Guide to the Geology of the Mt. Vernon Area, Jefferson County

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Field Trip Guide Leaflet 1989D November 4, 1989
Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Champaign, IL 61820

Cover photo: Geological Science Field Trip participants at the Nuxall Sand Pit northeast of Mt. Vernon.

Printed by authority of the State of Illinois/1989/300

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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 more Illinois counties; 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 or guardian. High school science classes should be supervised by at least one adult for every 10 students. A list of available guide leaflets for earlier trips, which can be used for planning class tours and private outings, may be obtained by contacting the Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820. (217) 244-2407 or 333-7372.

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GEOLOGIC FRAMEWORK OF THE MT. VERNON AREA

Location

The area of the Mt. Vernon geological science field trip lies within Jefferson County, which is slightly north of the center of southern Illinois. A nerve center of the state's oil industry, this area is about 280 miles south-southwest of Chicago, nearly 80 miles southeast of St. Louis, and about 100 miles north-northeast of Cairo.

Bedrock

The geology of the Jefferson County area has undergone many changes through hundreds of millions of years. The ancient Precambrian basement, composed of granitic igneous and possibly metamorphic, crystalline rocks more than a billion years old, underwent deep erosion when it was exposed at the earth's surface more than 500 million years ago. That erosion formed a landscape similar to that of parts of the present-day Missouri Ozarks. In southernmost Illinois, near what is now the Kentucky-Illinois Fluorspar Mining District, evidence from surface mapping, seismic exploration for oil, and measurements of the earth's gravitational and magnetic fields indicates that rift valleys like those in present-day east Africa formed during a period when plate tectonic movements were beginning to rip apart the early North American continent. These rift valleys, now referred to as the Rough Creek Graben and the Reelfoot Rift, filled with sands and gravels shed from the adjacent uplands and with sediments deposited in lakes that formed along the valley floors.

Near the begining of the Paleozoic Era, 525 million years ago, the rifting stopped, and the hilly Precambrian landscape began to slowly sink on a broad, regional scale. This permitted the invasion of a shallow sea from the south and southwest. During the several hundred million years of the Paleozoic Era, the area that is now southern Illinois continued to sink periodically, allowing shallow seas to ebb and flood across it. At times, however, the seas withdrew, and the sediments they had deposited were subjected to weathering and erosion. As a result, there are some gaps in the sedimentary record. By the end of the Paleozoic Era about 250 million years ago, at least 15,000 feet of sedimentary strata had accumulated (figs. 1 and 2). These strata range from about 523 million years old, the Cambrian Period of the Paleozoic Era, to 288 million years old, the Pennsylvanian Period. Based on evidence from outcrops and drill holes elsewhere in Illinois, younger rocks of latest Pennsylvanian and perhaps Permian (the youngest Paleozic rocks) or even younger age may once have been deposited in this area. However, during the 245 million years between the close of the Paleozoic Era and the onslaught of glaciation 1 to 2 million years ago, ample time passed for the erosion of perhaps thousands of feet of strata. All traces have been erased of any post-Pennsylvanian rocks that may have been present. Indirect evidence based on the rank of coal deposits and the generation of petroleum from source rocks indicates that perhaps as much as a mile and a half of latest Pennsylvanian and younger rocks once covered southern Illinois. In Jefferson County today, Paleozoic sedimentary strata reach total thicknesses of more than 9,000 feet in the northwest and about 12,300 feet in the southeast. Rocks of the Ordovician, Devonian, Mississippian, and Pennsylvanian Periods have been successfully tapped for their petroleum resources in Jefferson County.

In Jefferson County, the bedrock strata of Pennsylvanian age that occur immediately beneath the cover of glacial till consist of sandstone, siltstone, shale, limestone, coal, and underclay

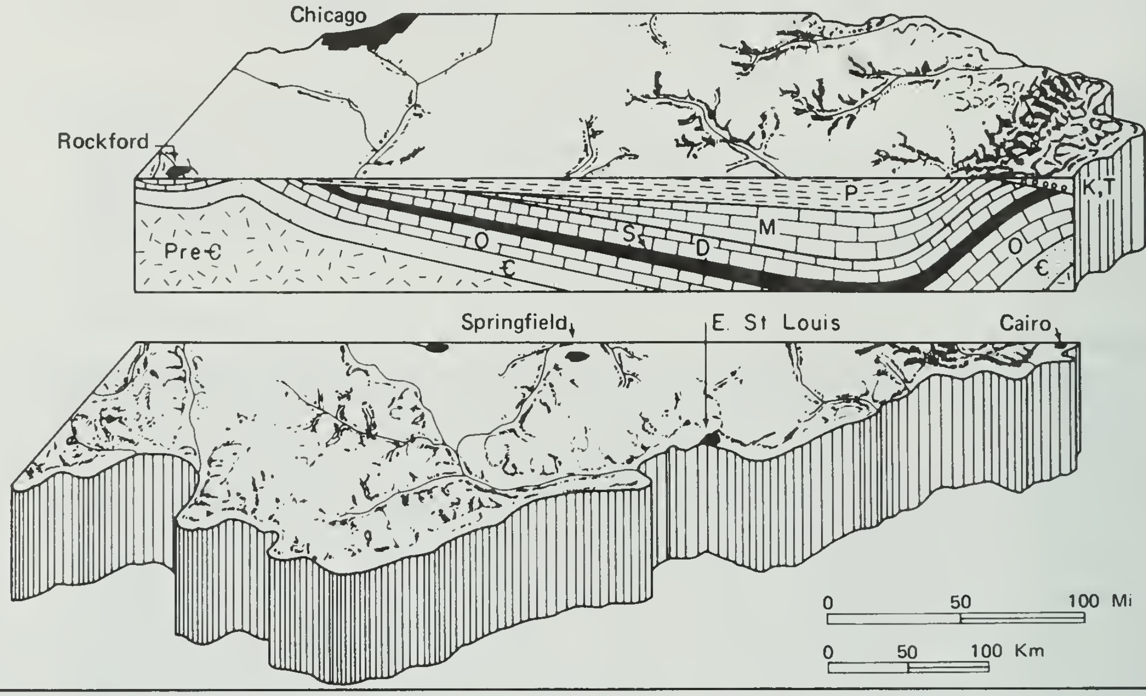


Figure 1. Stylized north-south cross section shows the structure of the Illinois Basin. The thickness of the sedimentary rocks has been greatly exaggerated to show detail, and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-C) granites. They form 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). Scale is approximate.

that were deposited in shallow seas and swamps between about 320 and 288 million years ago. Some of these rocks are exposed in scattered road- and stream-cuts. Oil fields that produce from Pennsylvanian-age sandstones have been developed in the northwestern part of the county. The total thickness of Pennsylvanian strata increases from slightly less than 1200 feet in northwestern Jefferson County to approximately 2000 feet in the southeastern corner. A description of these rocks and how they formed may be found at the back of this guide leaflet in *Depositional History of the Pennsylvanian Rocks.*

Structural and Depositional History

Near the close of the Mississippian Period (320 million years ago), gentle arching of the bedrock in eastern Illinois initiated the development of the La Salle Anticlinal Belt (fig. 3). An anticline is a geologic term for a buried hill or dome in which the rock layers have been bent into an arch. The La Salle Anticlinal Belt is a complex structure with smaller structures such as domes, anticlines, and synclines superimposed on the broad upwarp of the belt. This gradual arching continued through Pennsylvanian time. Because the youngest Pennsylvanian strata are absent from the area of the anticlinal belt because of nondeposition or erosion, we cannot know just when movement along the belt ceased—perhaps by the end of the Pennsylvanian or a little later, near the close of the Paleozoic Era during the Permian Period.

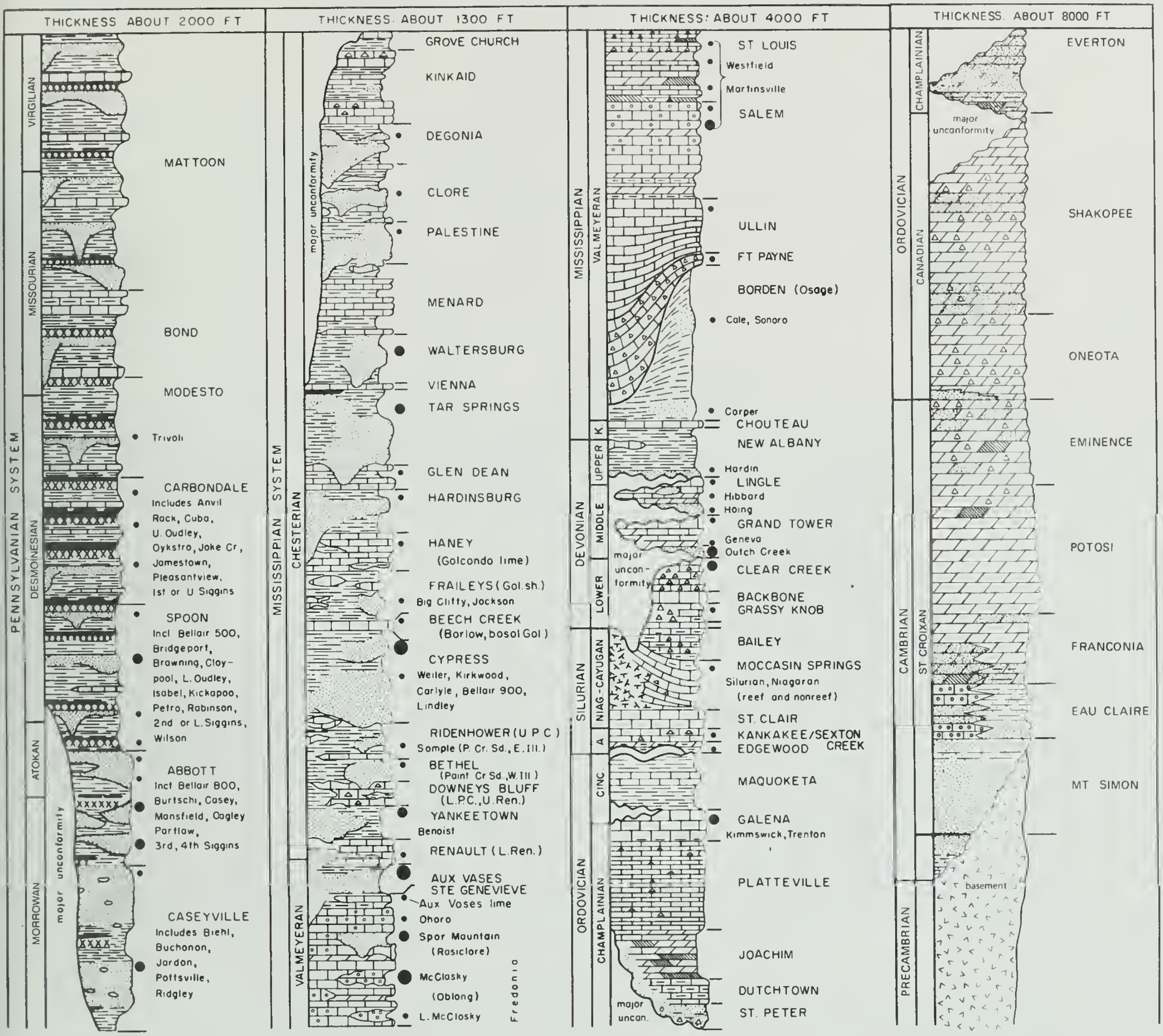


Figure 2. Generalized geologic column of southern Illinois. Black dots indicate oil and gas pay zones. Formation names are in capitals; other pay zones are not. About 4000 feet of lower Ordovician and upper Cambrian rocks under the St. Peter are not shown. Kinderhookian (K), Niagaran (Niag.). Alexandrian (A), and Cincinnatian (Cinc.). Series are abbreviated. Variable vertical scale. Originally prepared by David H. Swann. Modified from Illinois Geological Survey Illinois Petroleum 75.

Following the Paleozoic Era, during the Mesozoic Era, the rise of the Pascola Arch (fig. 4) in southeastern Missouri and western Tennessee separated the Illinois Basin from other basins to the south. The Illinois Basin is a broad downwarp covering much of Illinois, Southern Indiana, and Western Kentucky (fig.1). Development of the Pasocla Arch in conjunction with the earlier sinking of deeper parts of the Illinois Basin, gave the Illinois Basin its present asymmetrical, spoon-shaped configuration.

