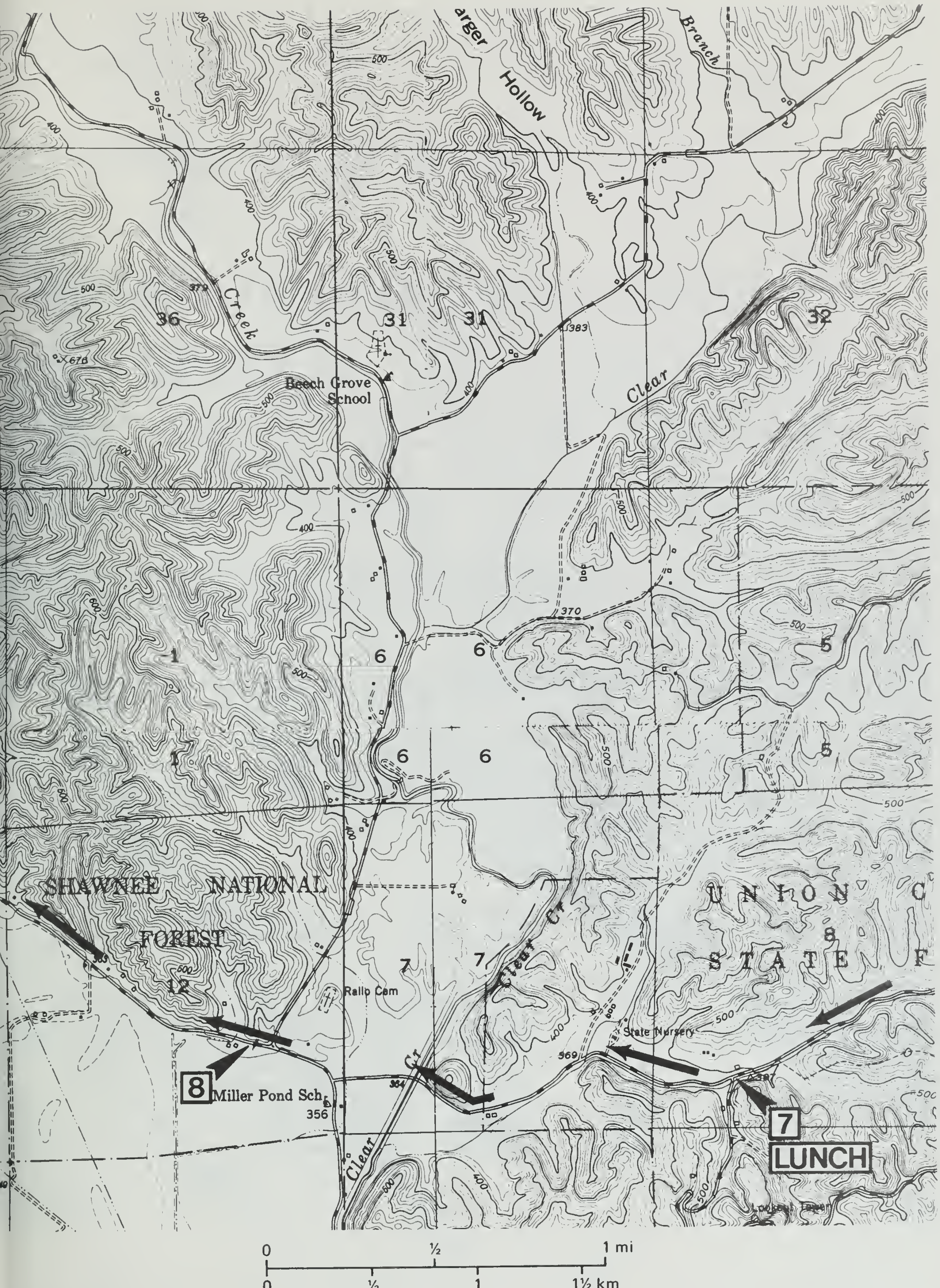
The origin of the small anticline here is puzzling. It could have formed as the result of initial upwarping of the strata, or it could be the result of the deep weathering and collapse of various portions of the rocks in this vicinty.

Miles to Next Point	Miles from Start	
0.0	25.25	Leave STOP 6 and **continue ahead** (westerly).
1.15	26.4	Prepare to turn left.
0.1	26.5	**Turn left** (south) at entrance to picnic area. **NOTE:** MILEAGE WILL RESUME AT THIS POINT. Cross concrete ford and select a picnic table or shelter.

STOP 7. LUNCH

(NE 1/4 SW 1/4 SW 1/4 Sec. 8, T. 12 S., R. 2 W., 3rd P.M., Union County; Jonesboro 7.5-minute Quadrangle (37089D3)).

0.0	26.5	Leave STOP 7 and return to entrance. STOP (1 WAY) at picnic area entrance. **Turn left** (southwesterly).
0.45+	26.95+	To the right is the entrance to the Union County State Nursery office.
0.55+	27.5+	Cross Clear Creek bridge and leave Trail of Tears State Forest.
0.1	27.6+	**NOTE**: Terrace remnants to the right.
0.3+	27.95	T-road from right (Beech Grove Baptist Church). Continue ahead and prepare to stop.



Hollow
Branch
Creek
Beech Grove
School
Clear
SHAWNEE NATIONAL
FOREST
UNION C
STATE F
State Nursery
Rallo Cem
Miller Pond Sch
8
7
LUNCH
Clear Cr
Clear
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1½ km

Miles to Next Point	Miles from Start	
0.05+	28.0+	PARK along narrow shoulder. **CAUTION:** Do not block the T-road intersection behind you. (Mileage - 27.95+)

STOP 8. Loess exposure in abandoned borrow pit above the Trail of Tears Road. West edge SW 1/4 NE 1/4 SE 1/4 Sec. 12, T. 12 S., R. 2 W., 3rd P.M., Union County; Ware 7.5-minute Quadrangle (37089D4).

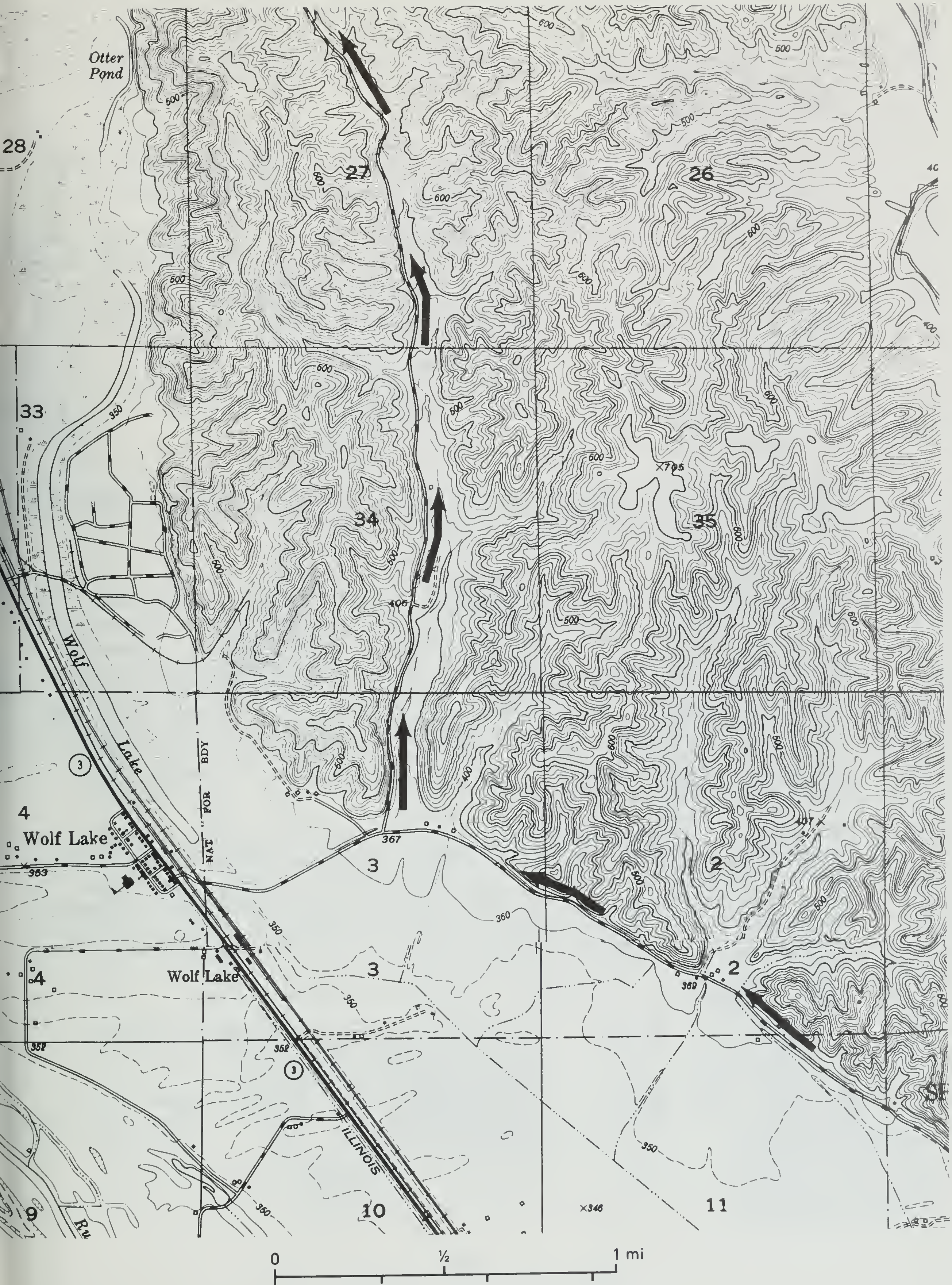
About 12 to 15 feet of loess which was blown from the Mississippi River floodplain during the Pleistocene Epoch. Nearly all of Illinois is covered by thin surficial deposits of glacial loess which consist principally of silt with subordinate amounts of sand or clay. The loess deposits exposed here were deposited during the times of advance and retreat of the Wisconsinan glacier in Illinois from 60,000 to 10,000 years ago. The Wisconsinan glacier never reached the Alto Pass area, but meltwaters from the glacier deposited large volumes of silt in the bottomlands of Mississippi Valley, and these were the source for the loess.

Most of the loess deposition probably occurred during the fall and early winter when winds from the northwest were strong and when the meltwaters from the glaciers had subsided, exposing the floodplain sediments and permitting them to dry.

The loess is thicker on the east bluffs of the river than on the west, and toward the east the loess becomes progressively thinner and finer-grained.

Of particular interest here is the amount of case hardening that has taken place across the face of the exposure. The surface of the exposure is hard enough that it is difficult to scrape away the face. This may be, in part, the result of an abnormal amount of carbonate that is incorporated in the loess to act as a cement.

0.0	28.0	Leave STOP 8. **continue ahead** (westerly)
2.25	30.25	Pass STOP 1. **Continue ahead** (northwesterly).
0.25	30.5+	Prepare to turn right.
0.1	30.6+	**Turn right** at T-road to the LaRue-Pine Hills Ecological area. **CAUTION:** Immediately after making the turn, cross the concrete ford.
0.7-	31.3-	Entrance to Pine Hills Camp Ground on the right. **Continue ahead** (northerly).
0.65+	31.95	**CAUTION:** Concrete ford.
0.7+	32.65	**CAUTION:** Concrete ford.
0.1+	32.75+	**CAUTION:** STEEPER Concrete ford.



Otter Pond
28
27
26
33
34
35
×705
Wolf Lake
Wolf
Lake
NAT FOR BDY
4
Wolf Lake
3
2
4
Wolf Lake
3
2
ILLINOIS
9
10
11
×346
367
369
353
352
352
0
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1½ km

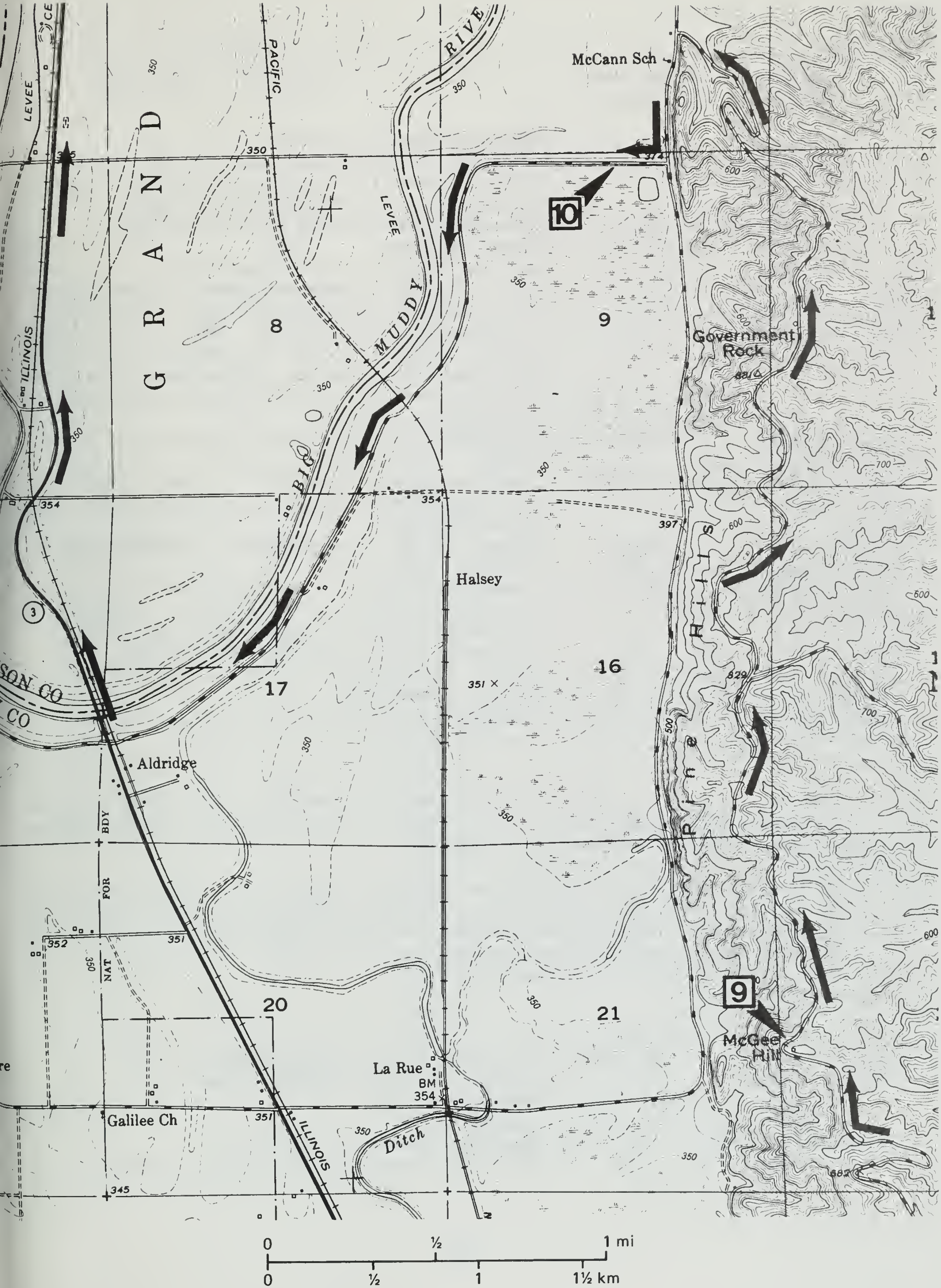
Miles to Next Point	Miles from Start	
0.5-	33.25	**CAUTION:** road steepens; very sharp curves ahead.
0.2	33.45	**Enter LaRue Pine-Hills Ecological Area.** Continue ahead.
0.2	33.65	The road ahead is both narrow and curvy, with very steep dropoffs on both sides of the road in many places; **stay alert.**
0.2	33.85	Allen's Flat Picnic Ground on the right. **Continue ahead** (northerly).
0.25+	34.1+	McGee Hill Picnic Ground to the right. **Continue ahead** (westerly).
0.1	34.2+	McGee Hill Observation Area to the left. PARK IN PROVIDED SPACES.