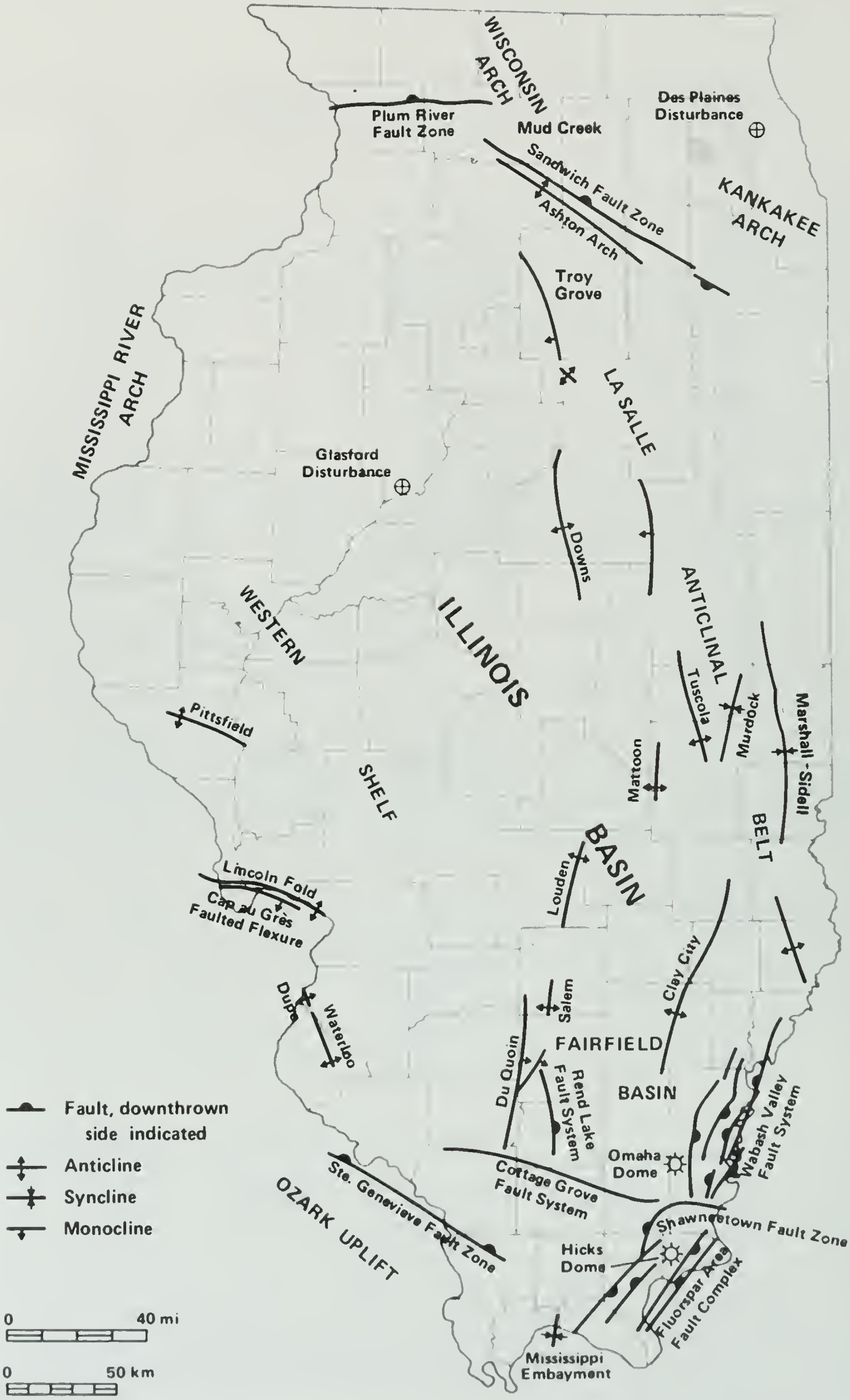


Figure 3. Major geologic structures of Illinois, compiled by Janis D. Treworgy, Dec. 1979.

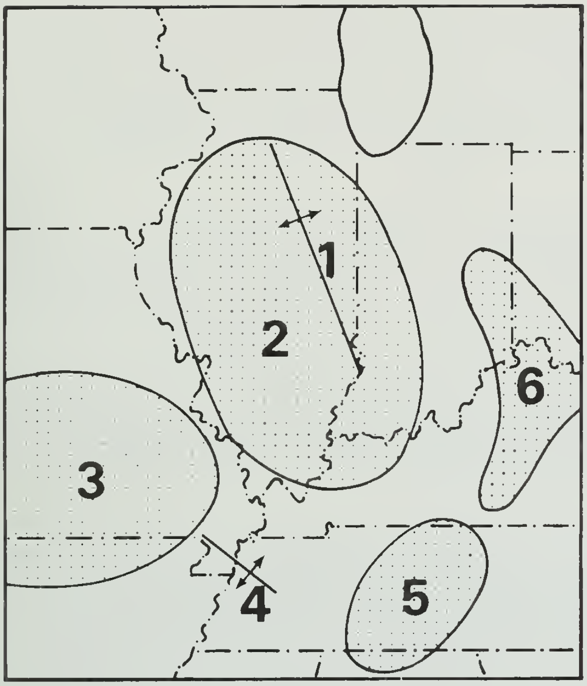


Figure 4. The location of some of the major structures in the Illinois region: (1) La Salle Anticlinal Belt, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, and (6) Cincinnati Arch.

The Mt. Vernon field trip area is located in the southwestern part of the Illinois Basin. Smaller subsidiary structures, such as the Fairfield Basin, were superimposed on the larger basin structure at various times during the geologic past. Jefferson County is in the southwestern part of the Fairfield Basin, which is bounded by the La Salle Anticlinal Belt on the northeast, the Du Quoin Monocline on the west, and the Cottage Grove Fault System on the south (fig. 3). The Du Quoin Monocline bifurcates (splits into two arms) in neighboring Perry County, and the eastern arm of this fold extends into Jefferson County, where it merges with the eastern flank of the Salem Anticline. Because tilting of the bedrock layers took place several times during the Paleozoic Era, the dips of successive strata are not parallel to one another.

The field trip route crosses the northern part of the Rend Lake Fault System, which is not known to be exposed at ground surface. This fault system has been studied and mapped extensively by Illinois State Geological Survey (ISGS) geologists (Keys and Nelson, 1980) working in nearby underground coal mines. The complex Rend Lake Fault System consists of a master fault that trends east-west and a large number of short, overlapping or staggered, oblique ("en echelon") northwest-trending faults. Most of the faults are normal faults, although other fault types have been encountered, such as high-angle reverse faults (fig. 5). The maximum displacement that has been noted is 55 feet. A few of the faults are several miles long, but most are much shorter. The age of this faulting is difficult to determine because younger rocks that might have been affected by the faults no longer exist. The evidence noted in the mines indicates that the faults are Pennsylvanian or younger, because the Pennsylvanian rocks in the mines are affected. The faulting must also be older than the Pleistocene (2 or 3 million years ago) because no glacial deposits appear to have been affected.

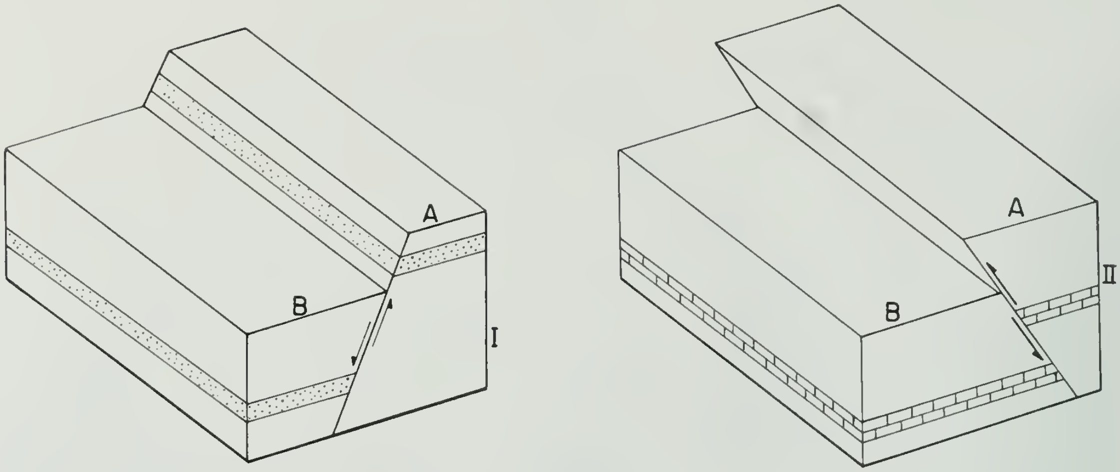


Figure 5. Vertical cross sections: I - a normal fault; II - a reverse fault; a = hanging wall; b = foot wall; arrows indicate the relative direction of movement of one block to another across the fault plane.

Glacial History

Beginning about 1.6 million years ago, during the Pleistocene Epoch, continental glaciers—massive sheets of ice thousands of feet thick—flowed slowly southward from Canada. The last of these glaciers melted from northeastern Illinois about 13,500 years before the present (B.P.). Mt. Vernon lies about 75 miles south of the late Wisconsinan Shelbyville Moraine, the earliest moraine of the Woodfordian Substage that was deposited about 22,000 years B.P. A brief general history of glaciation in North America and a description of moraines and other deposits commonly left by glaciers can be found in *Pleistocene Glaciations in Illinois* at the back of the guide leaflet.

Although ice sheets covered Illinois several times during the Pleistocene Epoch, North American continental glaciers reached their southernmost extent during the Illinoian glaciation, about 270,000 years B.P. From centers of snow and ice accumulation in Canada, they advanced as far south as the northern part of Johnson County, about 50 miles south of the field trip area. Although Illinoian glaciers probably created morainic ridges similar to those of the later Wisconsinan glaciers, we can find little evidence of them in the topography today. Illinoian moraines apparently were not so numerous and have been exposed to weathering and erosion for thousands of years longer than their younger Wisconsinan counterparts.

The topography of the bedrock surface throughout much of Illinois is largely hidden by glacial deposits except along major streams. In many areas the underlying bedrock surface is completely masked by a thick layer of glacial drift (material carried and deposited by glaciers). Studies of mine shafts, water-well logs, and other drill-hole information, coupled with scattered bedrock exposures in some stream valleys and roadcuts, indicate that the present land surface of the field trip area is largely a reflection of the underlying bedrock surface. The preglacial bedrock surface, only slightly modified by glacial erosion, has been subdued by a thin mantle of glacial drift.

Glacial drift is unevenly distributed across Jefferson County, partly because of the irregular bedrock surface and partly because of erosion. The drift filling the bedrock valley of the Big

Muddy River is somewhat more than 50 feet thick, but the uplands generally have less than 25 feet of drift.

A thin cover, 4 feet thick or less, of wind-blown silt called Peoria Loess (pronounced "luss") mantles the glacial drift in Jefferson County. This fine-grained dust, which covers most of Illinois outside the area of Wisconsinan glaciation, reaches thicknesses exceeding 15 feet near the Mississippi and Illinois Rivers. Soils in this area have developed in the loess and the underlying weathered, silty, clayey Illinoian till.

Drainage
In the Mt. Vernon area, erosion that took place long before the glaciers advanced across the state left a network of deep valleys carved into the bedrock surface. A drainage divide trending south-southeast extends from about the center of the county's northern boundary line to the county's southeast corner. Preglacial drainage northeast of the divide was through the now-buried bedrock Skillet Fork to the buried Wabash River. Drainage to the west of the divide flowed through the buried Big Muddy River to the buried lower Mississippi River. A small area in the northwest part of the county drained north and west to the buried Kaskaskia River.

The present-day drainage system is relatively complete with most streams having broad, terraced valleys and low gradients (bottom slopes). The uplands generally have good natural drainage, but the larger valley bottoms are poorly drained. Coal Bank Creek and several other small streams are tributaries to Horse Creek, which drains the northeastern part of the field trip area eastward to the Wabash River via Skillet Fork. Casey Fork and Sevenmile Creek and their tributaries drain the area east of Mt. Vernon southward to the Big Muddy River. The Big Muddy and Rayse Creek along with their tributaries drain the area west and south of Mt. Vernon southwestward to the Mississippi River. The larger streams are sluggish and occupy preglacial bedrock valleys for the most part.

Relief
The highest land surface along the field trip route is about one mile west of the last stop. The surface elevation here is slightly more than 620 feet above mean sea level (msl). The lowest elevation, about 405 feet msl, occurs on the Big Muddy River east of Waltonville. Therefore, the surface relief of the field trip area, calculated as the difference between the highest and lowest surfaces, is about 215 feet. Along Casey Fork northeast of Mt. Vernon relief is most pronounced, about 50 feet.

Physiography
The field trip area is in the western part of the Mt. Vernon Hill Country, the southernmost Illinois division of the Till Plains Section, Central Lowland Province (fig. 6). The Mt. Vernon Hill Country has a mature (mostly slopes) topography of low relief with limited upland prairies and broad alluviated (filled) valleys along the larger streams. With one or two exceptions in the northwest part of the region, glacial landforms (such as moraines and eskers) are essentially lacking. No pre-Illinoian drift deposits are known to be in the field trip area. Prior to glaciation, an extensive lowland called the "central Illinois peneplain" had been eroded into the relatively weak, Pennsylvania-age rocks south and east of the present-day Illinois River (Horberg, 1946, and Leighton, Ekblaw, and Horberg, 1948). The surface appears to have been of low relief, gently sloping from about 600 feet in the northern part of Jefferson County to about 550 feet or less in the southern part.

Figure 6. Physiographic divisions of Illinois.

By the time glaciation began about 1.6 million years ago, an extensive system of bedrock valleys was deeply entrenched in the central lowland surface. The predominant features of the Till Plains Section, including local features of the Mt. Vernon Hill Country, are determined largely by this preglacial topography. As glaciation began, streams probably stopped eroding their beds. When the ice melted, huge amounts of sediment were liberated from the front of the glaciers. This sediment began to fill in the channels of the streams, which did not have sufficient volumes of water to carry it away. These early sediments apparently were never completely flushed out of the stream channels by succeeding torrents of meltwater during later deglaciation.

MINERAL PRODUCTION

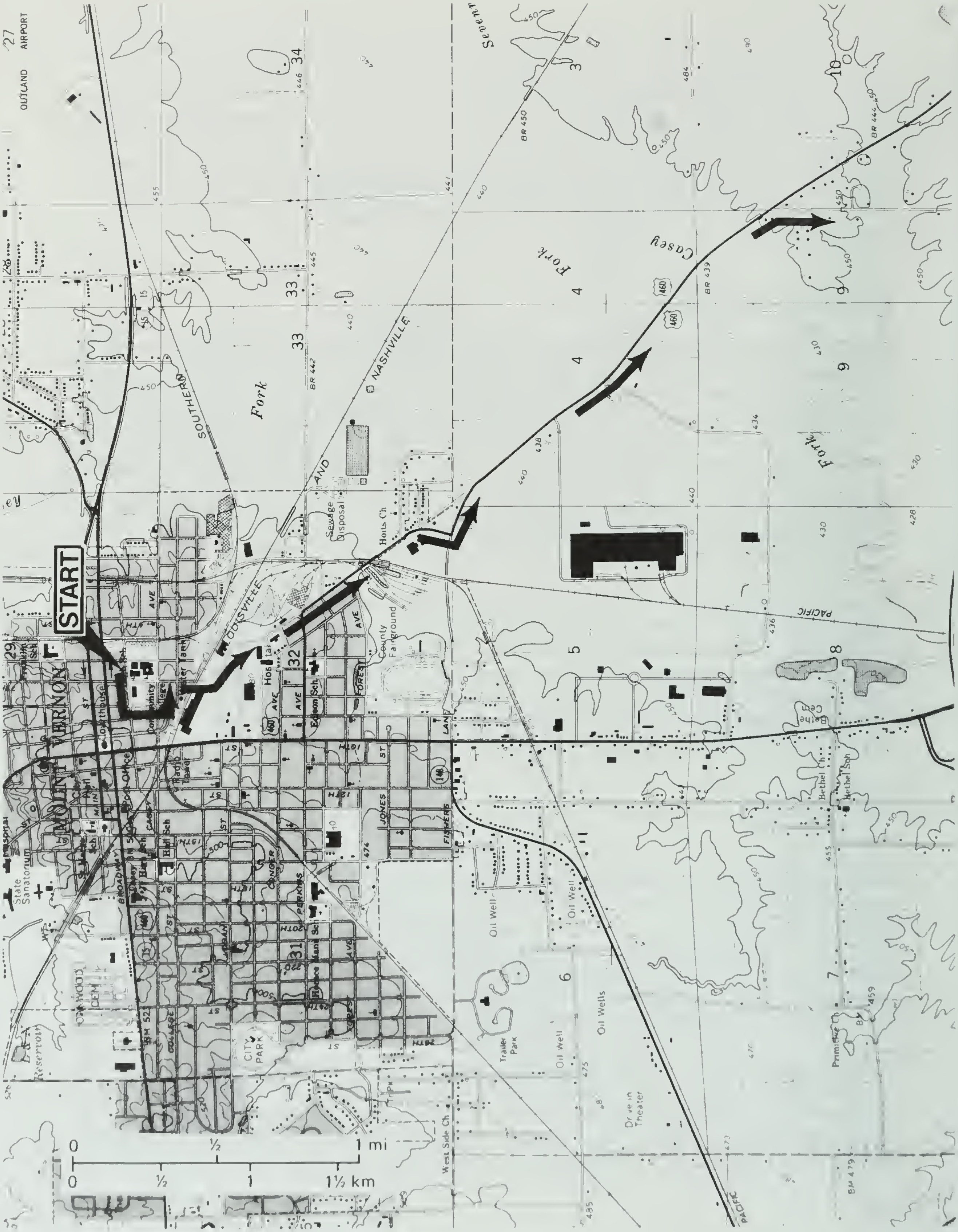
In 1987, the last year for which figures are available, Jefferson County ranked fifth among all Illinois counties in the total value of minerals produced. The ranking results from the county's production of coal and oil and gas, which together amounted to more than $123 million. Two underground mines produced more than 3.4 million tons of coal valued at more than $101.2 million. The cumulative total of coal production reported for 1833 through 1987 amounts to 145,640,008 tons, of which 5,353,358 tons was from surface-mining operations. Oil and gas production in Jefferson County accounted for 5.2 percent of the 1987 total for Illinois, a decline of 0.3 percent from 1986. Oil production amounted to 1,265,000 barrels of oil valued at $22,130,000. The cumulative reported total oil production from 1888 through 1987 amounts to 93,889,000 barrels.

Jefferson County is one of 99 counties in Illinois (out of 102) that reported mineral production in 1987. The total value of all minerals extracted, processed, and manufactured in Illinois during 1987 was $3,226,200,000, a decline of nearly $42 million from the previous year and the lowest recorded total value since 1978. In Illinois, coal continued to be the leading commodity, followed by oil, stone, sand and gravel, and clays. Illinois dropped from sixteenth to seventeenth among the 50 states in total production of nonfuel minerals but continues to lead all other states in production of fluorspar, industrial sand, and tripoli.

GROUNDWATER

Groundwater is a mineral resource frequently overlooked in assessing an area's natural resource potential. The availability of water is essential for orderly economic and community development. More than 48 percent of the state's 11 million citizens depend on groundwater for their water supply. Groundwater is derived from underground formations called aquifers. An aquifer is a body of rock that contains enough water-bearing porous and permeable materials to release usable quantities of water into an open well or spring. The water-yielding capacity of an aquifer can only be evaluated through well tests. Wells are pumped to determine the quality and quantity of groundwater available for use.

Because glacial deposits are thin throughout Jefferson County, deposits of water-yielding sand and gravel also are thin, occurring mainly in the deeper parts of the Big Muddy River and its tributaries. Sandstone layers that occur in the upper part of the Pennsylvanian System of rocks may yield domestic supplies of groundwater. Where present, water-bearing sandstone occurs at depths ranging from 150 to 350 feet.


START
MOUNT VERNON
OUTLAND AIRPORT
SOUTHERN
LOUISVILLE AND NASHVILLE
PACIFIC
Fork
Casey Fork
Sewage Disposal
Hotts Ch
County Fairground
Hospital
Edison Sch
Courthouse
Post Office
Community College
Water Tank
Radio Tower
State Sanatorium
OAKWOOD CEM
CITY PARK
Trailer Park
Oil Well
Oil Wells
Drive in Theater
West Side Ch
Bethel Ch
Bethel Sch
Bethel Cem
BROADWAY
JONES ST
FISHERS LANE
0 ½ 1 mi
0 ½ 1 1½ km

GUIDE TO THE ROUTE

Miles next point	Miles/ starting point	
0.0	0.0	Park your vehicle facing south on Seventh Street on the north side of Mt. Vernon High School (NE SW SE SW sec. 29, T2S, R3E, 3rd P.M., Jefferson County, Mt. Vernon 7.5-minute Quadrangle [38088C8][1]. STOP: 4-way at the intersection of Seventh and Jordan Streets. BEGIN mileage calculations here. TURN RIGHT (west) on Jordan Street.
0.05+	0.05+	STOP: 3-way at Eighth Street. TURN LEFT (south).
0.1-	0.15+	STOP: 2-way at Casey Avenue. TURN LEFT (east).
0.05+	0.25+	STOP: 4-way at Seventh Street. TURN RIGHT (south).
0.1+	0.35+	CAUTION: 3-track guarded Union Pacific (UP) and Louisville and Nashville (L&N) Railroad crossing. CONTINUE AHEAD (southerly) onto Shawnee Street.
0.15	0.55	To the left is the Precision Locomotive Works.
0.3+	0.85+	STOP: 1-way at Perkins Avenue. CONTINUE AHEAD (southerly).
0.25+	1.1+	CAUTION: 1-track unguarded UP railroad siding crossing.
0.05-	1.15+	CAUTION: 3-track guarded UP railroad crossing.
0.3+	1.45+	STOP: 1-way at Illinois Route (IL) 142. CAUTION: divided highway. TURN LEFT (easterly).
1.3+	2.8+	Cross Casey Fork and prepare to turn right.
0.25+	3.1	TURN RIGHT (south) at T-road intersection-1070N/1500E.0
0.9	4.0	Cross I-74 overpass.

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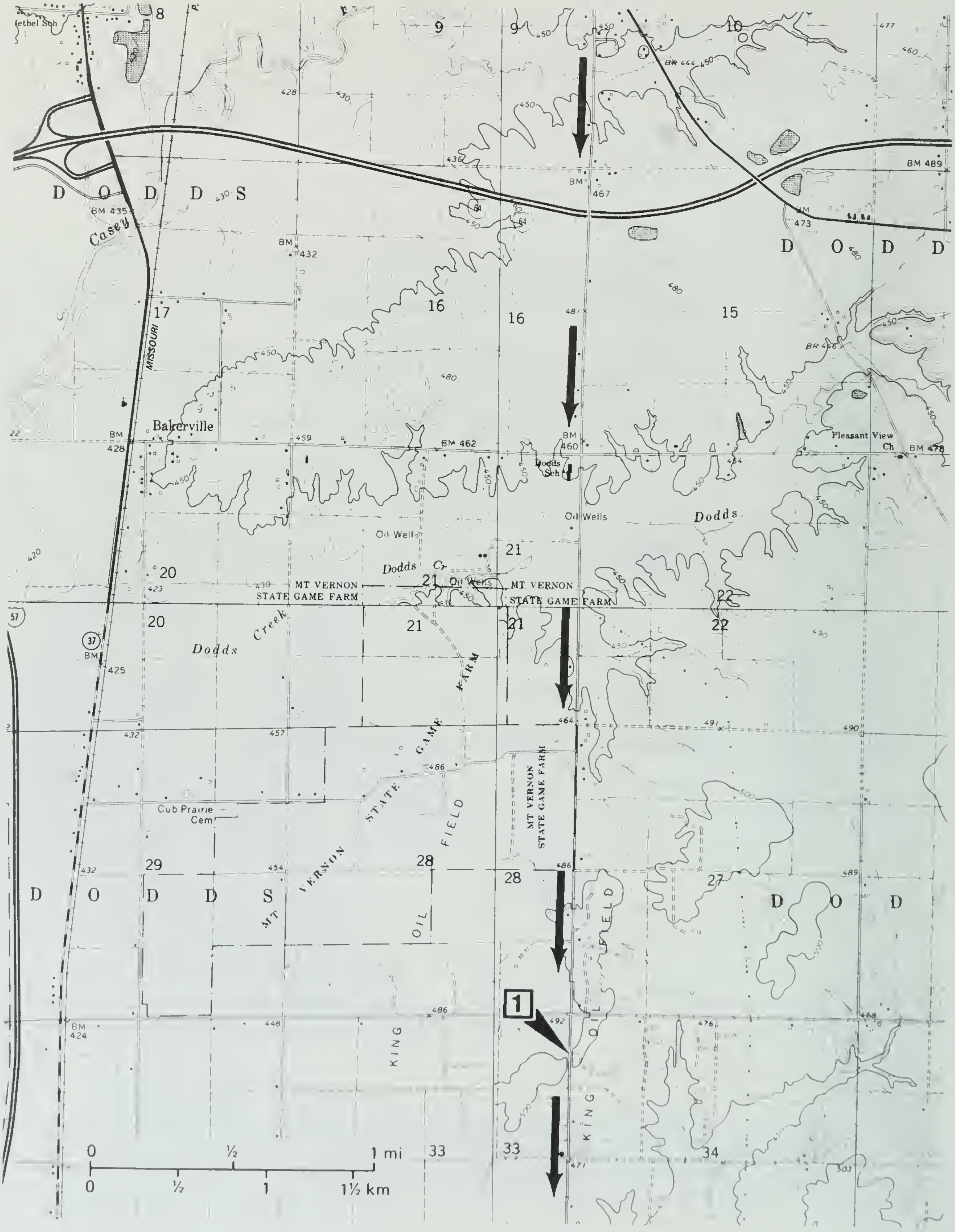
[1] The number in brackets following the topographic map name, [38088C8], is the code assigned to that map as part of the National Mapping Program. The state is divided into 1° blocks of latitude and longitude. The first pair of numbers refers to the latitude of the southeast corner of the block and the next three numbers designate the longitude. 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 column from the right.


Bakerville
Dodds Sch
Oil Wells
Oil Well
Dodds Cr
Dodds Creek
MT VERNON STATE GAME FARM
MT VERNON STATE GAME FARM
Cub Prairie Cem
Pleasant View Ch
MISSOURI
Casey
D O D D S
MT VERNON STATE GAME FARM
OIL FIELD
KING OIL FIELD
1
0 ½ 1 mi
0 ½ 1 1½ km

1.15+	5.15+	CAUTION: narrow bridge over Dodds Creek. NOTE: not all narrow bridges and culverts on the route are mentioned in the road log.
1.6+	6.8+	CAUTION: Crossroad-700N/1500E. CONTINUE AHEAD (south).
0.1+	6.9+	PARK along right road shoulder.

STOP 1. View King Oil Field tank battery and discuss oil and gas production in Jefferson County (SW NW NW NW sec. 34, T3S, R3E, 3rd P.M., Jefferson County, Spring Garden 7.5-minute Quadrangle [38088B7]).