STOP 9. View and discussion of the Mississippi River Valley. Center west edge NW 1/4 NW 1/4 SW 1/4 Sec. 22, T. 11 S., R. 3 W., 3rd P.M. Union County; Wolf Lake 7.5-minute Quadrangle (37089E4).

Toward the west is a view of the Mississippi River and its valley from near the crest of the Pine Hills Escarpment. This ridge is capped by the Grassy Knob Chert Member of the Bailey Limestone Formation of Lower Devonian age. The Grassy Knob ranges in thickness from 10 to 50 feet and is composed of reddish chert that has an irregular, brecciated structure broken by many joints. The rock here forms the cliff below which the steep slopes are lightly covered by loess-derived silt and partly by loose chert talus. Narrow stream channels which are developed in this zone have bottoms that broaden slightly before forming cascades or waterfalls over the underlying Bailey Limestone Formation. The impressive cliffs in this area are developed in the Bailey Formation.

The walls of the Mississippi Valley, which rise 350 to 400 feet above the floodplain, owe their steepness to the resistant nature of the Devonian cherty limestone to erosion. The valley flat is slightly more than four miles wide at this point. Although at present the Mississippi flows against the Missouri side of the valley, it has not always done so. Swampy areas along abandoned channels and meander scars of the river can be seen.

0.0	34.2+	Leave STOP 9 and **continue ahead** (northerly).
1.2+	35.4+	Crooked Tree Observation Area to the left. **Continue ahead** (northerly).
0.1	35.5+	**Y-intersection, bear left and ascend hill.**
0.05-	35.55	Highest elevation on Pine Hills Road--830 feet m.s.l.
0.25+	35.8+	Saddle Hill Observation Area to the left.


McCann Sch
PACIFIC
RIVER
LEVEE
GRAND
MUDDY
BIG
ILLINOIS
Government Rock
10
8
9
16
17
20
21
Halsey
Aldridge
Pine Hills
McGee Hill
9
La Rue
BM 354
Galilee Ch
Ditch
NAT FOR BDY
0 ½ 1 mi
0 ½ 1 1½ km

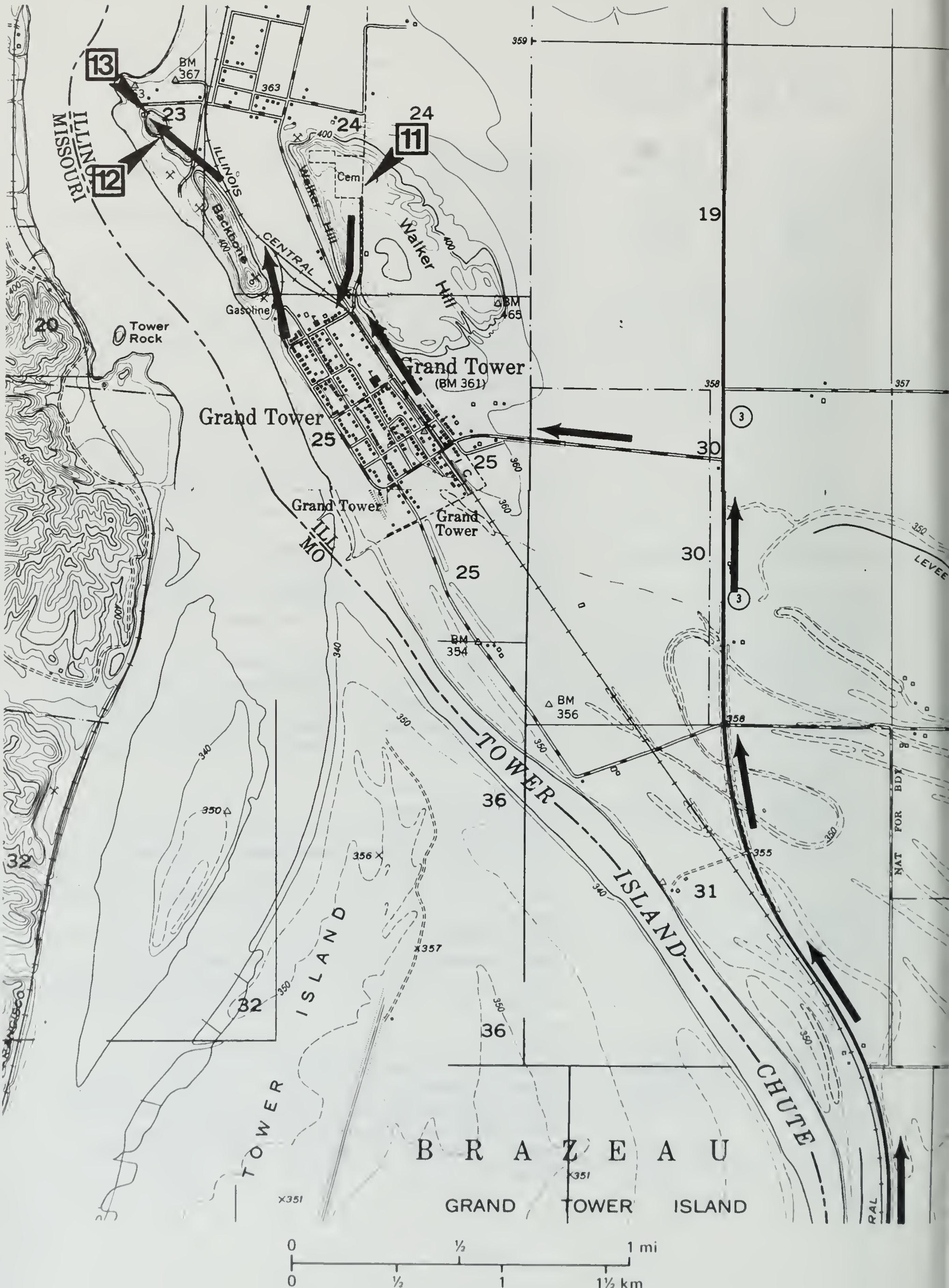
Miles to Next Point	Miles from Start	
		Continue ahead (northerly).
0.15+	36.0	The knob a little more than 100 feet off the road to the left appears to be the highest point in the Pine Hills--860 feet m.s.l.
0.6+	36.6+	Pine Ridge Observation Area to the left. **Continue ahead.**
0.1-	36.7	Hill to the left is Government Rock--831 feet m.s.l. **Continue ahead** (northerly).
0.25	36.95	Old Trail Point Observation Area to the left. **Continue ahead** (northerly) **NOTE:** This is one of the better views of the swampy areas of the Big Muddy River below with meander scars and oxbow lakes; as well as the valley of the Mississisppi.
0.4+	37.35+	**CAUTION:** Starting descent from top of ridge.
0.2+	37.55+	Small parking area to left. A trail goes to some magnificent views of the valley--375 feet above STOP 10.
0.6-	38.15	McCann Springs Picnic Grounds. **Continue ahead** and **bear left.**
0.1-	38.25-	T-Road intersection--**Turn left** (south) along the foot of the Pine Hills Bluff. A number of places give excellent profiles of the bluff, including one for our cover photograph.
0.35+	38.6+	T-road intersection from right. **Turn right.** (west) on the levee.
0.15	38.75+	PARK on top of levee as far to right as you can safely.

STOP 10. View of Lower Devonian Bailey Limestone and Pine Hills Bluff NW 1/4 NW 1/4 NW 1/4 NE 1/4 Sec. 9, T. 11 S., R. 3 W., 3rd P.M., Union County; Wolf Lake 7.5-minute Quadrangle (37089E4).

The Bailey Limestone forms part of the sheer 200+-foot cliff to the east. The Bailey, which is about 300 feet thick in this area, is the oldest unit of the Devonian System in southwestern Illinois. The formation consists of thin-bedded, slightly shaly, cherty, gray limestone. At the top of the bluff it is overlain by Grassy Knob Chert.

0.0	38.75+	Leave STOP 10 and **continue ahead** (west) along the man-made levee.
1.2-	39.95+	**CAUTION:** Rough, single track UP RR crossing--unguarded. **Continue ahead** (southwesterly).
1.35+	41.35-	Cross old abandoned and dismantled Illinois

Miles to Next Point	Miles from Start	
		Central (IC) RR right of way.
0.05-	41.35-	STOP (2-WAY) Crossroad SR 3. **Turn right** (north) on SR 3.
0.05+	41.4+	Cross Big Muddy River and enter Jackson County.
0.55	41.95+	Cross abandoned IC RR right of way.
0.15	42.1+	At road sign of "3 Jackson 0.67" view to the right at about 1:30 o'clock is of the Pine Hills Escarpment along which we just traveled. The high points or columns standing up toward the south are at the juncture of the T-road where we turned west onto the levee. **Continue ahead** (north).
0.3	42.4+	The broad alluviated valley of the Mississippi that we are traveling along has ridges and swales in it that are the result of scour and deposition from higher levels of the Mississippi and the Big Muddy Rivers as they have meandered back and forth across this wide valley.
2.0	44.4+	Ahead and just slightly to the right at 12:00 o'clock is Walker Hill. To the left is the eastern gas pipeline suspension tower sticking up behind the Backbone Ridge north of Grand Tower.
0.5	44.9+	The large hill straight ahead on this broad curve is Fountain Bluff which is composed mainly of Pennsylvanian Caseyville Sandstone. Mississippian rocks crop out below the Caseyville along the southwestern edge of Fountain Bluff.
0.7	45.6+	Prepare to turn left.
0.15+	45.75+	Enter Grand Tower.
0.25	46.0+	**Turn left** at T-road intersection toward "downtown" area of Grand Tower. You are on the Great River Road of Illinois. Go around the curve ahead to the left and prepare to turn right.
0.8+	46.85+	**Turn right** (northwestward) on the east side of the dismantled IC RR right-of-way.
0.25-	47.1	The "Loose Caboose" is on the old IC RR right-of-way to the left. **Continue ahead** (northwesterly).
0.2	47.3	Walker Hill apartments to the right.
0.05	47.35	Crossroad. **Turn right** and ascend steep hill.
0.3+	47.65+	Enter Walker Hill Cemetery. **NOTE:** MILEAGE RESUMES FROM ENTRANCE. Just after entering **turn right** on the narrow cemetery drive. **Please stay on the drives.** PARK near Veteran's Memorial.


13
12
11
BM 367
363
23
24
24
ILLINOIS
MISSOURI
ILLINOIS
Cem
Backbone
Walker Hill
Walker Hill
CENTRAL
19
359
BM 465
Gasoline
20
Tower Rock
Grand Tower
(BM 361)
Grand Tower
25
25
358
357
3
30
30
3
360
Grand Tower
Grand Tower
ILL
MO
25
350
LEVEE
BM 354
340
BM 356
356
350
TOWER
ISLAND
CHUTE
36
350
356
355
31
NAT FOR BDY
32
357
32
TOWER ISLAND
TOWER
36
BRAZEAU
351
351
GRAND TOWER ISLAND
0
½
1 mi
0
½
1
1½ km

STOP 11. Discussion of structure in this locality and view of parts of the Mississippi Valley. NW 1/4 SW 1/4 NW 1/4 SE 1/4 Sec. 24, T. 10 S., R. 4 W., 3rd P.M., Jackson County; Altenburg 7.5-minute Quadrangle (37089F5).

The view toward the north is across the abandoned segment of Mississippi Valley toward Fountain Bluff and the east valley wall. The cliff along the south end of Fountain Bluff is composed largely of Pennsylvanian Battery Rock Sandstone. The Battery Rock is underlain by the Mississippian Palestine Sandstone and Menard Limestone and is overlain by the Pennsylvanian Pounds Sandstone.