The oil and gas industries have been important industries in Illinois since production was first established here 100 years ago. The success of early explorers encouraged additional exploration throughout the state. Annual production peaked at nearly 148 million barrels in 1940—ranking Illinois as the fourth largest oil-producing area in the world that year. Annual production has declined since then to a total of about 20 million barrels last year (fig. 7). Much of this decline is due to the difficulty in locating new oil and gas reservoirs. Nevertheless, approximately 3.3 billion barrels of oil worth more than $15 billion have been produced in Illinois thus far, and ongoing projects will add to that total.

Exploration for oil and gas in Illinois is concentrated in the southern half of the state where good oil and gas reservoirs are known to exist (fig. 8). Oil and gas are thought to have originated in organic-rich shales that were buried and, over tens of millions of years, subjected to sufficient heat and pressure to generate hydrocarbons. These hydrocarbons then slowly migrated through microscopic spaces in the rocks into more porous sandstones, limestones, and dolomites from which we pump out the oil today. Since hydrocarbons float on water, and since most porous rocks contain water or saltwater, oil and gas typically

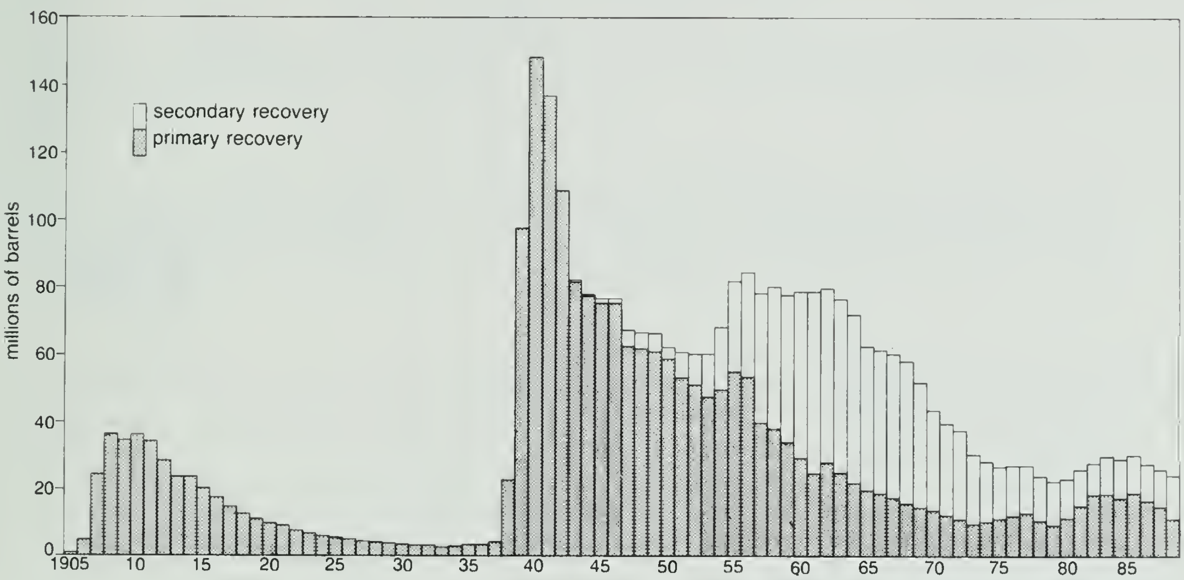


Figure 7. Annual crude oil production in Illinois, 1905-1988.

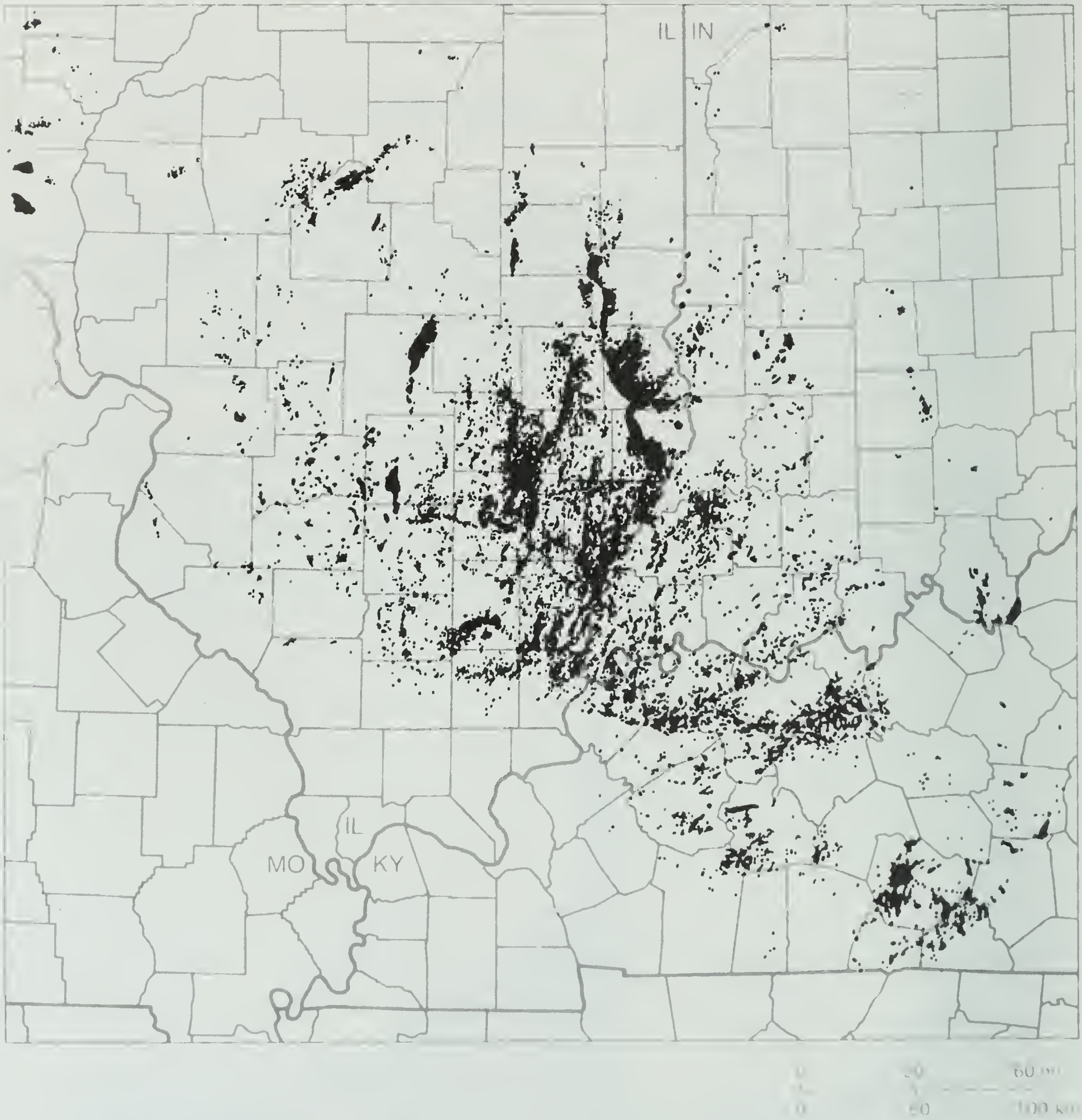


Figure 8. Oil fields of the Illinois Basin.

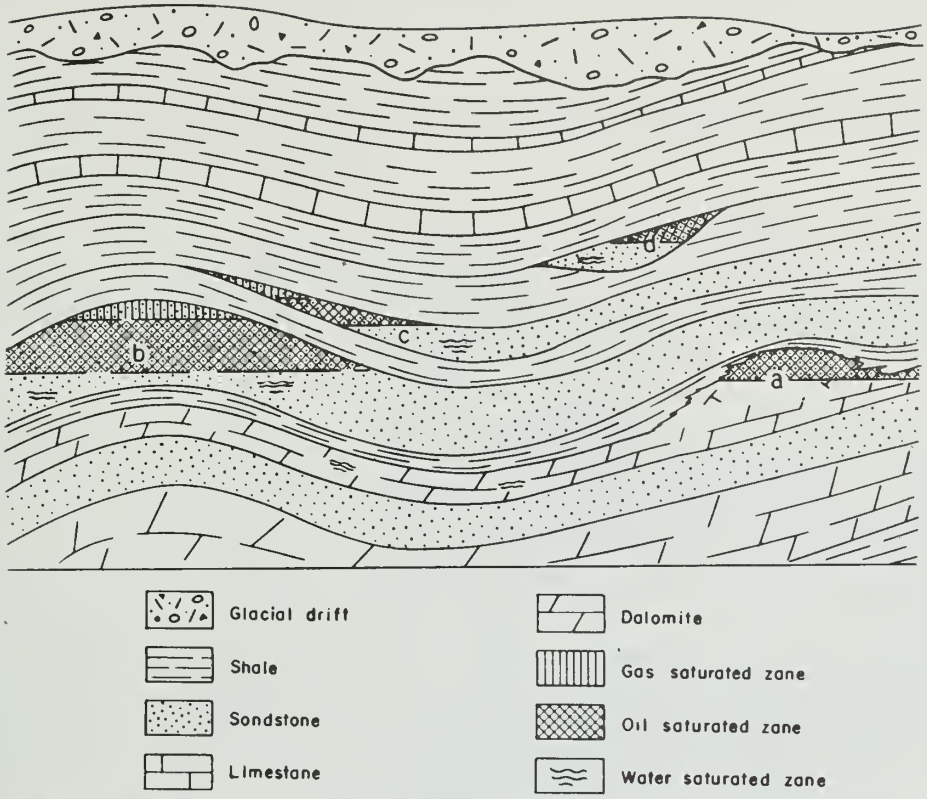


Figure 9. Places where oil is found in Illinois: (a) coral reefs, (b) anticlines, (c) pinchouts, and (d) channel sandstones.

"float" upward through the porous rocks until they reach a barrier to further migration. For this reason, oil and gas commonly are found at the highest positions of a porous rock layer, such as at the top of an anticline (a geologic term for a buried hill or dome in which the rock layers have been bent into an arch; see fig. 9).

Most of the oil and gas fields in Illinois are located on anticlines buried at depths ranging from 400 to 5400 feet below ground level. Geologists can locate these anticlines by studying rock layers that are exposed at the surface, by studying nearby wells, and by acquiring geophysical information, such as seismic data. Geophysical methods detect differences in the speeds that rock layers deep underground transmit energy waves, which are essentially sound waves.

Because small anticlines are hard to find, and because changes in rock characteristics are difficult to predict, most exploratory holes, or "wildcats," fail to find oil. Typically, the ratio of discoveries to dry holes is about 1:10 in the United States. Much research effort is being conducted in an attempt to improve this success ratio.

Once a discovery is made, additional wells are drilled nearby. If successful, they result in the development of a field. Whenever possible, the drilling of these development wells is guided by geologists' interpretations of the shape and characteristics of the reservoir rocks. These interpretations are based on data from rock samples, cores, and wireline geophysical logs from pertinent wells, and from seismic data acquired throughout the area. It is important to accurately portray as many geologic factors as possible to best develop a field because each type of reservoir has different characteristics that can affect production. For example, a sandstone deposited as a beach ridge complex may contain streaks of oil-filled porosity that

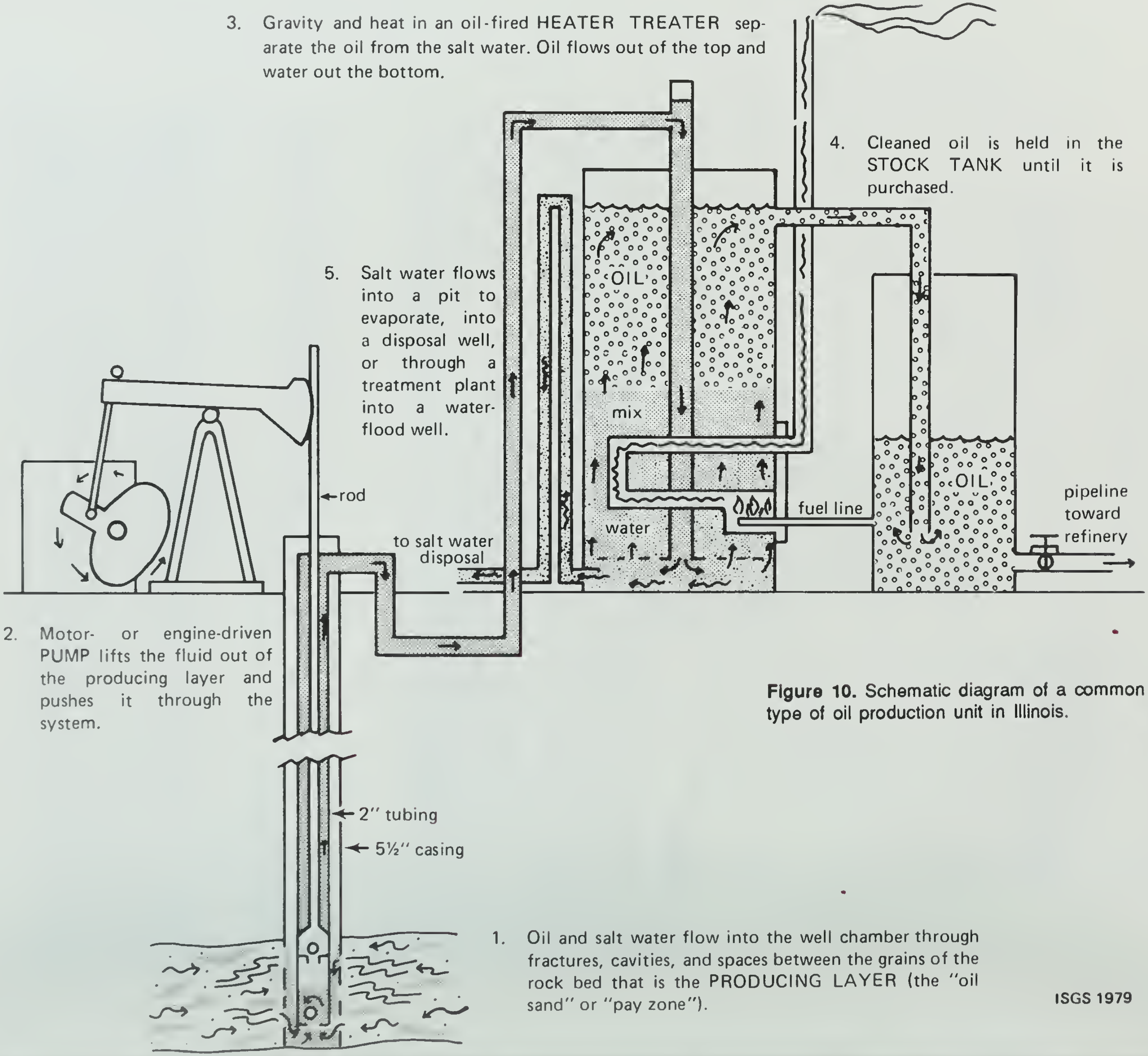


Figure 10. Schematic diagram of a common type of oil production unit in Illinois.