Faulting of bedrock strata along the Rattlesnake Ferry Fault Zone, a segment of the much larger Ste. Genevieve Fault Zone (fig. 5), occurred between Walker Hill and the Devil's Bake Oven and Backbone, less than one quarter of a mile to the west (fig. 8). The northern part of Walker Hill is underlain by Mississippian (Valmeyeran) Salem Limestone, to the west, and St. Louis Limestone, to the east. These formations were extracted from a quarry, now abandoned and undergoing reclamation, at the northwest end of Walker Hill. These strata were fairly steeply tilted down about 20 degrees easterly. The northern part of Walker Hill has been down-dropped along the Rattlesnake Ferry Fault Zone relative to the southwest end, so that Middle Devonian rocks have been upthrown against the younger Mississippian strata. The southwest end of Walker Hill is tilted to the south-southwest. Figure 9 is a cross-section along line A-B (fig. 8) to show the relative positions of the various stratigraphic units after faulting. The line extends from Tower Rock, on the Missouri side of the Mississippi River, through the Devil's Backbone, and to the southern end of Fountain Bluff.

Walker Hill, the Backbone, and Fountain Bluff are erosional bedrock features that were once part of the western bluff of the Ancient Mississippi River. They became isolated on the Mississippi valley flat when the river shifted from the valley east of Fountain Bluff to its present position. The cause of this shifting is probably related to the Pleistocene glaciation of the region.

The Pleistocene Illinoian glaciation occurred 300(?) to 125 thousand years ago, and Illinoian glacial till occurs about 8 miles to the northeast along Cedar Creek in Jackson County. It is possible that the glacier moved into the Alto Pass area and crossed the Mississippi Valley to the bluff on the Missouri side. The ice dammed the river and caused it to flow across the upland along the edge of the west bluff, where it intercepted a tributary valley and cut a new channel. When the ice melted away, the river had permanently established its present channel on the west side of Fountain Bluff.

No direct evidence exists to confirm that the ice actually advanced this far, but considering the high relief of the area, any drift deposited by the ice could easily have been removed by erosion.

During the Wisconsinan glaciation and Recent time the river alluviated its valley. There is a maximum of about 200 feet of glacial outwash and Holocene alluvium in the abandoned Mississippi River bedrock valley. When the Wisconsinan glacier melted, an enormous amount of water flowed downvalley, and the old channel was again temporarily used by the river.

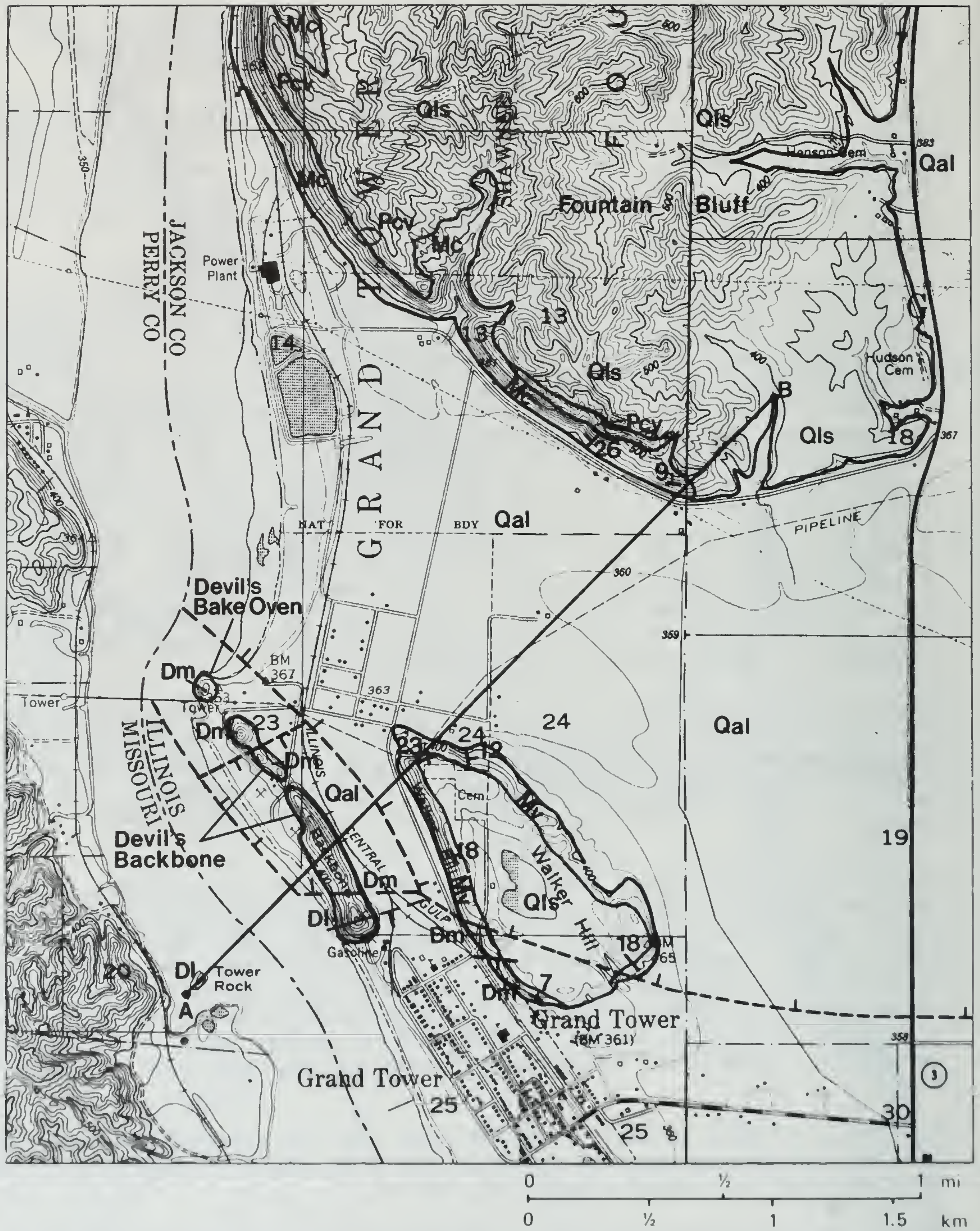
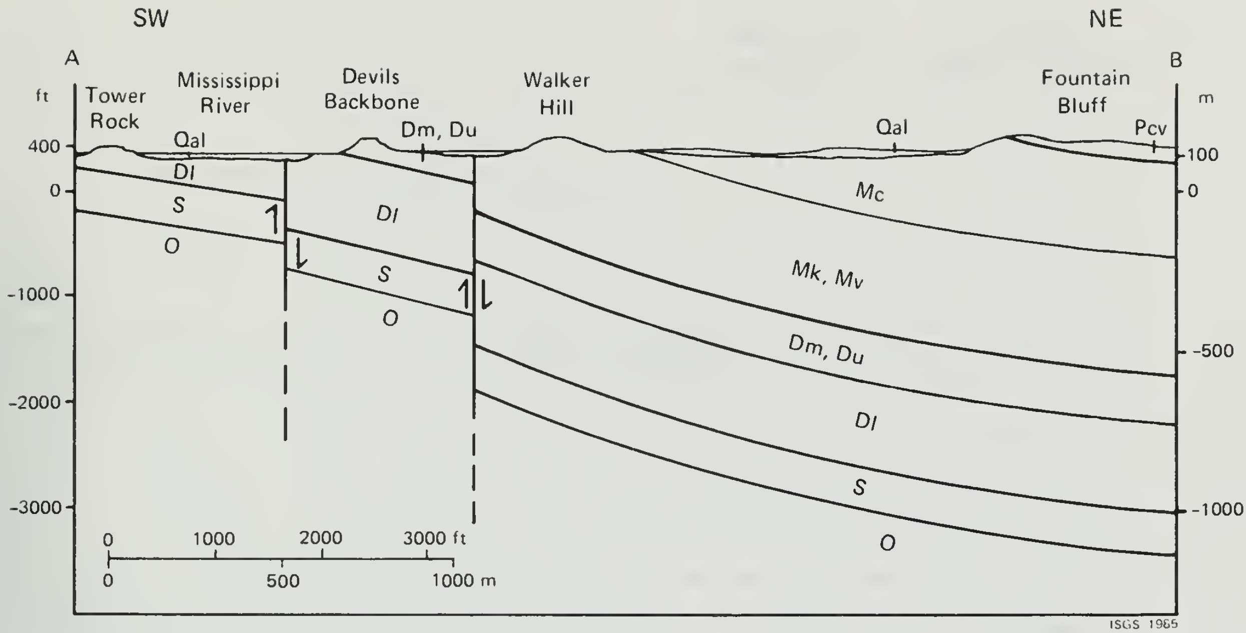


Figure 8 Geologic map of the Ste. Genevieve Fault Zone at Grand Tower, Illinois. Line of cross section A-B shown on figure 9 (from Nelson and Lumm, 1985).



Qal	QUATERNARY alluvium		DEVONIAN
	PENNSYLVANIAN	Dm, Du	Middle and Upper Devonian Series
Pcv	Caseyville Formation	Dl	Lower Devonian Series
	MISSISSIPPIAN	S	SILURIAN
Mc	Chesterian Series	O	ORDOVICIAN
Mk, Mv	Kinderhookan and Valmeyeran Series		

Figure 9 Cross section of line A-B, figure 8, near Grand Tower, Illinois (from Nelson and Lumm, 1985).

Miles to Next Point	Miles from Start	
0.0	47.65	Leave STOP 11 and Walker Hill Cemetery. **NOTE:** RESUME MILEAGE FIGURES FROM ENTRANCE.
0.2+	47.9+	**CAUTION:** Descend steep hill.
0.1	48.05	STOP (2-WAY) Crossroad. **Continue ahead** (west).
0.1+	48.15+	Grand Tower municipal building to the right. **Continue ahead** (west).
0.05+	48.2+	STOP (1 WAY) T-road intersection. Levee just ahead. **Bear right** and ascend the drive (northerly) up the levee toward the Devil's Backbone Park.
0.05-	48.25+	Just as you get to the top of the levee, to the left at about 10:00 o'clock is a view of Tower Rock on the Missouri side. At this time you can walk on dry land from Missouri out to it. That's how low the river is.
0.15-	48.4	**Turn right** at T-road intersection.
0.05+	48.45+	Abandoned quarry to left in the Backbone Limestone.
0.05+	48.55	The ridge to the left is the Devil's Backbone.
0.3+	48.85+	T-road intersection. STOP (1 WAY) from the

Miles to Next Point	Miles from Start	
		left. **Turn left**
0.05-	48.9+	**Turn right** (northerly) along the river side of the Devil's backbone.
0.1+	49.05+	PARK as far off roadway as possible.

STOP 12. Exposures of Devonian Lingle and Grand Tower Formations exposed in the Devil's Backbone NE 1/4 NW 1/4 NE 1/4 SW 1/4 Sec. 23, T. 10 S., R. 4 W., 3rd P.M. Jackson County; Altenburg 7.5-minute Quadrangle (37089F5).

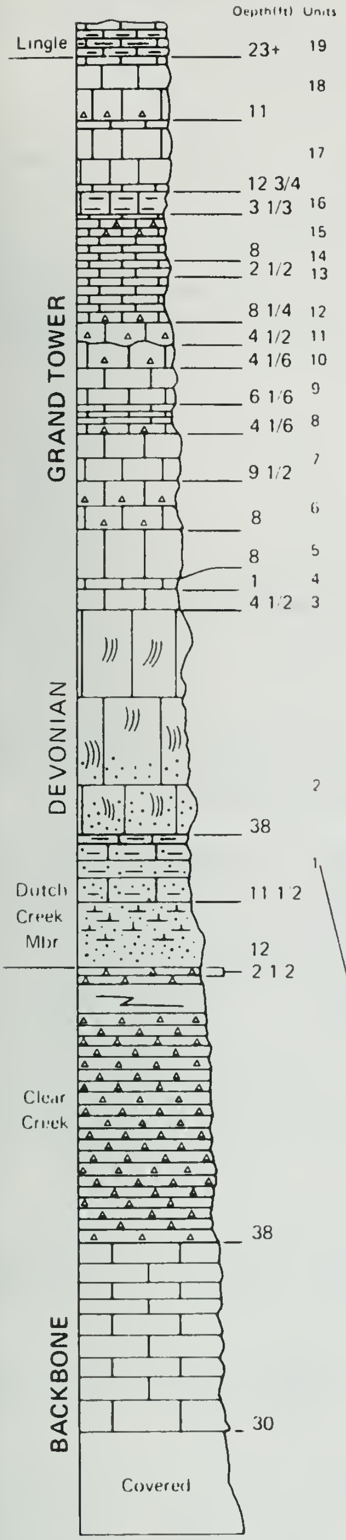
The abandoned quarry noted at mileage 48.45+ is the type section of the Lower Devonian Backbone Limestone (fig. 10); Savage, 1920). Although this light-gray, massive, crystalline, pure limestone is commonly up to 100 feet thick in the outcrop area, it is as much as 200 feet thick in the subsurface wherever it rims the deeper part of the Illinois Basin. In the abandoned quarry only the upper 38 feet have been accessible, but the upper contact with the overlying Clear Creek Chert is well exposed. As noted previously, where the Backbone is absent, it is difficult to differentiate the Clear Creek Chert from the Grassy Knob Chert that normally occurs beneath the Backbone. The limestone commonly contains large crinoid stems and many brachipods in addition to gastroponds, bryozoans, conodonts, and trilobites.

Backbone Park is located along a narrow ridge called the "Devil's Backbone." This ridge is a "hogback" (any ridge with a sharp summit and steep, almost equally inclined, sides) that is held up by resistant Devonian limestones and cherts. The steep dips observed here are the result of movement along the Rattlesnake Ferry Fault Zone (figs. 8 and 9). As noted previously, this ridge, along with Walker Hill (STOP 11) and Fountain Bluff, a little more than one mile (1.6 km) to the north of us, was once part of the west bluff of the Mississippi River. The geologic section exposed near the north end of the park is as follows:

	Thickness
Lingle Limestone Formation	
Shale, greenish gray, fossiliferous	10'
Limestone, buff to tan, finely crystalline, fossiliferous	20'
Grand Tower Limestone Formation	
Limestone, gray, finely crystalline, cross-bedded in lower part, some fossiliferous zones	85'

The Grand Tower Limestone was named for Grand Tower, Illinois.