trend in directions quite different from the porous trends in a sandstone deposited in a tidal channel; a Silurian pinnacle reef contains porous carbonate rocks that differ markedly from carbonate rocks found in an oolite shoal.

Due to limits in technology, about 70 to 80 percent of the oil is left behind in the rocks after initial production is completed. Whenever possible, some of this remaining oil is forced out by injecting fluids, such as water, into the reservoir and pushing the oil toward producing wells. This "waterflood" method of recovery is used extensively in Illinois and typically enables about 50 percent of the original oil to be extracted (fig. 10).

Some of the most important research dealing with oil and gas resources concerns designing better methods to extract oil from reservoirs. The United States Department of Energy, in conjunction with the State of Illinois, is presently funding such research by the Oil and Gas Section at the Illinois State Geological Survey. This project, which involves staff at the Survey who are experienced in geology, engineering, and geophysics, is being conducted with cooperation from the oil industry. This multidisciplinary study will characterize key reservoirs in Illinois and will ultimately detail improved and enhanced recovery techniques. By developing better drilling, completion, and extraction methods, it should be possible to improve recovery efficiency and consequently add significantly to the state's oil reserves. In addition, improved recovery will improve the economics of exploring for oil, thus encouraging exploration. Such improvements will be welcome news to some 60,000 people whose work revolves around the petroleum industry in Illinois.

0.0	6.9+	Leave Stop 1 and CONTINUE AHEAD (south).
0.4+	7.3+	Just beyond the T-road on the left and some 300 feet east of the road is a working oil well pumpjack.
0.45+	7.8+	STOP: 1-way at T-road intersection-600N/1500E. TURN LEFT (east). CAUTION for next mile--drain tiles with unmarked ends under roadway.
1.0	8.8+	TURN RIGHT (south) on 1600E.
0.1	8.9+	PARK along right road shoulder.

STOP 2. View uplands to west and Big Muddy River Valley (ctr. E edge NE NE sec. 3, T4S, R3E, 3rd P.M., Jefferson County, Spring Garden 7.5-minute Quadrangle [38088B7]).

Because of the tree cover in this area, it is difficult to find a good view that portrays the field trip area's general topography. Remnants of the upland surface in the northern part of Jefferson County exceed elevations of slightly more than 600 feet msl. The imaginary surface constructed by connecting all of the higher elevations in the field trip area generally slopes gently southward to somewhat less than 500 feet msl through a distance of some 14 miles. The bedrock upland surface, on the other hand, slopes from slightly more than 550 feet in the north to some 470 feet in this vicinity; actually, here we are along one of the valleys that cuts into the general upland surface, and the bedrock surface is close to 440 feet msl (40 to 50 feet beneath us). The bedrock surface slopes from here southwestward

2
Round Knob Cem
Moores Prairie Ch
Water Tank
Woodall BM 446
BM 424
Bonnie
Holiness Camp
Public Access
ILLINOIS
EASTERN
Creek
0
½
1 mi
0
½
1
1½ km

for about 4 miles to the preglacial Casey Fork, where the channel bottom elevation is lower than 350 feet msl and the ground surface elevation is about 400 feet.

Shaw (1915) noted the presence of extinct lakes in southern Illinois and adjacent areas and selected Lake Muddy as an example. Parts of Lake Muddy reached into our field trip area. Shaw thought that this lake originated sometime after Illinoian glaciation because the lake deposits are found above Illinoian glacial drift. He saw two separate episodes of lake development, one shortly after Illinoian time and the other during Wisconsinan time. More recent reconnaissance work in the Jefferson-Franklin area indicates that Shaw either did not recognize the Illinoian-Sangamon Soil relationship or else misinterpreted it.

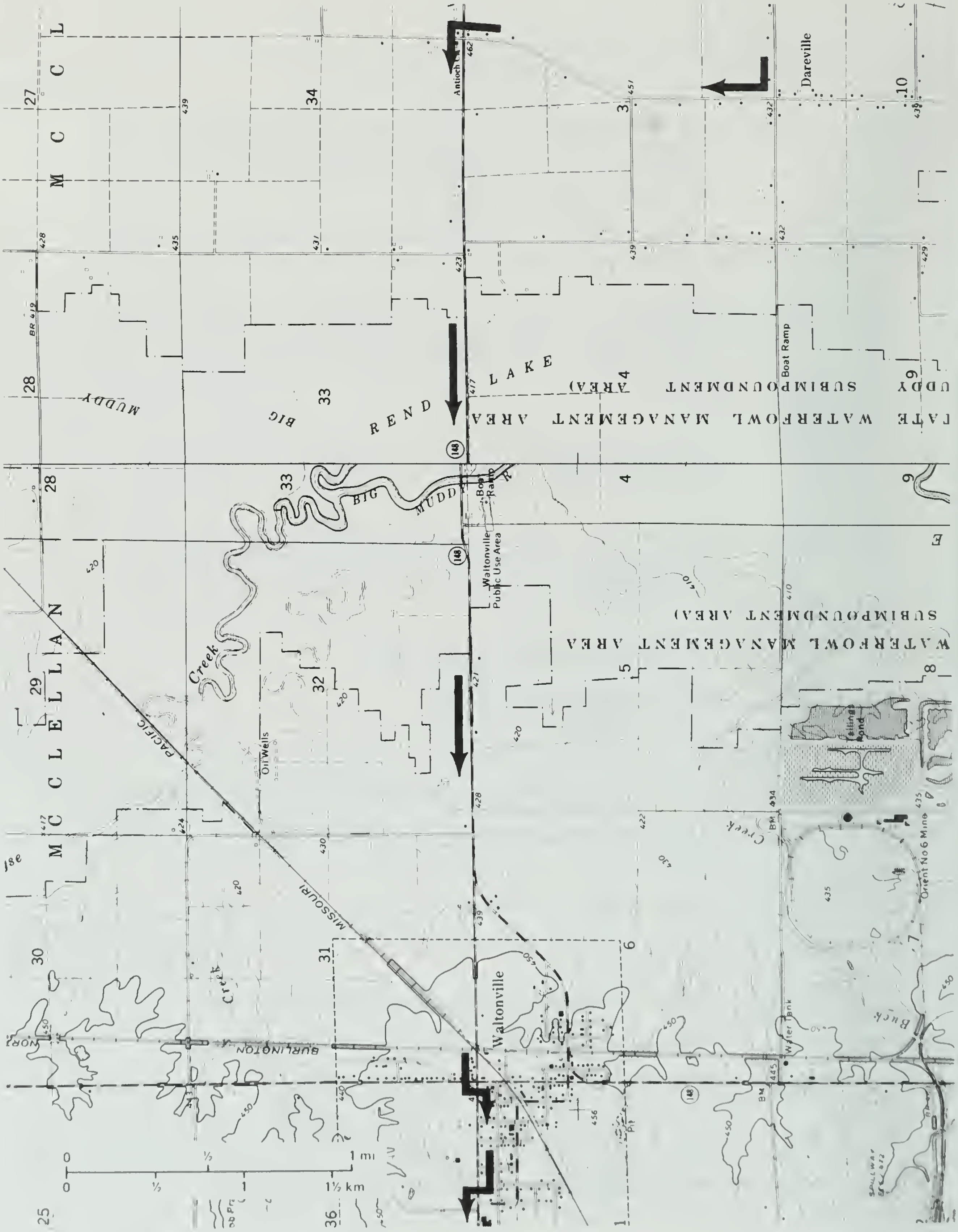
In the field trip area, a terrace level at about 440 feet msl is eroded into Illinoian glacio-lacustrine deposits that accumulated in a much earlier lake during the waning stages of Illinoian glaciation. Shaw considered these glacio-lacustrine deposits to be alluvial fans formed from loess that had washed down from the uplands onto the lake deposits. However, more recent work has shown that the Sangamon Soil is developed into the glacio-lacustrine deposits below the Peoria Loess of Wisconsinan age. These uppermost terraces have darker-colored soils that are better drained and more productive than the light gray, thin, poorly drained soils formed on the higher uplands where thin loess is underlain by till.

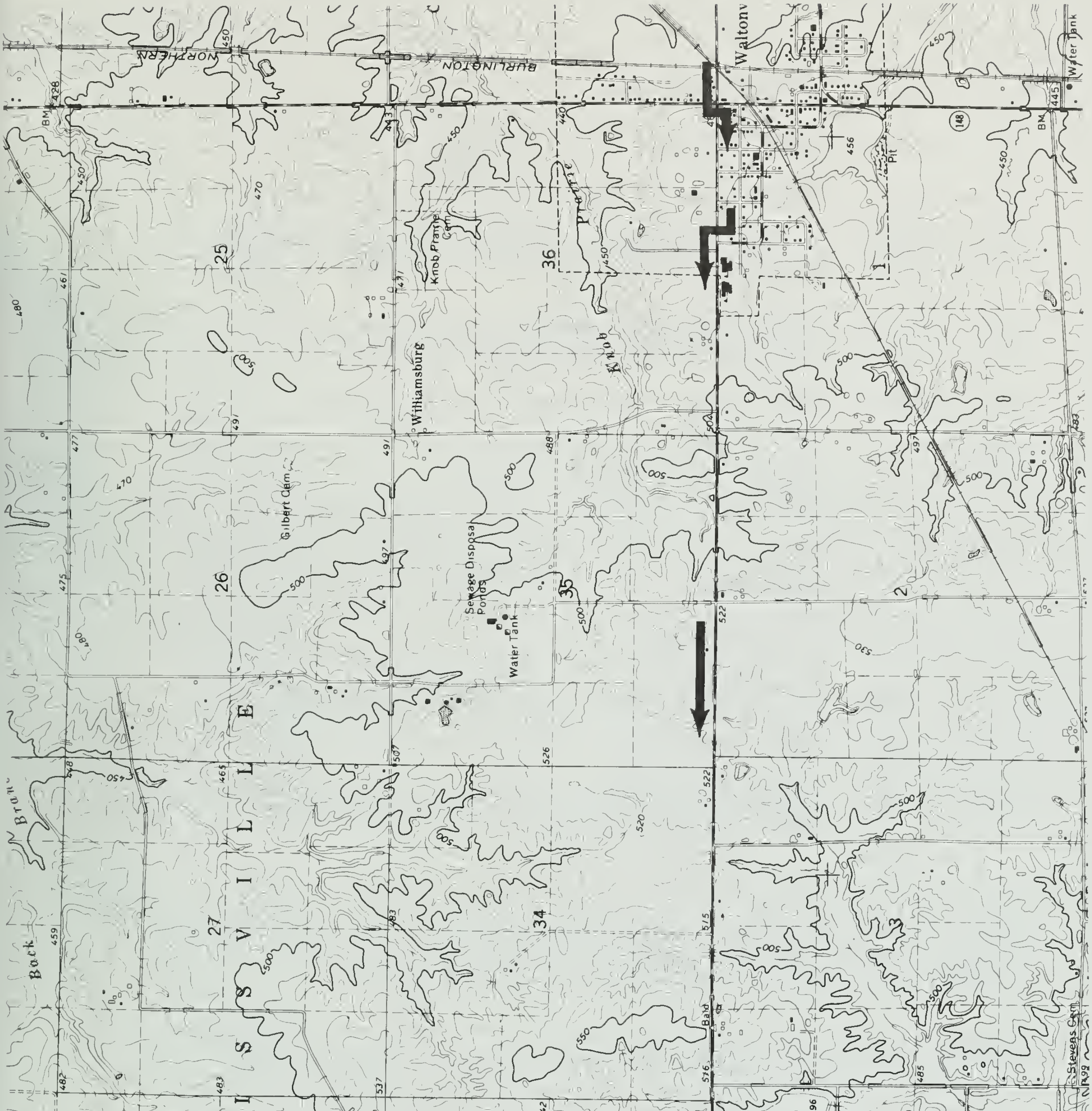
Shaw's Lake Muddy formed when meltwater torrents in the Mississippi River during Wisconsinan Woodfordian time were overloaded with transported sediment and thus deposited great quantities of debris within the valley, damming its tributaries, including the Big Muddy River. Ponded behind these dams, the finer sediments carried by the streams settled out in the slack water and gradually filled the bottom lands. These lakes do not appear to have been long lived because shoreline features in general are poorly developed or lacking. It seems likely that lake levels fluctuated considerably during the year and from year to year, thus preventing development of prominent shoreline features. Farther downstream, terraces formed at elevations from about 395 to 410 feet in bottom deposits of an early Woodfordian lake and from about 385 to 395 feet in deposits of a later, lower lake. This suggests that lakes persisted at those elevations for a significant period. Water levels may have been somewhat higher, but there may also have been times when the bottoms were not completely inundated, not unlike present conditions in the Rend Lake subimpoundment areas just to the west (Rend Lake has a surface elevation of 405 feet msl). Sheetwash from rain and snow acting over thousands of years has moved the fine materials from the gacial drift and the overlying loess downslope onto the top of the lake bed sediments, masking their boundaries and producing the gently sloping valley wall here.