Toward the southwest near the Missouri side, the small rock island known as Grand Tower, rises above the Mississippi River. The island is composed of



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Figure 10 Generalized Columnar Section at the Bakeoven and Backbone, North of Grand Tower, Illinois. (modified from Collinson *in* Meents and Swann, 1965; Fraunfelter, 1987).

Bailey Limestone, which also forms the west bluff of the river. Measuring only one-fourth acre, Grand Tower is the smallest national park in the United States and was set aside in 1871 by President Grant.

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

Miles to Next Point	Miles from Start	
0.0	49.05+	Leave STOP 12 and continue ahead.
0.1	49.15+	PARK as far off roadway as possible.

STOP 13. Exposure of Devonian Lingle, Grand Tower, and Dutch Creek strata in the Devil's Bake Oven. W 1/2 SW 1/4 SE 1/4 NW 1/4 Sec. 23, T. 10 S., R. 4 W., 3rd P.M., Jackson County; Altenburg 7.5-munute Quadrangle).

The entire thickness of the Middle Devonian Grand Tower Limestone, 157 feet (48 m), is exposed in the Devil's Bake Oven, the prominent, high, tilted, bedrock knob about 300 feet north of the road. Figure 10 illustrates the details of the rock strata exposed in the Bake Oven; the numbered units in the upper part of the illustration are for the units that are exposed there. According to Willman (1975), the Grand Tower is mostly coarse-grained, light-gray, medium- to thick-bedded, cross-bedded, pure fossiliferous limestone, but is also contains lithographic limestone, which becomes more abundant upwards. In eastern Illinois, about due east of this locality, the Grand Tower thickens to nearly 250 feet. The Grand Tower is abundantly fossiliferous.

A calcareous sandstone or sandy limestone is present at the base, the Dutch Creek Member. The latter can be seen at the southwest corner of the knob during periods of low river levels.

In order to leave here, continue ahead north over the levee to the right of the edge of the pipeline. Bear right and **continue ahead** (east) for 0.35 miles to a STOP (1 WAY) at a T-intersection.

Turn right, head south along the west side of Walker Hill into the main part of Grand Tower to get to the blacktop that we came in on. Take a left at that point...the first STOP sign to the south of here. Turn left and return to SR 3. Turn right (south) towards Ware, Anna, Jonesboro, Cape Girardeau, etc.

To go north, turn left here. Continue to the T-intersection at the foot of Fountain Bluff. Then turn right and continue to SR 3. Turn left (north) toward Chester or Murphysboro/Carbondale, etc. The massive sandstone that you see to the north is the basal Pennsylvanian Battery Rock.

Have a safe trip home. Join us again in the spring.

BIBLIOGRAPHY

Bates, R.L., and J.A. Jackson, (eds.), 1980, Glossary of Geology: American Geological Institute, Falls Church, VA, 2nd Ed., 751 p.

Cote, W.E., D.L. Reinertsen, and G.M. Wilson, 1965, Alto Pass Area; Illinois State Geological Survey Geological Science Field Trip Guide Leaflet 1965F, 22p.

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

Fraunfelter, G.H., 1987, Geologic Features Near Grand Tower, Illinois: The Devil's Backbone, the Devil's Bake Oven, and Fountain Bluff: in Biggs, D.L. (ed.), Geological Society of America Centennial Field Guide--North-Central Section, Art, 60, p. 245-250.

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

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

Lamar, J.E., 1953, Siliceous Materials of Extreme Southern Illinois - Silica, Novaculite, Ganister, Calico Rock, and Chert Gravels: Illinois State Geological Survey Report of Investigations 166, 39 p.

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

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

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

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

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

Samson, I.E., 1988, Illinois Mineral Industry in 1985 and Preliminary Mineral Production Data for 1985: Illinois State Geological Survey Illinois Mineral Note 99, 45 p.

BIBLIOGRAPHY

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

Treworgy, Janis D., 1981, Structural Features in Illinois: A Compendium. Illinois State Geological Survey Circular 519, 22 p.

Weller, J.M., and G.E. Ekblaw, 1940, Preliminary geologic map of parts of the Alto Pass, Jonesboro, and Thebes quadrangles: Illinois State Geological Survey Report of Investigations 70, 26 p.

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

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

Willman, H.B., et al, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

Woller, D.M., 1988, Personal communication about municipal water supplies in Union and Jackson Counties: Illinois State Water Survey.

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississiippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

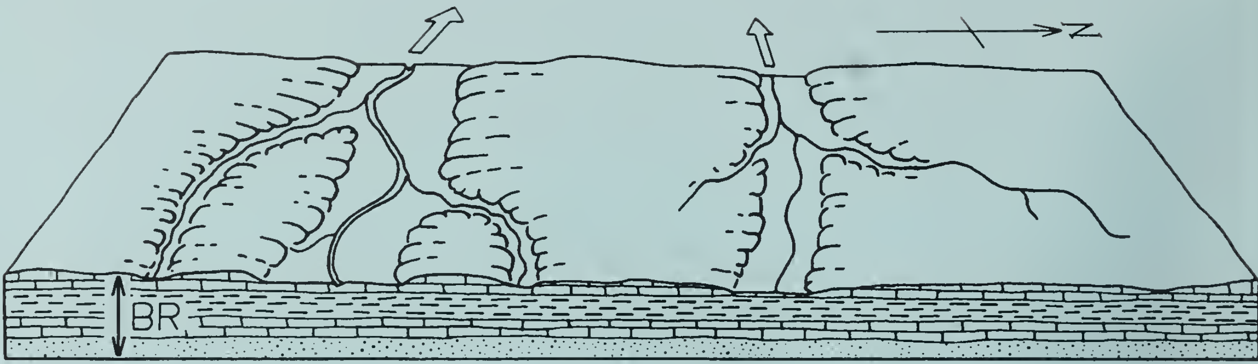
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as "key beds," or stratigraphic markers, and are evidence of the passage of a long interval of time.

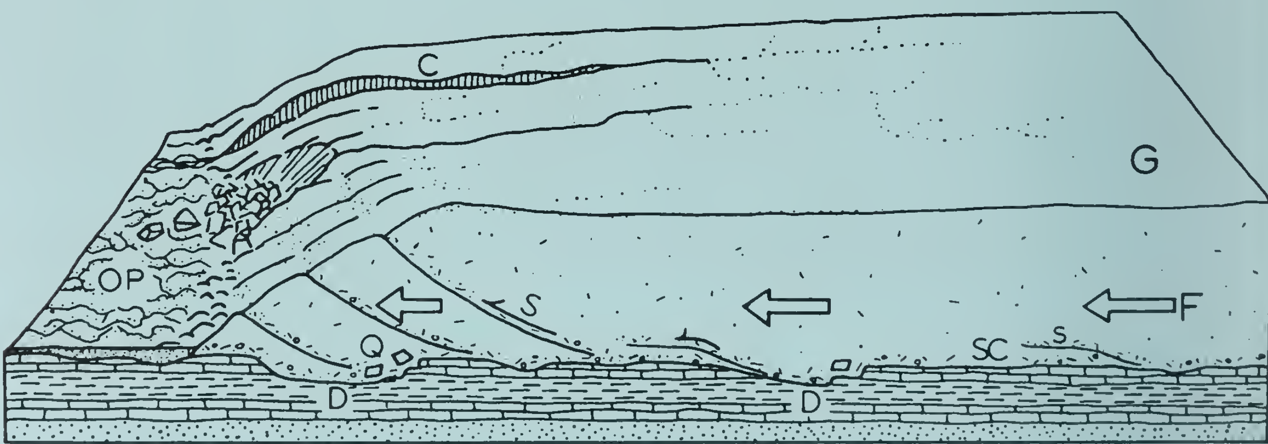
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

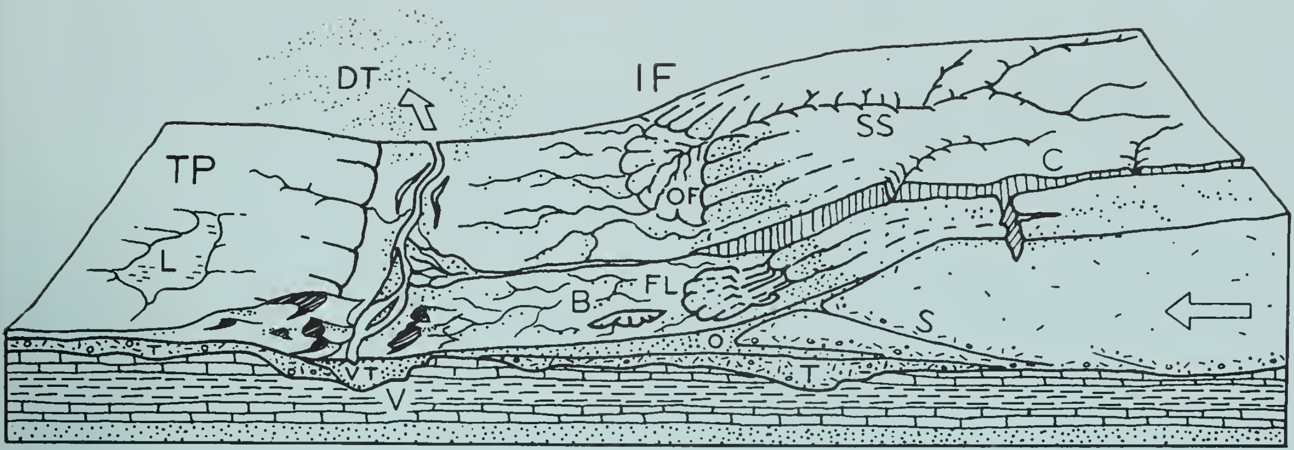
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



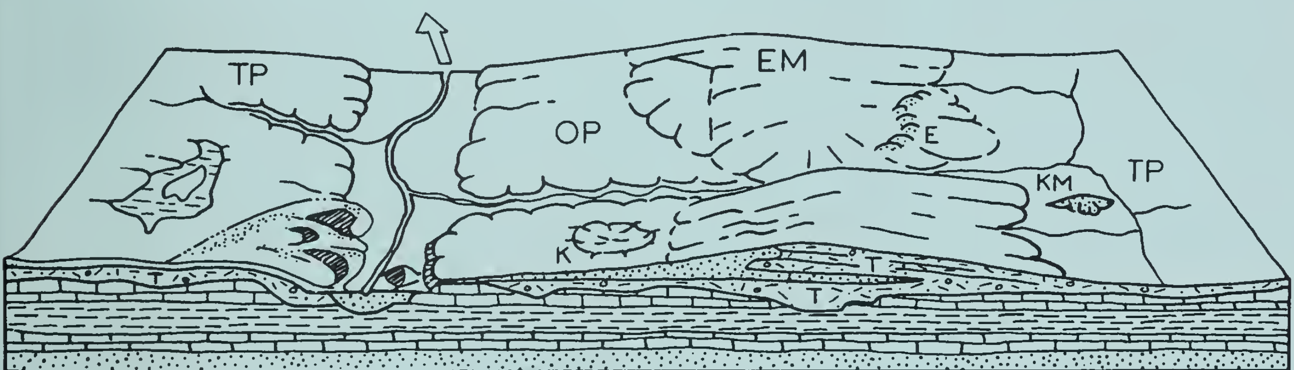
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.



3. **The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.



4. **The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

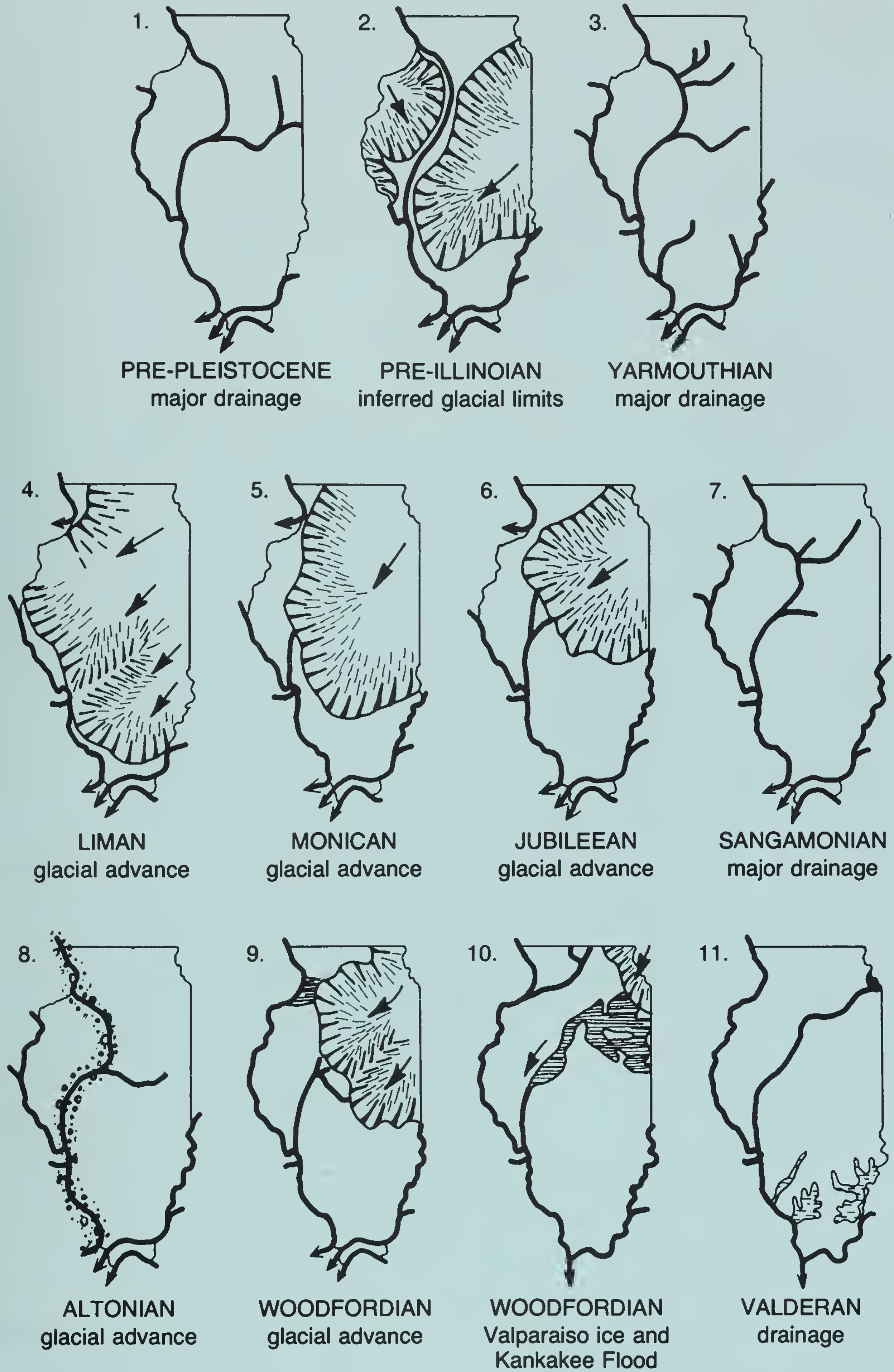
TIME TABLE OF PLEISTOCENE GLACIATION

		STAGE		SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
		HOLOCENE (interglacial)		Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
				10,000		
Pleistocene		WISCONSINAN (glacial)	late	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
				11,000		
				Twocreekan	Peat and alluvium	Ice withdrawal, erosion
				12,500		
				Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
				25,000		
			mid	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
				28,000		
			early	Altonian	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers
				75,000		
		SANGAMONIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
				125,000		
		ILLINOIAN (glacial)		Jubileean	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
				Monican	Drift, loess, outwash	
				Liman	Drift, loess, outwash	
				300,000?		
		YARMOUTHIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
				500,000?		
	Pre-Illinoian	KANSAN* (glacial)			Drift, loess	Glaciers from northeast and northwest covered much of state
				700,000?		
		AFTONIAN* (interglacial)			Soil, mature profile of weathering	(hypothetical)
				900,000?		
		NEBRASKAN* (glacial)			Drift (little known)	Glaciers from northwest invaded western Illinois
				1,600,000 or more		

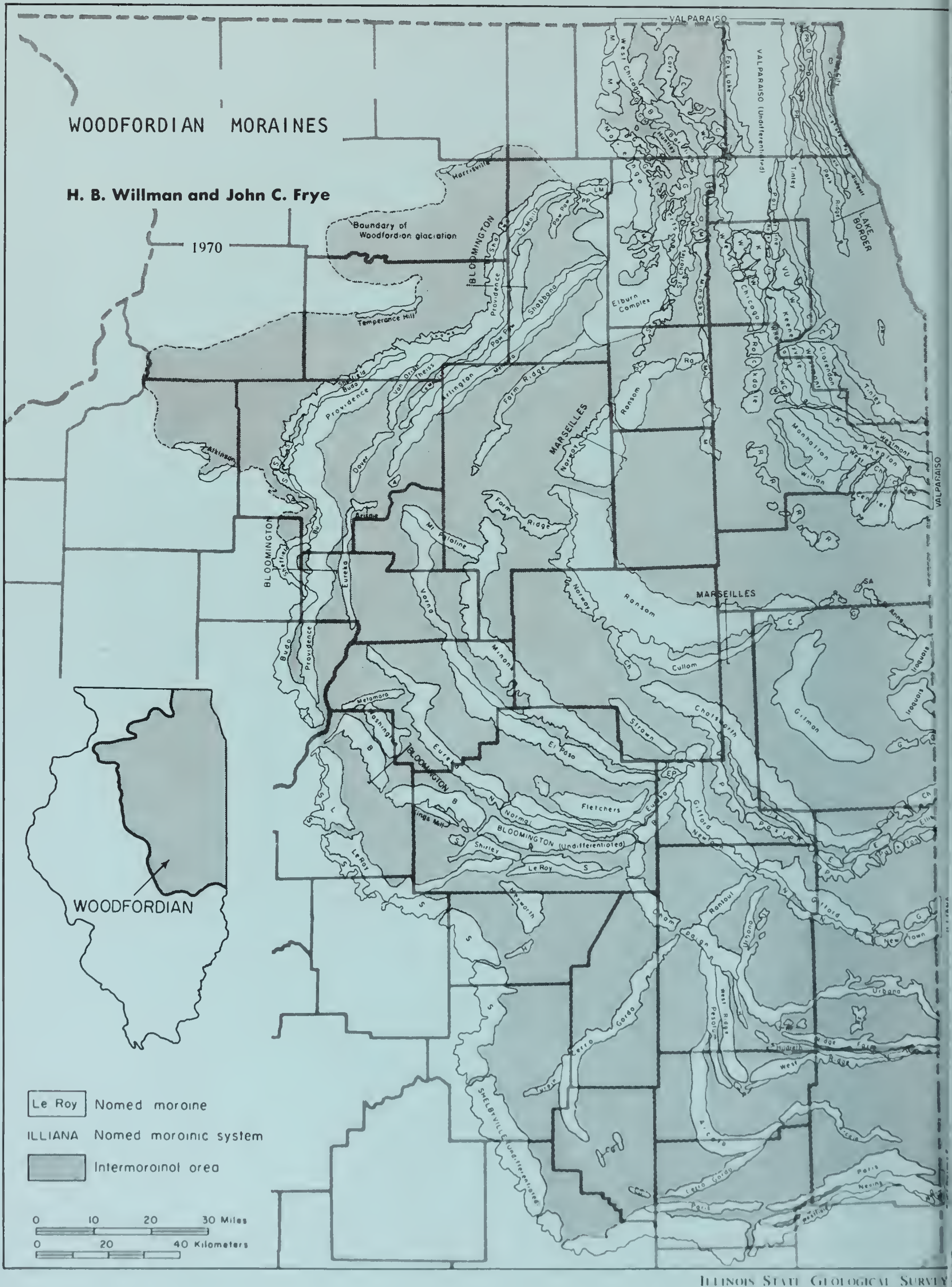
ld oversimplified concepts, now known to represent a series of glacial cycles.

(Illinois State Geological Survey, 19

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(Modified from Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)



WOODFORDIAN MORAINES
H. B. Willman and John C. Frye
1970
Boundary of Woodfordian glaciation
VALPARAISO
VALPARAISO (Undifferentiated)
LAKE BORDER
BLOOMINGTON
MARSEILLES
BLOOMINGTON (Undifferentiated)
SHELBYVILLE (Undifferentiated)
Harrisville
Temperance Hill
Atkinson
Sheffield
Buda
Providence
Van Orin
Theiss
Arlington
Mendota
Paw Paw
Shabbona
La Moille
Farm Ridge
Dover
Arispie
Mt. Palatine
Eureka
Varna
Minonk
Norway
Ransom
Elburn Complex
St. Charles
Chicago
Keeneyville
Rockdale
Clarendon
Tinley
Manhattan
Wilton
Wheaton
Westmont
Marengo
Huntley
Fox Lake
Cary
West Chicago
Park Ridge
Blodgett
Deerfield
Cullom
Chatsworth
Strawn
El Paso
Gilman
Iroquois
Metamora
Washington
Normal
Fletchers
Shirley
Le Roy
Heyworth
Gifford
Newtown
Rantoul
Paxton
Urbana
West Ridge
Pesotum
Cerro Gordo
Arcola
Paris
Nevins
Le Roy Named moraine
ILLIANA Named morainic system
Intermorainal area
WOODFORDIAN
0 10 20 30 Miles
0 20 40 Kilometers

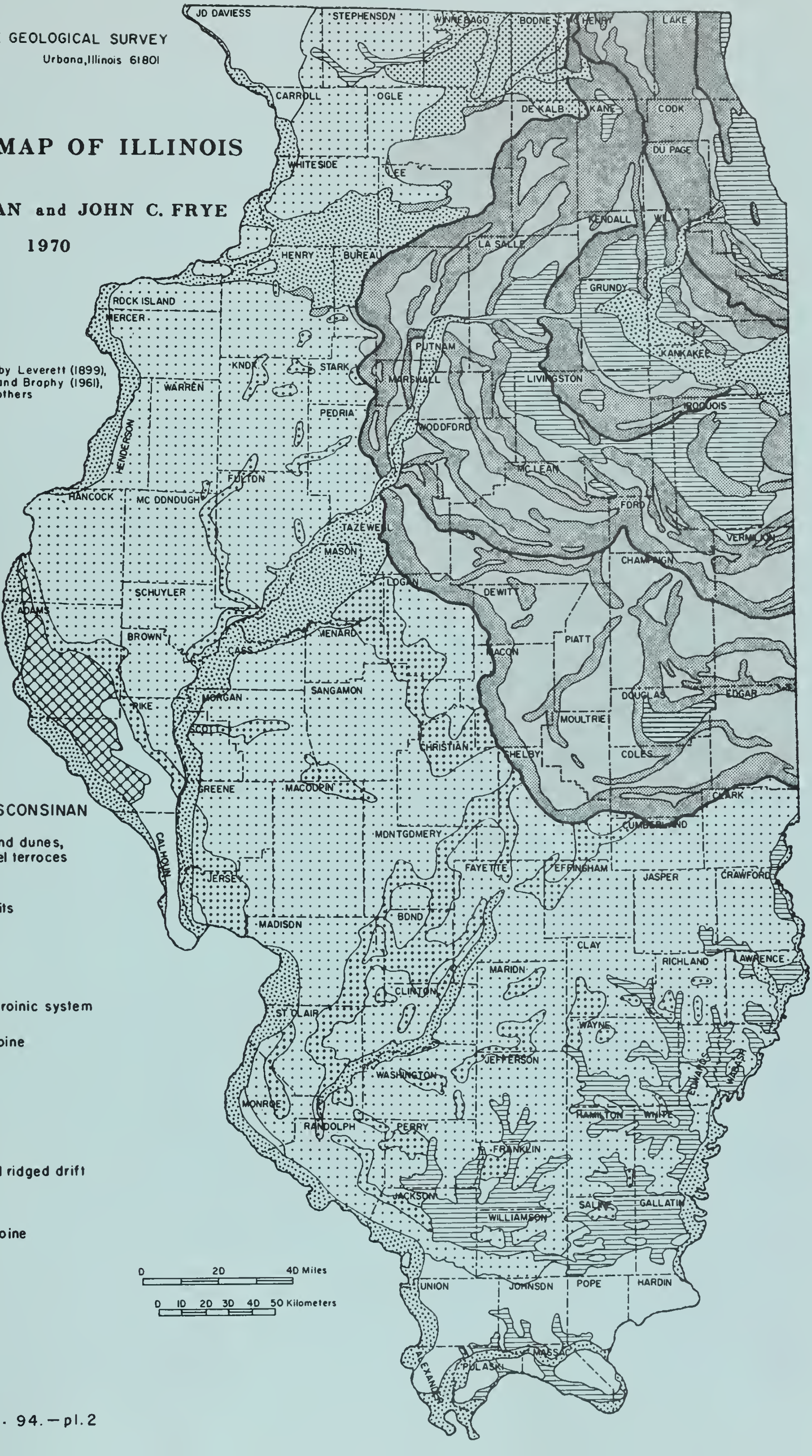
ILLINOIS STATE GEOLOGICAL SURVEY
John C. Frye, Chief   Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblaw (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