Shaw mainly used geomorphology, the study and classification of landforms, and a study of the surface materials to interpret the southern Illinois area. At that time, the details of Pleistocene stratigraphy (definition and description of natural divisions of rocks) and soil studies were in their infancy. Current workers are using these details as tools to help classify the deposits and decipher the Quaternary history of the area. They now know that the area west of us here covered by Rend Lake is underlain by Woodfordian lake bottom sediments. When we reach IL 37 in about 4 miles, we will be along the eastern edge of the early Woodfordian lake. West of Bonnie, we will cross over the Casey Fork and Big Muddy Subimpoundments, both areas of wide, flat bottoms that seem quite wide for the size of the streams now occupying them.

Bonnie
Public Access
Holiness Camp
Mason Cem
Dareville
Gaging Station
CASEY FORK SUBIMPOUNDMENT DAM
BONNIE PUBLIC USE AREA
REND LAKE
(CASEY FORK
STATE
WATERFOWL
SUBIMPOUNDMENT
CASEY
Casey
ILLINOIS
EASTERN
AND
CHICAGO
Woodall BM 446
BM 424
BM 419
0 ½ 1 mi
0 ½ 1 1½ km

0.0	8.9+	Leave STOP 2 and CONTINUE AHEAD (south).
0.55+	9.45+	View roadcut to the left. The Illinoian glacial till in the upper part of the roadcut has gotten too wet and has slumped down across the underlying Pennsylvanian silty shale and siltstone. Except for the slumped area, the roadcut is pretty much grassed over.
0.15+	9.65-	To the left is a roadcut exposing Pennsylvanian medium-gray shale and micaceous tan siltstone. Exposure is partially slumped and messed up.
0.15+	9.8	STOP: 2-way at 500N/1600E. Tri-County Electric Cooperative substation to the left in the northeast corner of the intersection. CAUTION: visibility somewhat limited in both directions. CONTINUE AHEAD (south).
0.4	10.2	View to west.
0.6	10.8	STOP: 2-way at 400N/1600E. There is also another Tri-County Electric Cooperative substation to the left in the NE corner of the intersection. TURN RIGHT (west).
2.75+	13.6+	CAUTION: 1-track guarded Louisville and Nashville (L&N) railroad crossing with IL 37 less than 100 feet beyond. STOP: 1-way. DO NOT STOP ON RAILROAD TRACKS. IL 37 is some 200 feet east of I-57 here. TURN RIGHT (north).
0.1+	13.7+	Cross Rend Lake/Atchison Creek bridge.
0.85+	14.6+	CAUTION: Enter hamlet of Bonnie.
0.4	15.0+	Prepare to turn left.
0.1	15.1+	TURN LEFT on Campground Road toward Rend Lake Wildlife Refuge.
0.4+	15.5+	Cross I-57 overpass. CONTINUE AHEAD (south and west) on the blacktop.
0.9	16.45+	Enter the Casey Fork Subimpoundment area of Rend Lake.
0.65	17.1	Cross Casey Fork.
1.95+	19.05+	CAUTION: Bump over single unguarded L&N railroad track.
0.45+	19.5+	STOP: 2-way at 500N/950E in Dareville. TURN RIGHT (north).
1.1+	20.65+	STOP: 2-way at IL 148/975E. TURN LEFT (west).
0.7+	21.4+	Freeman United Coal Mining Company, Orient Mine #6 portal to the left.
0.4+	21.8+	Enter the Big Muddy Subimpoundment area of Rend Lake.


M C C L
M C C L E L L A N
BIG MUDDY
BIG BEND LAKE
WATERFOWL MANAGEMENT AREA
SUBIMPOUNDMENT AREA
Dareville
Antioch Ch
Boat Ramp
Waltonville Public Use Area
Waltonville
Oil Wells
Creek
MISSOURI PACIFIC
BURLINGTON
Tailings Pond
Orient No 6 Mine
Water Tank
0 ½ 1 mi
0 ½ 1 1½ km



Waltonville
Burlington Northern
Williamsburg
Knob Prairie Cem
Knob Prairie
Gilbert Cem
Sewage Disposal Ponds
Water Tank
Blissville
Back Branch
Bald
Stevens Cem
Pit
Central
0
½
1 mi
0
½
1
1½ km

0.4	22.2+	Cross Big Muddy River.
1.3	23.5+	Prepare to leave IL 148 just ahead at curve.
0.1+	23.6+	CONTINUE AHEAD (west) on gravel road at IL 148/675E.
0.2+	23.85	CAUTION: the gravel road becomes Knob Street upon entering the hamlet of Waltonville.
0.35+	24.2+	CAUTION: unguarded railroad interchange spur and 100 feet west to 3-track junction of Burlington Northern (BN) and UP.
0.1+	24.35-	STOP: 1-way at Hirons Street. TURN LEFT (south).
0.05+	24.4+	TURN RIGHT (west) on Union Street.
0.4+	24.8+	STOP: 2-way at Main Street. TURN RIGHT (north) east of the school.
0.05+	24.9+	STOP: 1-way at T-road intersection with Knob Street- 600N/550E. TURN LEFT (west).
3.0	27.9+	Prepare to turn right.
0.1+	28.05+	TURN RIGHT (north) at T-road intersection-600N/250E.
3.75	31.85+	Prepare to stop ahead.
0.01+	31.95+	PARK along right road shoulder as far off of the blacktop as you can safely. CAUTION: fast traffic.

STOP 3. Examine and collect Opdyke Coal and associated rocks of the Pennsylvanian Mattoon Formation in the roadcut (W edge SW NW NE sec. 16, T3S, R1E, 3rd P.M., Jefferson County, Woodlawn 7.5-minute Quadrangle [38089C1]).

Various geologists, beginning with Engelmann in the 1860s, have studied the Pennsylvanian bedrock strata exposed at and near the surface in Jefferson County, but detailed maps of the area are not readily available. The widely spaced outcrops in the county make conventional geologic mapping difficult; some of the stratigraphic units are thin and difficult to tell apart when viewed alone, "out of context." It's easy to make mistakes in identifying the units and correlating them from place to place. However, when several units can be studied together in a single exposure, one or two generally can be identified and properly placed in the stratigraphic sequence. Except for thickness, the coal exposed here appears to correlate well with the coal that is found about 6 miles north-northwest of Mt. Vernon along IL 37. Based on the assemblage of fossil plant spores extracted from this coal, Dr. R.A. Peppers, Survey palynologist, correlates it with the Opdyke Coal Member of the Mattoon Formation (fig. 11), named for exposures and from old mines near the hamlet of Opdyke about 8 miles southeast of Mt. Vernon on IL 142. The overlying limestone here may be the Omega LImestone Member, although this interpretation may be subject to change with more detailed

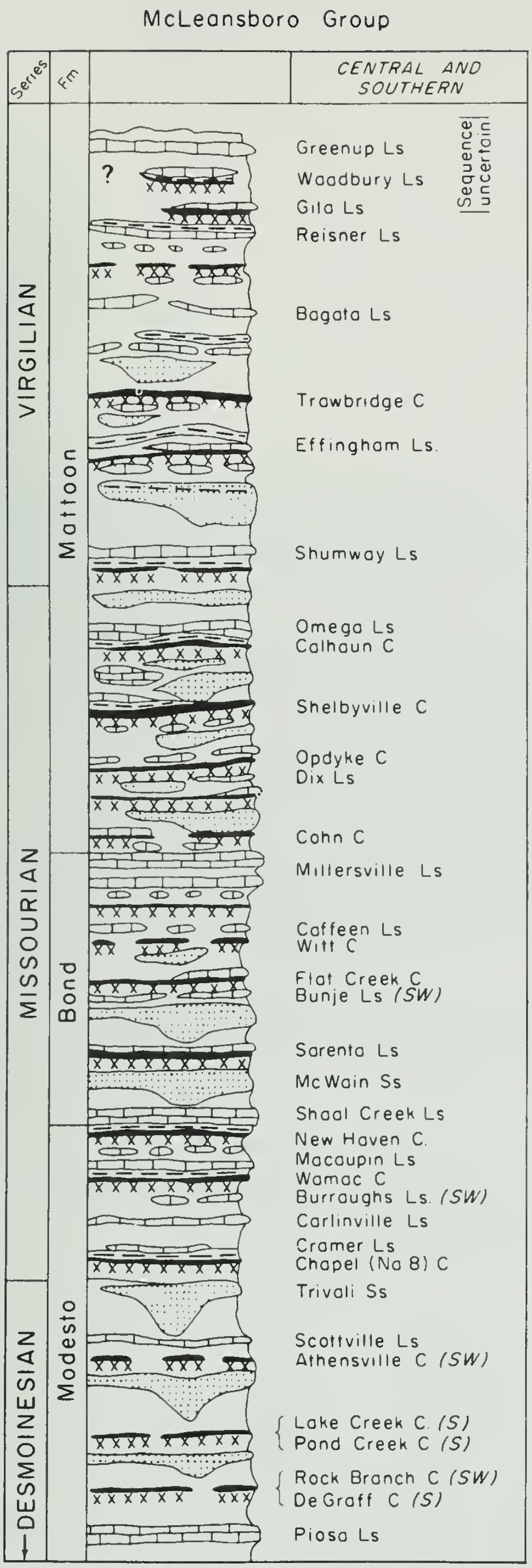


Figure 11. Classification of the McLeansboro Group, Pennsylvanian System.

work in the area. A limestone that was quarried about 7 miles north-northwest of Mt. Vernon just a few years ago was called the Omega Limestone. At the quarry, the Omega was thicker and of better quality than the thin-bedded, argillaceous stone you see here. Following is a brief description of the rocks exposed here:

QUATERNARY SYSTEM

Pleistocene Series

Illinoian Stage

Liman Substage

Glasford Formation

Till - not studied; 8 ± feet.

PENNSYLVANIAN SYSTEM

McLeansboro Group

Missourian Series

Mattoon Formation

Omega (?) Limestone Member - dark gray but weathers light tan, argillaceous, fossiliferous; 1 ± foot.

Unnamed shale - gray to brownish-gray, thin, evenly-bedded, noncalcareous, bedding surfaces rusty appearing, contains a few scattered plant traces; 5-6 feet.

Opdyke Coal Member - coal, bright banded, bony in part; 6-8 inches.

Shale - gray, noncalcareous, firm, compact, unevenly bedded with plant traces, contains plant and leaf remains; 8 inches.

Coal - bright luster when fresh; 4 inches.

Unnamed underclay - brownish-gray, noncalcareous, firm, slightly sandy, containsbrownish and carbonized plant traces, some remains fairly-well preserved; 8 inches.