EXPLANATION

HOLOCENE AND WISCONSINAN

Alluvium, sand dunes, and gravel terraces

WISCONSINAN

Lake deposits

WOODFORDIAN

Moraine

Front of morainic system

Groundmoraine

ALTONIAN

Till plain

ILLINOIAN

Moraine and ridged drift

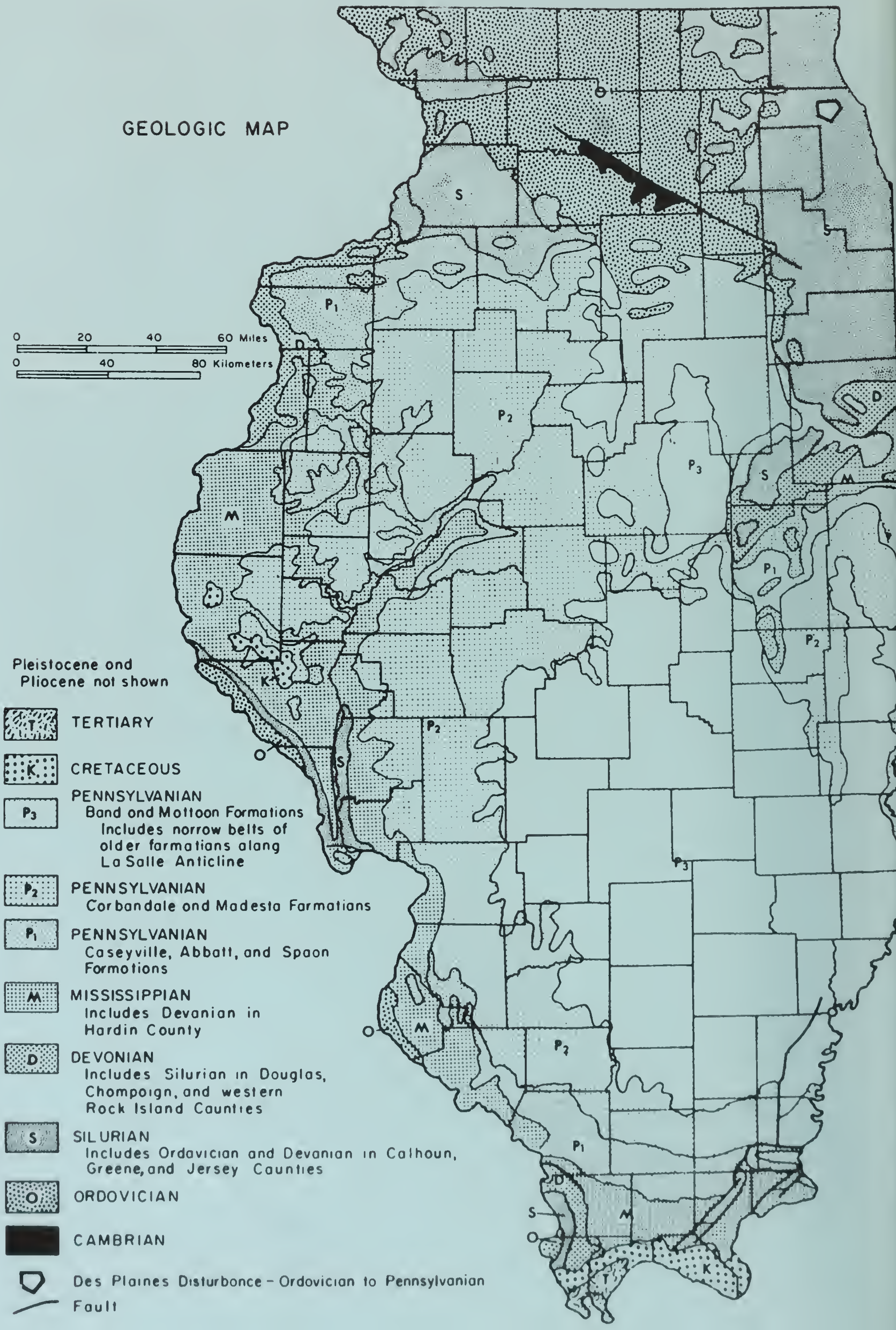
Groundmoraine

KANSAN

Till plain

DRIFTLESS

Modified from Bull. 94.—pl.2


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

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS

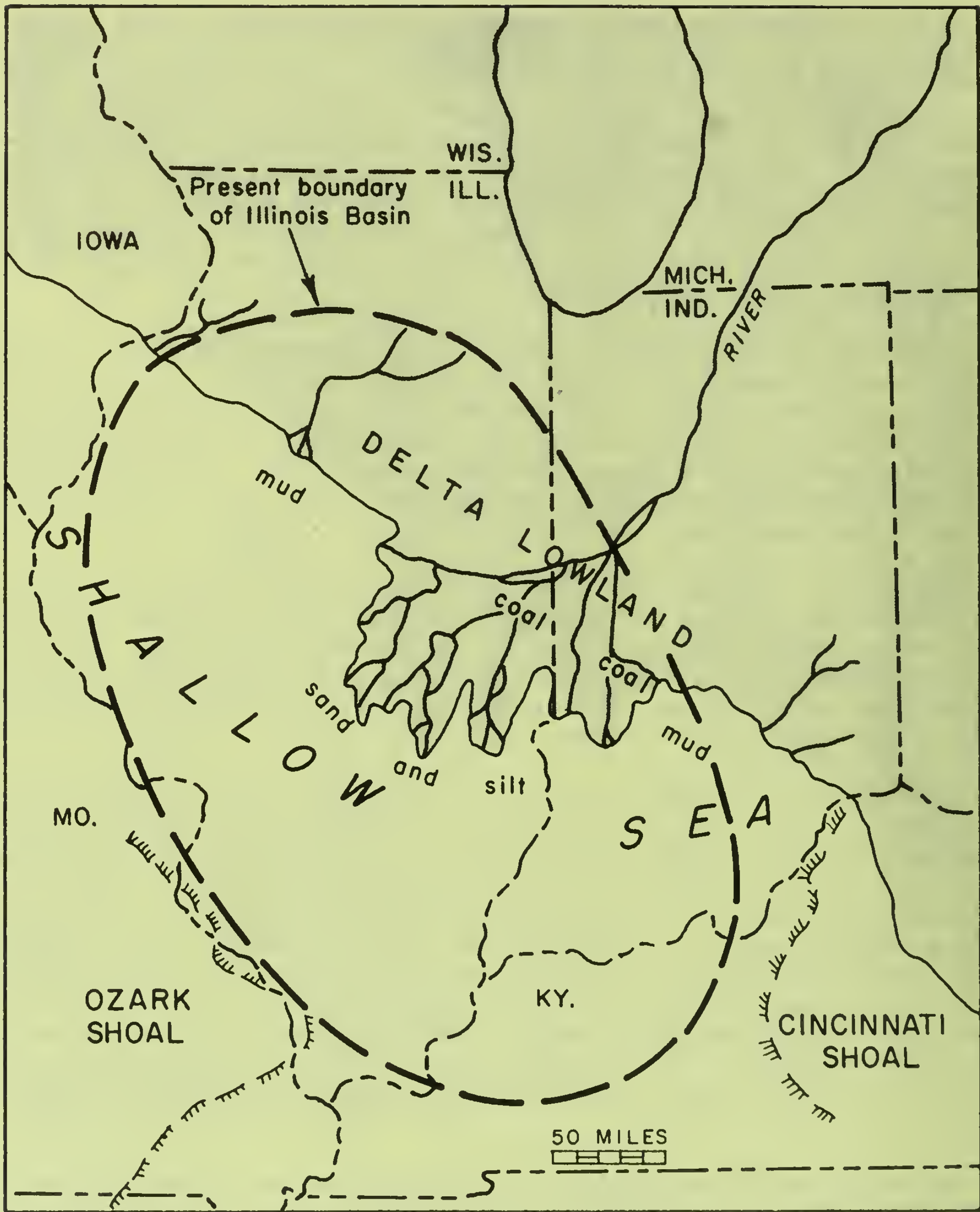
At the close of the Mississippian Period, about 310 million years ago, the Mississippian sea withdrew from the Midcontinent region. A long interval of erosion took place early in Pennsylvanian time and removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. An ancient river system cut deep channels into the bedrock surface. Erosion was interrupted by the invasion of the Morrowan (early Pennsylvanian) sea.

Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those that existed during Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands in the northeast. A great delta was built out into the shallow sea (see paleogeography map on next page). As the lowland stood only a few feet above sea level, only slight changes in relative sea level caused great shifts in the position of the shoreline.

Throughout Pennsylvanian time the Illinois Basin continued to subside while the delta front shifted owing to worldwide sea level changes, intermittent subsidence of the basin, and variations in the amounts of sediment carried seaward from the land. These alternations between marine and nonmarine conditions were more frequent than those during pre-Pennsylvanian time, and they produced striking lithologic variations in the Pennsylvanian rocks.

Conditions at various places on the shallow sea floor favored the deposition of sandstone, limestone, or shale. Sandstone was deposited near the mouths of distributary channels. These sands were reworked by waves and spread as thin sheets near the shore. The shales were deposited in quiet-water areas—in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Most sediments now recognized as limestones, which are formed from the accumulation of limey parts of plants and animals, were laid down in areas where only minor amounts of sand and mud were being deposited. Therefore, the areas of sandstone, shale, and limestone deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sandstones, shales, and limestones were deposited on the deltaic lowland bordering the sea. The nonmarine sandstones were deposited in distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies, 100 or more feet thick, were deposited in channels that cut through many of the underlying rock units. The shales were deposited mainly on floodplains. Freshwater limestones and some shales were deposited locally in fresh-water lakes and swamps. The coals were formed by the accumulation of plant material, usually where it grew, beneath the quiet waters of extensive swamps that prevailed for long intervals on the emergent delta lowland. Lush forest vegetation, which thrived in the warm, moist Pennsylvanian climate, covered the region. The origin of the underclays beneath the coals is not precisely known, but they were probably deposited in the swamps as slackwater muds before the formation of the coals. Many underclays contain plant roots and rootlets that appear to be in their original places. The formation of coal marked the end of the nonmarine portion of the depositional cycle, for resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were then laid down over the coal.



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

Pennsylvanian Cyclothems

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

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting front of the delta lowland. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an ideally complete cyclothem consists of 10 sedimentary units. The chart on the next page shows the arrangement. Approximately 50 cyclothems have been described in the Illinois Basin, but only a few contain all 10 units. Usually one or more are missing because conditions of deposition were more varied than indicated by the ideal cyclothem. However, the order of units in each cyclothem is almost always the same. A typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal portion (the lower 5 units) of each cyclothem is nonmarine and was deposited on the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal are marine sediments and were deposited when the sea advanced over the delta lowland.

Origin of Coal

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

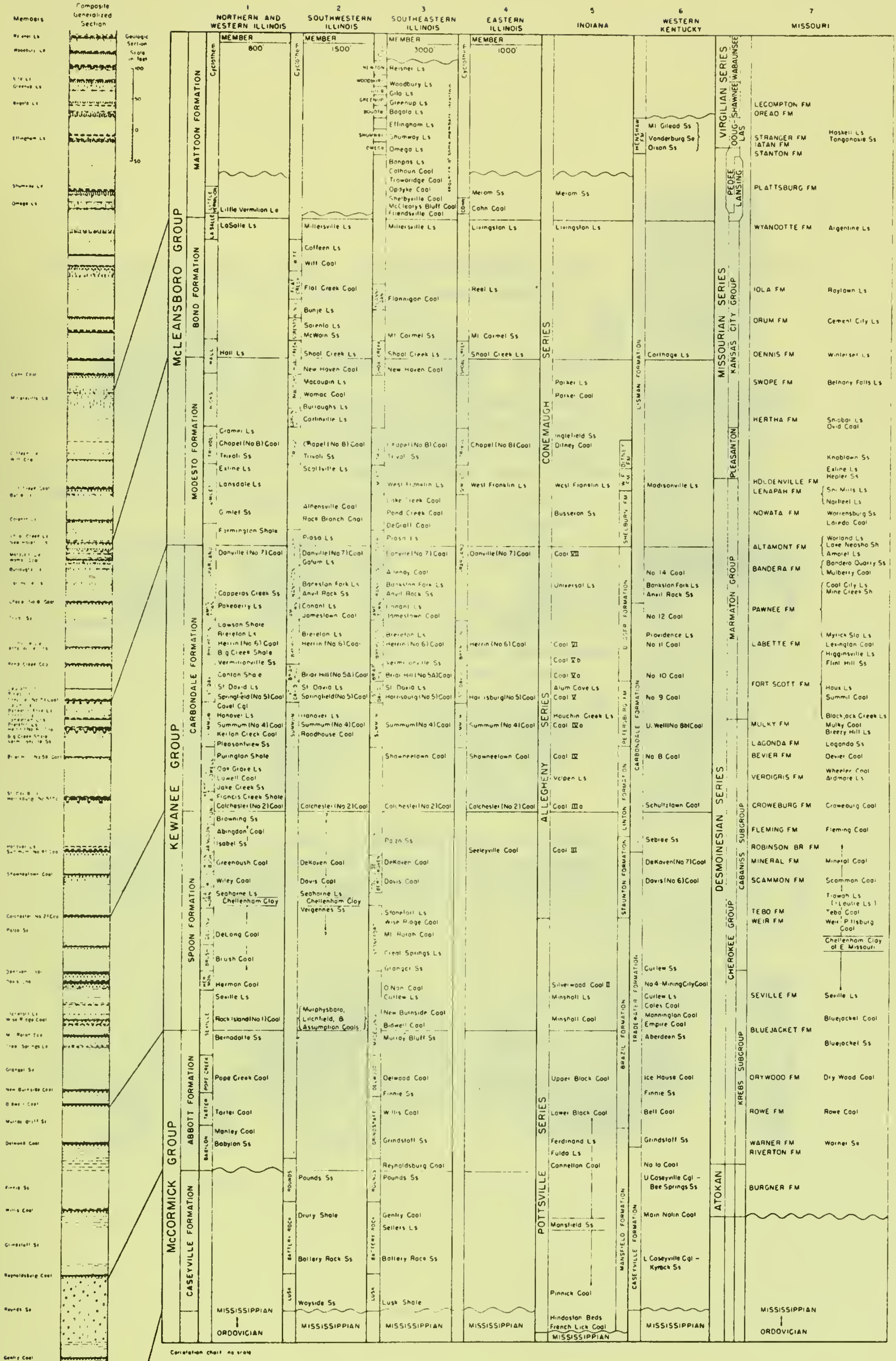
Plant debris from the rapidly growing swamp forests—leaves, twigs, branches, and logs—accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably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

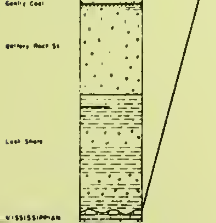
The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests and initiated marine conditions of deposition. The peat deposits were buried by marine sediments. Following burial, the peat deposits were gradually transformed into coal by slow chemical and physical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coalification process, and the peat deposits were changed into coal.

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

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

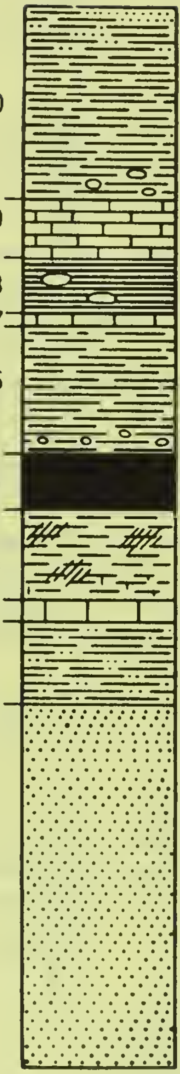
The exact origin of the carbonaceous black shales that occur above many coals is uncertain. The black shales probably are deposits formed under restricted marine (lagoonal) conditions during the initial part of the invasion cycle, when the region was partially closed off from the open sea. In any case, they were deposited in quiet-water areas where very fine, iron-rich muds and finely divided plant debris were washed in from the land. The high organic content of the black shales is also in part due to the carbonaceous remains of plants and animals that lived in the lagoons. Most of the fossils represent planktonic (floating) and nektonic (swimming) forms—not benthonic (bottom dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shales formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient waters of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.