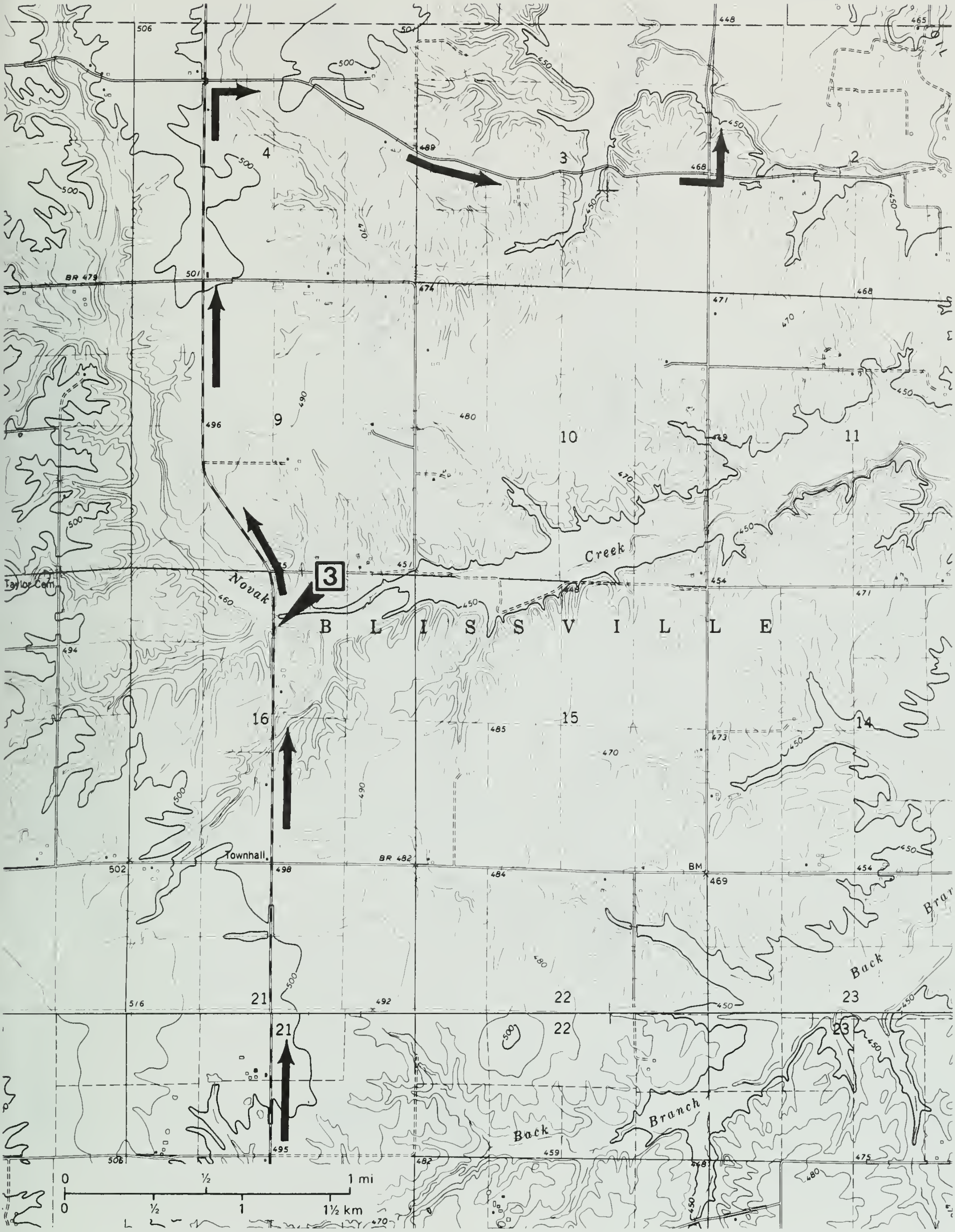
Unnamed shale - gray, noncalcareous, much rust on bedding planes, sandy, finely micaceous, firm, contains a few scattered plant traces; 3+ feet.

Unnamed sandstone - olive to brownish-gray, micaceous, beds up to 5 inches thick,

Noncalcareous, contains brown stem and leaf impressions; 4-5 feet.

Unnamed shale - olive to brownish-gray, micaceous, sandy, evenly bedded; 6+ feet to water level.

0.0	31.95+	Leave **STOP 3** and CONTINUE AHEAD (north) across Novak Creek. CAUTION: visibility from the south is poor.
1.85	33.85+	Prepare to turn right.
0.1+	33.95+	TURN RIGHT (easterly) at 1175N/225E.
1.5+	35.45+	Exposure of slumped Pennsylvanian siltstone in the road cut on the east valley wall.
0.05	35.5+	Example of poor site selection for refuse dumping on the left. Leachates from this site, especially after a hard rain, will drain rather quickly into Rend Lake.

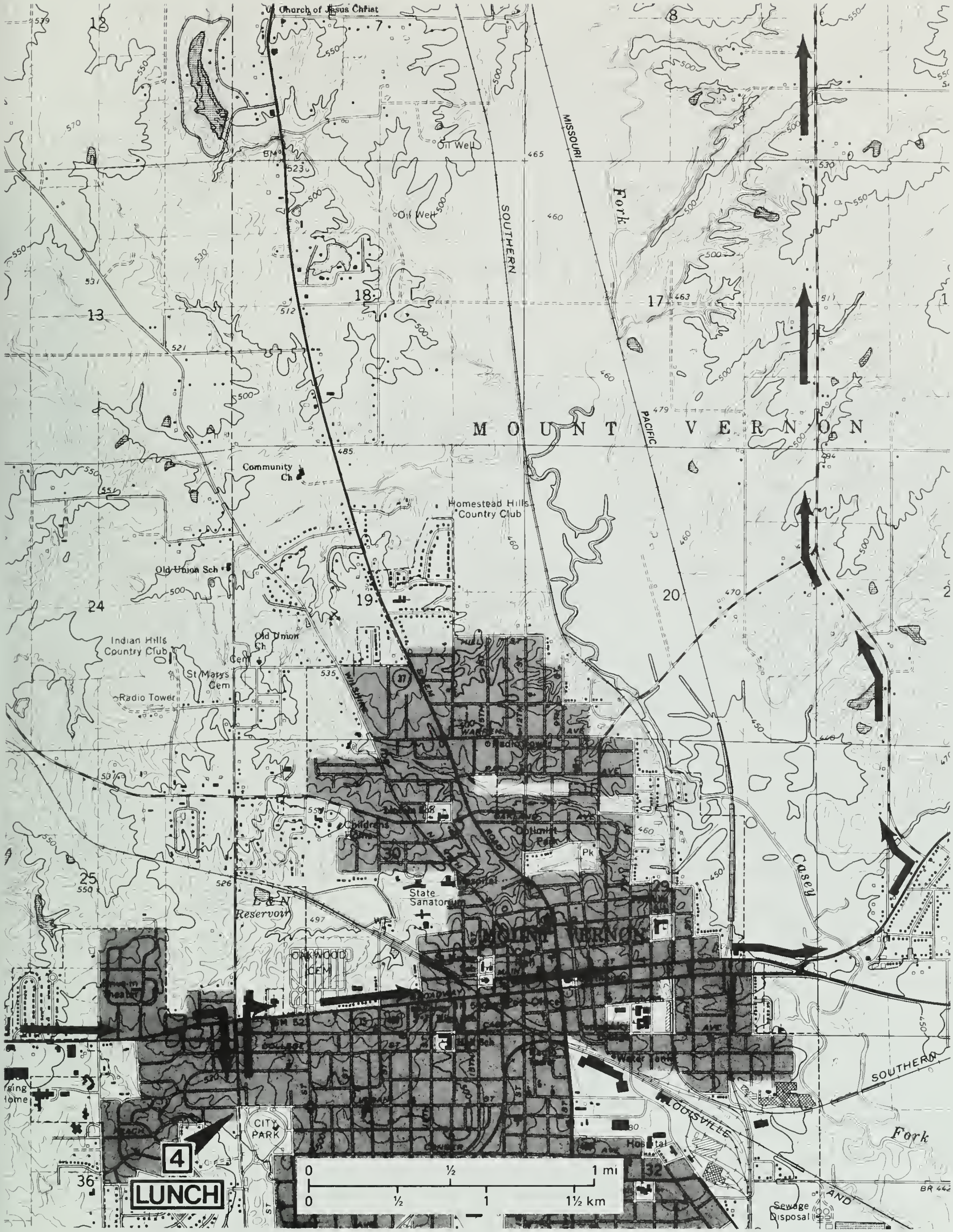


BLISSVILLE
Novak Creek
Back Branch
Taylor Cem
Townhall
BR 479
BR 482
BM
3
0 ½ 1 mi
0 ½ 1 1½ km


Slade Cem
Memorial Gardens Cem
BM 462
BM 488
Gaston
BM 495
Oil Well
Rend L
NORTHERN
WOODLAWN OIL FIELD
Rayse
Roaches
0 ½ 1 mi
0 ½ 1 1½ km

LOUISVILLE AND NASHVILLE
NASHVILLE
Drivers
Harper
BIG MUDDY RIVER
Nursing Home
West Salem Sch
Cem
Sunset Memorial Cem
OIL FIELD
Oil Wells
Rend Lake Camp
Slade Cem
PACIFIC
0 ½ 1 mi
0 ½ 1 1½ km

0.25+	35.8+	CAUTION: crossroad at 1150N/400E with visibility somewhat poor to the left. STOP not marked but traffic on the cross-road moves fairly fast. TURN LEFT (north).
0.35+	36.15+	Cross Raysey Creek.
0.65	36.8+	STOP: 2-way at 1250N/IL 15. TURN RIGHT (east) toward Mt. Vernon.
0.55	37.35+	Route passes through the Woodlawn Oil Field, which is on an anticline located in T. 2 & 3 S., R. 1 & 2 E. The field was discovered in 1940 and consists of 1,980 proved acres with 203 wells completed through 1986. There were 69 producing wells at the end of 1986. Production in 1986 was 33,700 bbls.; total production through 1986 - 18,637,400 bbls. Producing horizons: Mississippian Tar Springs Sandstone (Ss), Cypress (Ss), Benoist (Ss), Aux Vases (Ss), Ohara limestone (Ls), Spar Mountain (sandy Ls), McClosky (Ls), and Devonian Lingle (Ss). Depths to the tops of the producing horizons range from 1440 to 3690 feet; pay zone thicknesses range from 3 to 25 feet. The deepest test in the field went to the Ordovician at a depth of 5,101 feet.
1.5+	38.9	CAUTION: bump at 1-track guarded BN railroad crossing.
0.15+	39.05+	CAUTION: Woodland T-road intersection from left at 1250N/625E.
2.55+	41.6+	Cross Big Muddy River.
1.35	43.0	CAUTION: Entering congested area ahead.
0.15+	43.15+	CAUTION: Mt. Vernon city limits.
0.35	43.5+	CAUTION: STOPLIGHT at junction with I-57 and I-64 southbound.
0.1+	43.65	Cross I-57 and I-64 overpass.
0.1+	43.75+	CAUTION: STOPLIGHT at junction with I-57 and I-64 northbound. CONTINUE AHEAD (easterly).
0.1+	43.9+	CAUTION: STOPLIGHT at frontage road. CONTINUE AHEAD (easterly).
0.25+	44.15+	CAUTION: STOPLIGHT at Veterans Memorial Drive. CONTINUE AHEAD (easterly) on Broadway. NOTE: stay In inside lane.
0.15+	44.35+	CAUTION: STOPLIGHT at entrance to mall on right.
0.25+	44.65+	CAUTION: STOPLIGHT at 34th Street. CONTINUE AHEAD (easterly) and MOVE TO the RIGHT lane.
0.35	45.0+	Prepare to turn right.
0.1+	45.15+	CAUTION: STOPLIGHT at 27th Street. TURN RIGHT (south) toward the city park.


Church of Jesus Christ
MISSOURI
PACIFIC
SOUTHERN
Oil Well
Fork
MOUNT VERNON
Community Ch
Homestead Hills Country Club
Old Union Sch
Indian Hills Country Club
Old Union Ch
St Marys Cem
Radio Tower
State Sanatorium
L & N Reservoir
OAKWOOD CEM
MOUNT VERNON
Casey
Fork
CITY PARK
Water Tank
LOUISVILLE AND
SOUTHERN
Hospital
Sewage Disposal
4
LUNCH
0 ½ 1 mi
0 ½ 1 1½ km

0.25+	45.45+	STOP: 4-way at Logan Street. Mileage will resume from this 4-way stop. Follow the leader and instructions from here for lunch parking (Logan and 27th Street intersection: SW SW NW NW sec. 3l, T2S, R3E, 3rd P.M., Jefferson County, Mt. Vernon 7.5-minute Quadrangle [38088C8]).

STOP 4. LUNCH.

0.0	45.45+	Leave STOP 4 and CONTINUE AHEAD (north) on 27th Street.
0.25+	45.7+	CAUTION: STOPLIGHT at Broadway. TURN RIGHT (east).
0.85	46.6	CAUTION: 1-track guarded L&N railroad crossing.
0.15-	46.75-	CAUTION: STOPLIGHT at 12th Street. CONTINUE AHEAD (east) on Broadway and enter business district. Get into the CENTER LANE and stay on IL 15. Stay on IL 15.
0.1+	46.85+	CAUTION: STOPLIGHT at 10th Street. CONTINUE AHEAD (east) past the courthouse.
0.05+	46.9+	CAUTION: STOPLIGHT at 9th Street. CONTINUE AHEAD (east) and MOVE TO LEFT lane.
0.3+	47.25+	CAUTION: 1-track guarded Norfolk Southern (NS) railroad crossing.
0.2+	47.45+	CAUTION: 1-track guarded UP railroad crossing.
0.1	47.55+	Prepare to turn left.
0.1+	47.7	TURN LEFT (northeasterly) on Old Fairfield Road.
0.05-	47.7+	STOP: 2-way at westbound IL 15. CONTINUE AHEAD (northeasterly) on Old Fairfield Road.
0.15+	47.9+	Cross Casey Fork.
0.35	48.25+	Prepare to turn left.
0.05+	48.3+	TURN LEFT on Tolle Road and CONTINUE AHEAD (northerly) on the blacktop for almost 5 miles.
4.8	53.1+	Prepare to stop.
0.1+	53.3	PARK along right road shoulder as far off the blacktop as you can safely. CAUTION: fast traffic.