ROCK STRATIGRAPHIC
AND
CYCLICAL CLASSIFICATIONS
OF THE
PENNSYLVANIAN STRATA OF ILLINOIS

1960



10 Shale, gray, sandy at top; contains marine fossils and ironstone concretions, especially in lower part.

9 Limestone; contains marine fossils.

8 Shale, black, hard, laminated; contains large spheroidal concretions and marine fossils.

7 Limestone; contains marine fossils.

6 Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.

5 Coal; locally contains clay or shale partings.

4 Underclay, mostly medium to light gray but dark gray at top; upper part noncalcareous, lower part calcareous.

3 Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.

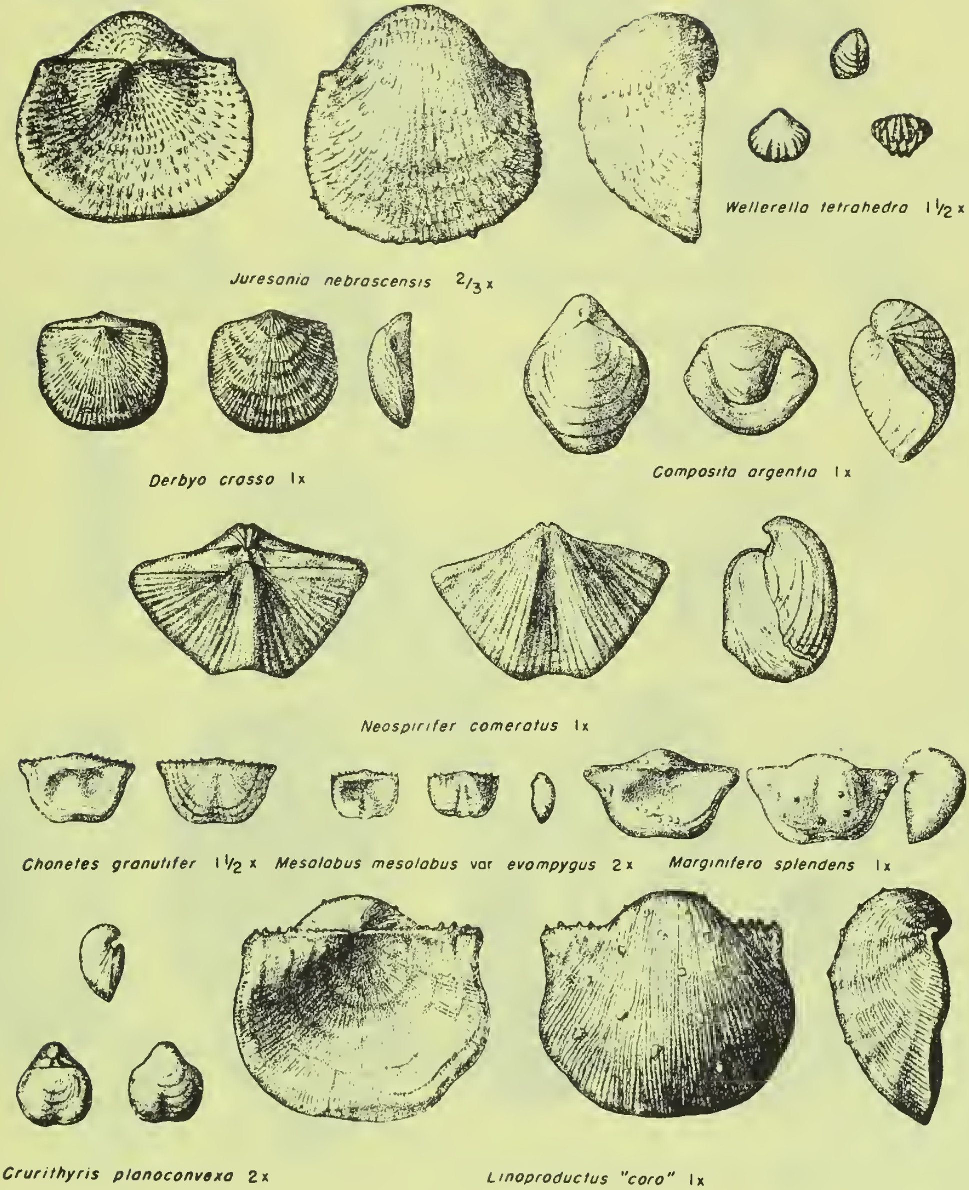
2 Shale, gray, sandy.

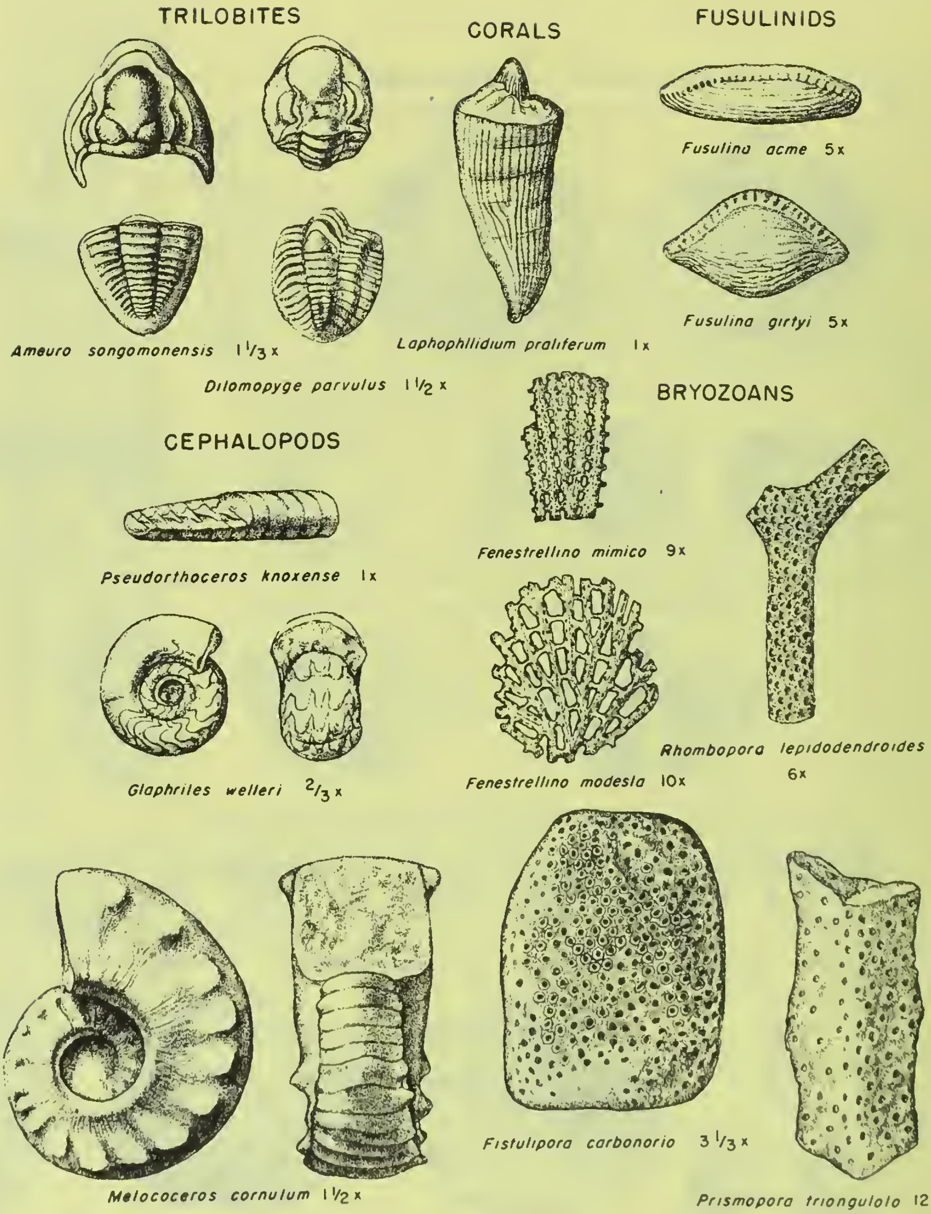
1 Sandstone, fine grained, micaceous, and siltstone, argillaceous; varies from massive to thin bedded; usually has an uneven lower surface.

AN IDEALLY COMPLETE CYCLOTHEM

(Reprinted from Fig. 42, Bulletin No. 66, Geology and Mineral Resources of the Marseilles, Ottawa, and Streator Quadrangles, by H. B. Willman and J. Norman Payne)

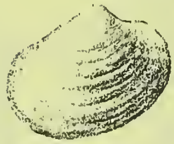
BRACHIOPODS




TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5 x
Fusulina girtyi 5 x
Ameura sangamonensis 1 1/3 x
Lophophyllidium proliferum 1 x
Ditomopyge parvulus 1 1/2 x
BRYOZOANS
CEPHALOPODS
Fenestrellina mimica 9 x
Pseudorthoceras knoxense 1 x
Rhombopora lepidodendroides 6 x
Glaphrites welleri 2/3 x
Fenestrellina modesta 10 x
Fistulipora carbonaria 3 1/3 x
Metacoceras cornutum 1 1/2 x
Prismopora triangulata 12 x

PELECYPODS

Nucula (Nuculopsis) girtyi 1x



Edmonia ovata 2x

Astartella concentrica 1x

Dunbarella knighti 1½x

Cardiomorpha missouriensis "Type A" 1x

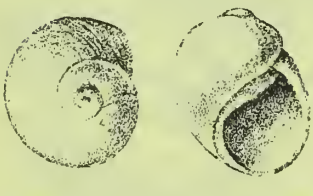
Cardiomorpha missouriensis "Type B" 1½x

GASTROPODS

Euphemites carbonarius 1½x

Trepospira illinoisensis 1½x

Donaldina robusta 8x



Naticopsis (Jedria) ventricosa 1½x

Trepospira sphaerulata 1x

Knightites montfortianus 2x

Glabrocingulum (Glabrocingulum) grayvillense 3x

FOSSIL PLANTS, FRANCIS CREEK SHALE

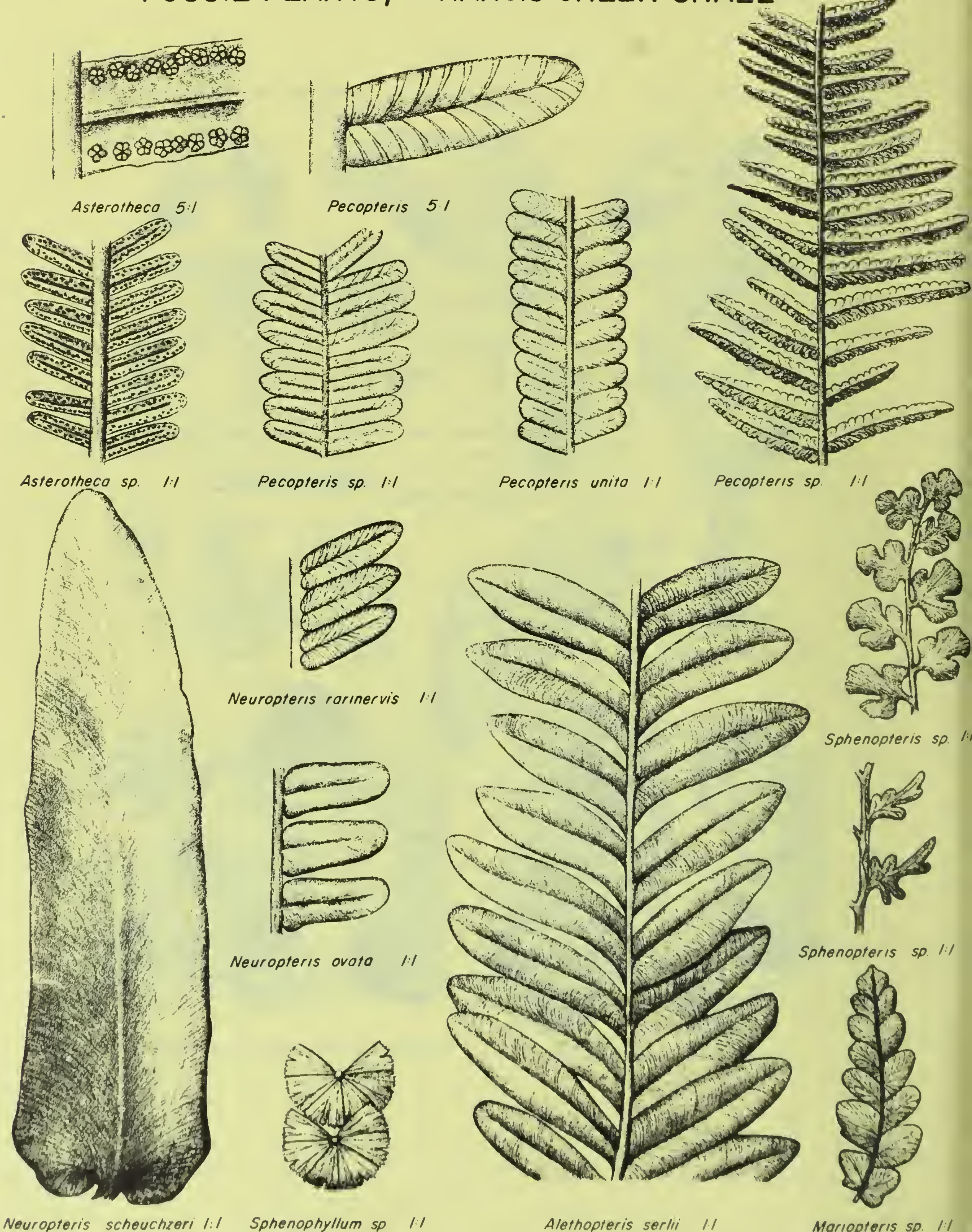


PLATE 3
(corrected)

MISSISSIPPIAN DEPOSITION

(The following quotation is from Report of Investigations 216: Classification of Genevievian and Chesterian...Rocks of Illinois [1965] by D. H. Swann, pp. 11-16. One figure and short sections of the text are omitted.)

During the Mississippian Period, the Illinois Basin was a slowly subsiding region with a vague north-south structural axis. It was flanked by structurally neutral regions to the east and west, corresponding to the present Cincinnati and Ozark Arches. These neighboring elements contributed insignificant amounts of sediment to the basin. Instead, the basin was filled by locally precipitated carbonate and by mud and sand eroded from highland areas far to the northeast in the eastern part of the Canadian Shield and perhaps the northeastward extension of the Appalachians. This sediment was brought to the Illinois region by a major river system, which it will be convenient to call the Michigan River (fig. 4) because it crossed the present state of Michigan from north to south or northeast to southwest....

The Michigan River delivered much sediment to the Illinois region during early Mississippian time. However, an advance of the sea midway in the Mississippian Period prevented sand and mud from reaching the area during deposition of the St. Louis Limestone. Genevievian time began with the lowering of sea level and the alternating deposition of shallow-water carbonate and clastic units in a pattern that persisted throughout the rest of the Mississippian. About a fourth of the fill of the basin during the late Mississippian was carbonate, another fourth was sand, and the remainder was mud carried down by the Michigan River.

Thickness, facies, and crossbedding...indicate the existence of a regional slope to the southwest, perpendicular to the prevailing north 65° west trend of the shorelines. The Illinois Basin, although developing structurally during this time, was not an embayment of the interior sea. Indeed, the mouth of the Michigan River generally extended out into the sea as a bird-foot delta, and the shoreline across the basin area may have been convex more often than concave.

....The shoreline was not static. Its position oscillated through a range of perhaps 600 to 1000 or more miles. At times it was so far south that land conditions existed throughout the present area of the Illinois Basin. At other times it was so far north that there is no suggestion of near-shore environment in the sediments still preserved. This migration of the shoreline and of the accompanying sedimentation belts determined the composition and position of Genevievian and Chesterian rock bodies.

Lateral shifts in the course of the Michigan River also influenced the placement of the rock bodies. At times the river brought its load of sediment to the eastern edge of the basin, at times to the center, and at times to the western edge. This lateral shifting occurred within a range of about 200 miles. The Cincinnati and Ozark areas did not themselves provide sediments, but, rather, the Michigan River tended to avoid those relatively positive areas in favor of the down-warped basin axis.

Sedimentation belts during this time were not symmetrical with respect to the mouth of the Michigan River. They were distorted by the position of the river relative to the Ozark and Cincinnati shoal areas, but of greater importance was sea current or drift to the northwest. This carried off most of the mud contributed by the river, narrowing the shale belt east of the river mouth and broadening it west of the mouth. Facies and isopach maps of individual units show several times as much shale west of the locus of sand deposition as east of it. The facies maps of the entire Chesterian...show maximum sandstone deposition in a northeast-southwest belt that bisects the basin. The total thickness of limestone is greatest along the southern border of the basin and is relatively constant along that entire border. The proportion of limestone, however, is much higher at the eastern end than along the rest of the southern border, because little mud was carried southeastward against the prevailing sea current. Instead, the mud was carried to the northwest and the highest proportion of shale is found in the northwestern part of the basin.

Genevievian and Chesterian seas generally extended from the Illinois Basin eastward across the Cincinnati Shoal area and the Appalachian Basin. Little terrigeneous sediment reached the Cincinnati Shoal area from either the west or the east, and the section consists of thin limestone units representing all or most of the major cycles. The proportion of inorganically precipitated limestone is relatively high and the waters over the shoal area were commonly hypersaline... Erosion of the shoal area at times is indicated by the presence of conodonts eroded from the St. Louis Limestone and redeposited in the lower part of the Gasper Limestone at the southeast corner of the Illinois Basin...

The shoal area included regions somewhat east of the present Cincinnati axis and extended from Ohio, and probably southeastern Indiana, through central and east-central Kentucky and Tennessee into Alabama....

Toward the west, the seaway was commonly continuous between the Illinois Basin and central Iowa, although only the record of Genevievian and earliest Chesterian is still preserved. The seas generally extended from the Illinois and Black Warrior regions into the Arkansas Valley region, and the presence of Chesterian outliers high in the Ozarks indicates that at times the Ozark area was covered. Although the sea was continuous into the Ouachita region, detailed correlation of the Illinois sediments with the geosynclinal deposits of this area is difficult.

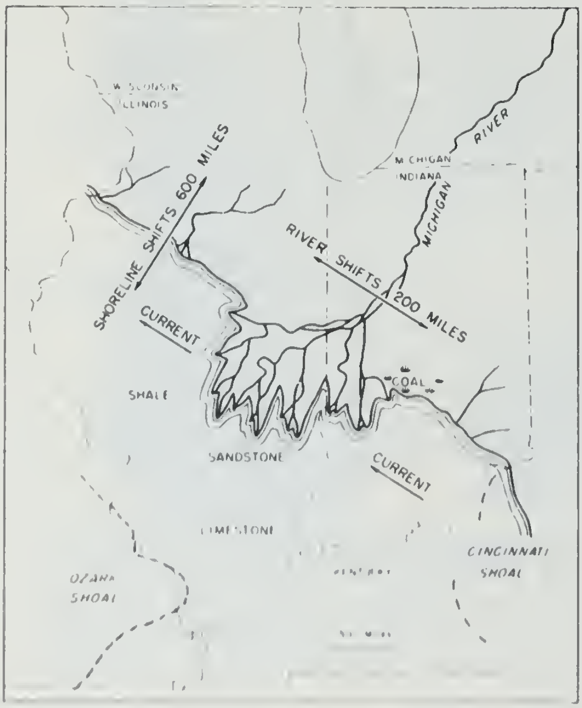
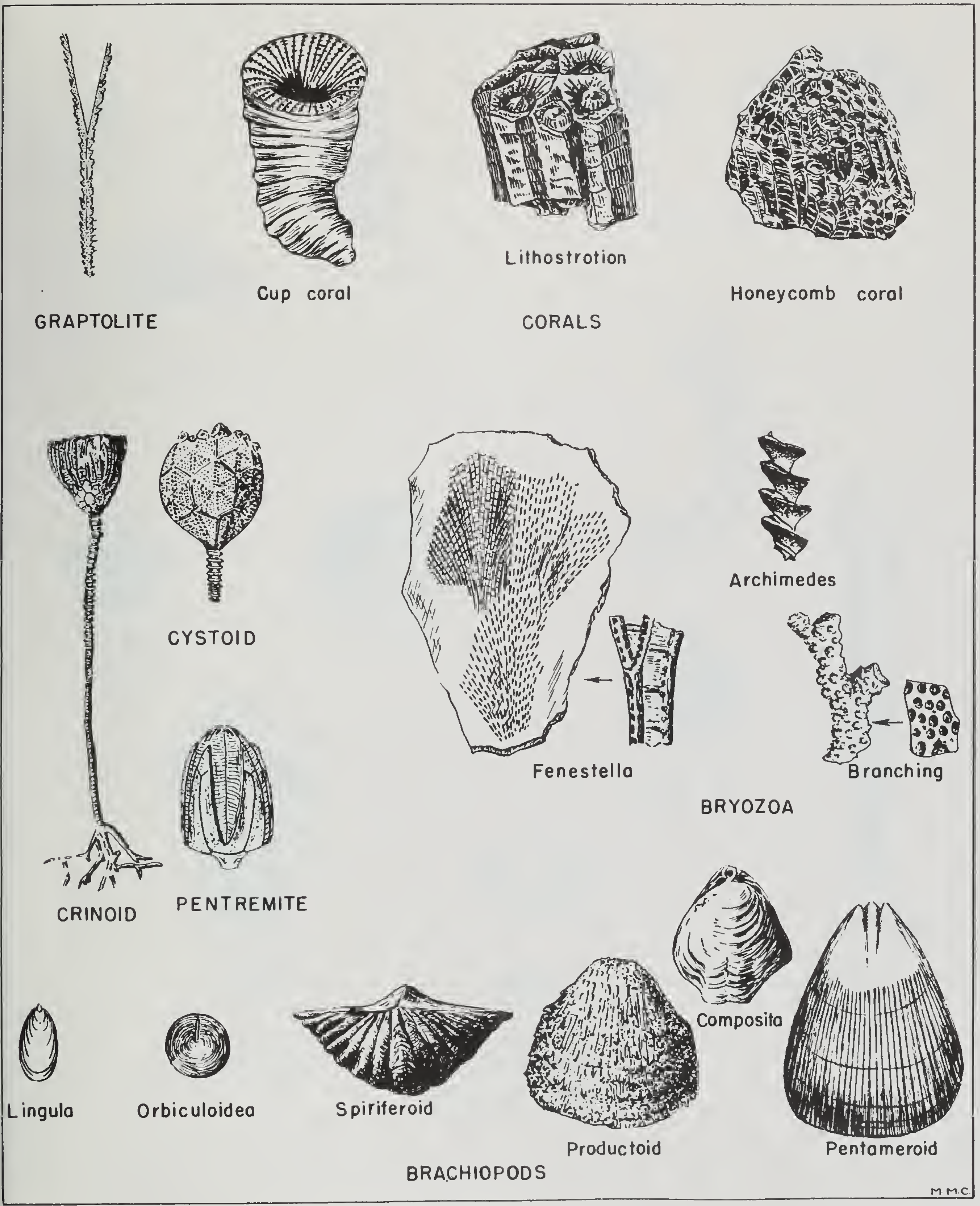
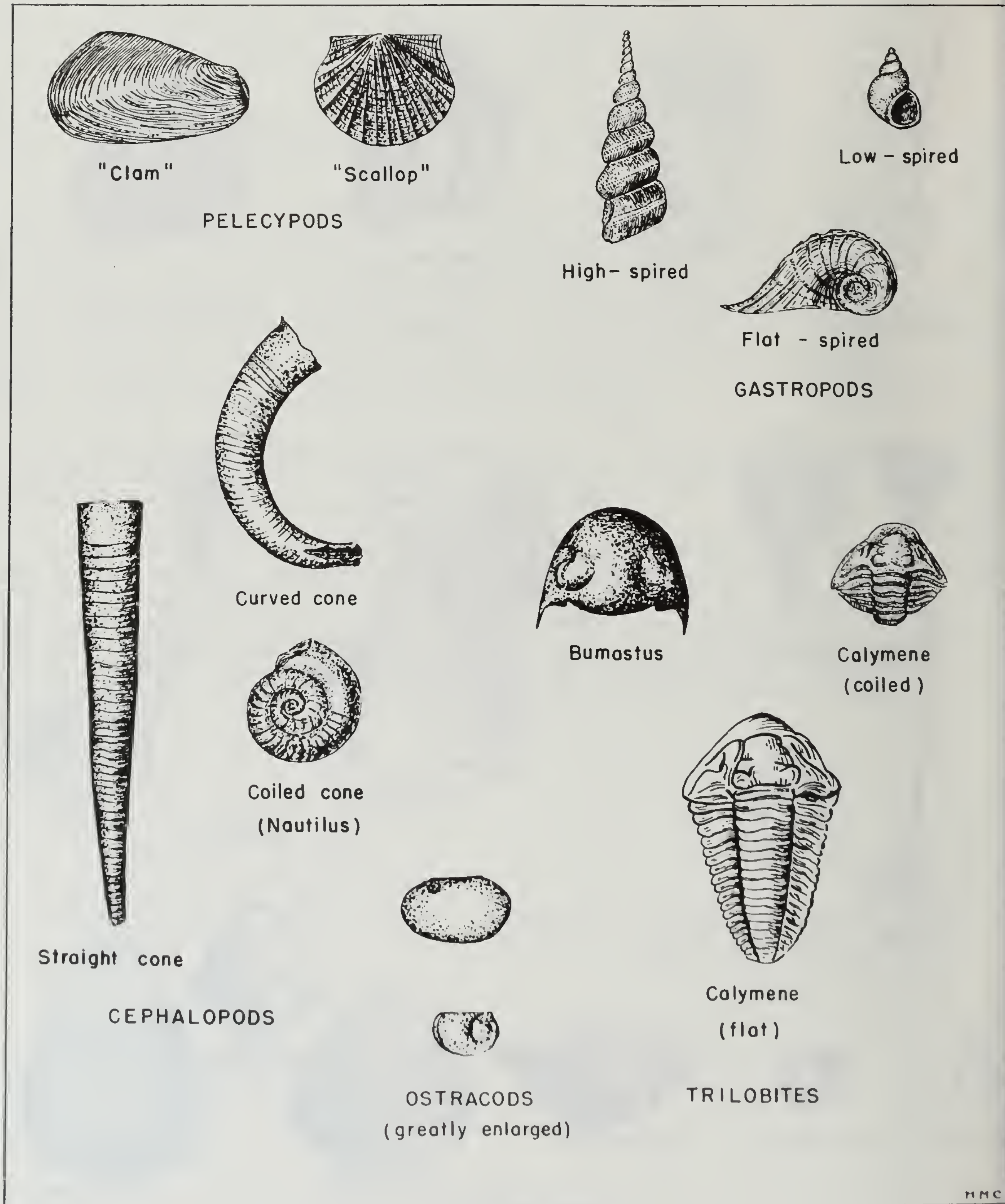


Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.

COMMON TYPES of ILLINOIS FOSSILS



COMMON TYPES of ILLINOIS FOSSILS



START
LUNCH
1
2
3
4
5
6
7
8
9
10
11
12
13
GRAND TOWER
POMONA
HOWARDTON
ALDRIDGE
WOLF LAKE
WARE
BERRYVIL
GRAND TOWER ISLAND
MISSISSIPPI RIVER
MISSISSIPPI
PERRY COUNTY
PINE HILLS RECREATION AREA
ALTO PASS
POP 304
BALD KNOB
TRAIL OF TEARS STATE FOREST
S I U WILDLIFE RESEARCH BLDG
MISSOURI PACIFIC
BIG MUDDY
0
1
2 mi
0
1
2
3 km