STOP 5. Examine Pennsylvanian sandstone and overlying Pleistocene glacial deposits at the Mt. Vernon Sand Company (entrance on the west side of road: SW SE SW SE sec. 33,

Fork
29
Oil Well
Miller Lake
28
27
26
Lake
Oak Grove Cem
Oil Wells
Miller
32
33
34
35
5
Hopewell Ch
T VERNON
MOUNT VERN
4
3
2
Jaycee
Lake
Akward Creek
Salem Ch
8
9
10
11
Sevenmile
Creek
0 ½ 1 mi
0 ½ 1 1½ km

T1S, R3E, 3rd P.M., Jefferson County, Harmony 7.5-minute Quadrangle [38088D7]). NOTE: you MUST have permission to enter these premises.

In the northwestern corner of this active sand pit, a fresh exposure shows a common soil of the area and typical geologic materials found along stream valleys of the Jefferson County area. Weathered Pennsylvanian sandstone at depths of 2 to 6 feet and a mantle of loess make up the parent material of the Frondorf soil (fig. 11). Frondorf silt loam and associated soils are classified as Alfisols and have formed under woodland vegetation. An Alfisol is a soil order that is characterized by being clay-rich and by having a distinct yellow to yellow-brown surface layer about 1 foot thick. Other types of Alfisols are found in the area where the loess mantle is thicker, up to 8 feet on hill tops, and where the Glasford Formation is more than 2 feet thick. The Glasford Formation is made up of glacial deposits (drift) of Illinoian age formed by glaciers that covered most of Illinois between 300,000 and 125,000 years ago.

The top of the Glasford Formation was at the land surface for about 50,000 years. During this time, the Sangamon Soil formed; it now is buried and in general terms is called a *paleosol*, a term that means old soil. On the left side of the exposure some of the Glasford Formation appears to be till, but this is uncertain because it is so highly weathered. In the past this clay-rich, weathered drift was called *gumbotil* (3Bg). The weathering during the formation of the Sangamon Soil was very strong and altered the upper 5 to 10 feet of the sandstone (Cr; hard sandstone is designated R for rock). A prominent feature of this weathering is the strong brown color of the joints, caused by iron staining and clay skins that have moved down from the soil horizons above.

Near the middle of the exposure, the Sangamon Soil becomes truncated in the down-slope direction. A stone-rich zone and discontinuous stone lines can be seen. This indicates an old event of soil erosion that seems to merge the drift with the overlying Roxana Silt, because stones are distributed throughout the interval (colluvial zone, fig. 12).

Most of the Roxana Silt is loess but has been mixed with drift material during deposition of the Roxana. In the south part of the exposure, the surface horizon of the Farmdale Soil has

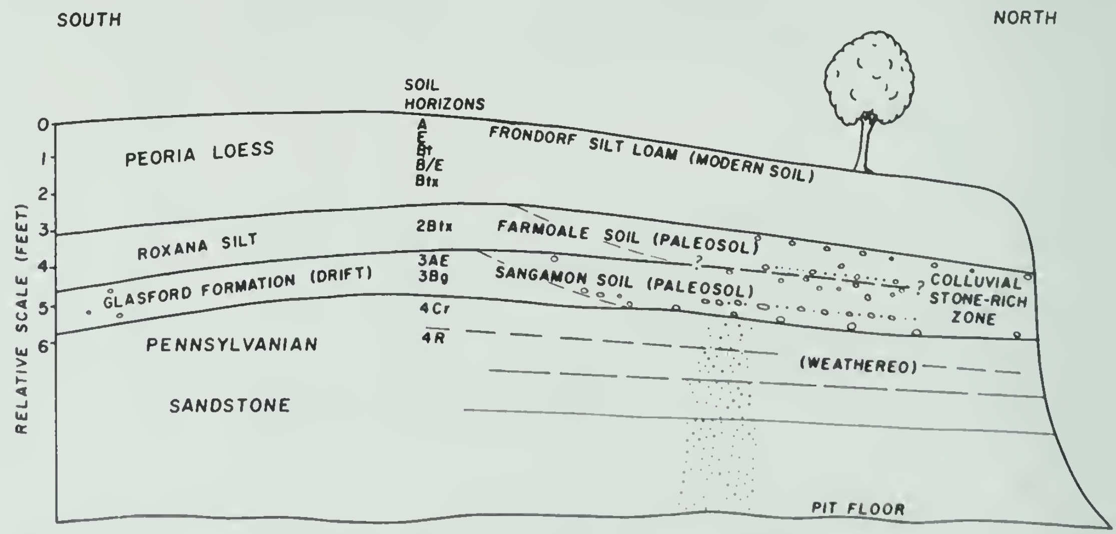


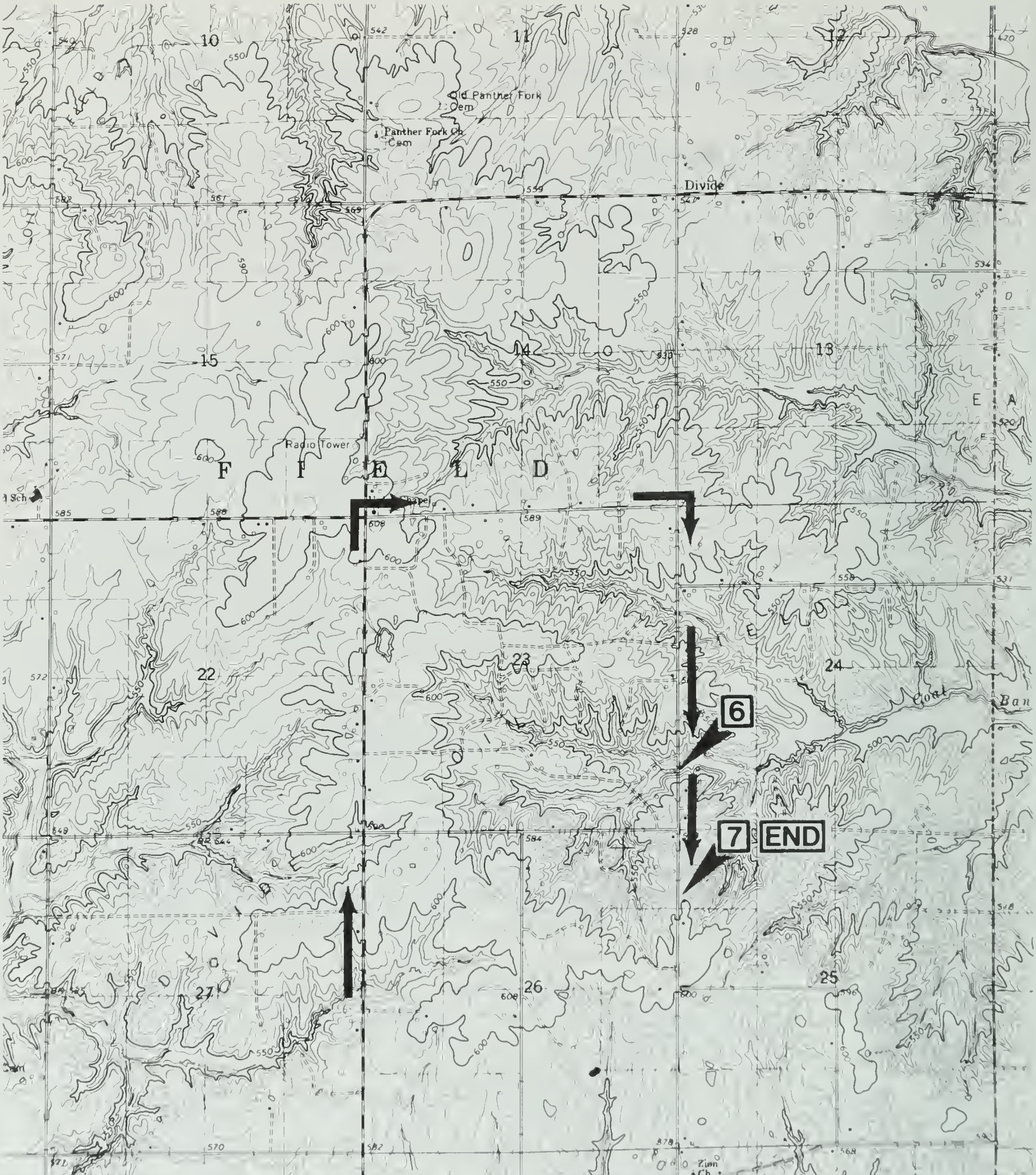
Figure 12. Nuxoll Sand Pit. SE,SW Sec. 33, T15, R3E, Jefferson County.

been preserved but has been greatly modified by the modern soil formation, transforming it into a fragipan layer (2Btx), a somewhat cemented zone that inhibits root development.

Based on geologic correlations, the Roxana Silt represents a long interval of time from about 75,000 to 25,000 years ago. The top of the Farmdale Soil has been C-14 dated in many places in Illinois to be about 25,000 years old. The Farmdale Soil has been eroded on the right end of the exposure, which indicates that the Farmdale surface sloped to the north in parallel with the present surface toward the present valley. Blending of the drift and the silt with some weakly expressed stone lines in the colluvial zone indicates a long time interval of episodic soil erosion during the early Wisconsinan time.

Late Wisconsinan time is represented by the distinct layer of Peoria Loess that covers the Farmdale surface. Geologic evidence throughout the Midwest indicates that the Peoria was deposited during the interval between 25,000 and 12,500 years ago, when the Wisconsinan glacier was in northeastern Illinois. The modern soil (Frondorf silt loam) is a relatively well developed soil, based on the sequence of soil horizons. Important indicators of soil development are the B/E and Btx horizons, where strong mineral weathering and bleaching (B/E), and clay translocation and weak cementation (BTX) has occurred.

0.0	53.3	Leave **STOP 5** and CONTINUE AHEAD (northeasterly).
1.5+	54.8+	BEAR LEFT (north) on blacktop at curve-1865N/1600E.
0.7	55.55+	This in the area of the Divide Consolidated Oil Field, which is located on an anticline in T.1 S., R. 3 & 4 E. The field was discovered in 1943 and consists of 5420 proved acres, with 375 wells completed through 1986. There were 202 producing wells as of the end of 1986. Production in 1986 was 286,700 bbls.; total production since 1943, 12,693,100 bbls. Producing horizons include Mississippian Aux Vases Sandstone (Ss), Ohara limestone (Ls), Spar Mountain (sandy Ls), McClosky (Ls), St. Louis (Ls), Salem (Ls), and Ullin (Ls). Depths to the tops of producing horizons range from 2620 to 3502 feet; pay zone thicknesses range from 6 to 10 feet. The deepest test in the field was into the Devonian at a depth of 4700 feet.
0.85-	56.4	You are crossing an elevation of 610 to 620 feet msl here. The highest surface elevation, 620^{+} feet msl, along the field trip route is about 0.1 mile to the right (east).
0.80	57.2+	STOP: 4-way at 2100N/1600E. TURN RIGHT (east).
0.95+	58.2+	STOP: 1-way at T-road intersection-2100N/1700E. TURN RIGHT (south).
0.75	58.95+	Descend north valley wall of Coal Creek and prepare to stop.
0.05+	59.05	PARK along right road shoulder. CAUTION: shoulder is narrow and adjacent bank is steep. Do NOT park in the narrow roadcut on the south valley wall of Coal Creek.



Old Panther Fork Cem
Panther Fork Ch Cem
Divide
Radio Tower
F I E L D
Chapel
6
7 END
Zinn Ch
Goat
0 ½ 1 mi
0 ½ 1 1½ km

STOP 6. Examine Pennsylvanian sandstone exposed in the roadcut and in the north-facing stream bank east of the road on the south side of Coal Creek (W edge NW SW SW sec. 24, T1S, R3E, 3rd P.M., Jefferson County, Harmony 7.5-minute Quadrangle [38088D7]).

As Coal Bank Creek eroded its valley, it cut down across a part of an ancient stream channel formed during the Pennsylvanian Period about 290 million years ago. The ancient channel was filled with sandy sediments that later became indurated or lithified (hardened) into the sandstone we see exposed along the south side of the creek and in the roadcut up the hill to the south. The sandstone appears to be some 30 to 40 feet thick. Channel sandstones similar to this one are fairly common in the Pennsylvanian rock sequence in Illinois.

Thin shale interbeds up to several inches thick and crossbedding are common in these deposits, as we can see here. Some of the crossbedded units contain abundant coalified plant debris. It is not clear whether the coaly material was ripped loose from coal exposures nearby and incorporated into the sand or whether large pieces of peaty material were ripped loose somewhere else, carried into the area, incorporated into the sand, and then coalified as the sand was hardening into rock. Some of the sandstone beds are 1 or 2 feet thick, while others are only 1 inch or so thick. Iron salts carried in solution in groundwater that moves slowly through the sandstone precipitate when they are exposed to the air at the outcrop face. These salts harden the surface and stain it reddish-brown in the lower part of the exposure. The upper part of the sequence exposed in the roadcut does not have the iron carbonate cement and so is much softer and more easily eroded. The upper part along the road looks very much like the weathered sandstone at Stop 5.

The stratigraphic position and name of the sandstone here is not clear. The sandstone does not appear to contain any fossils that might help us to diagnose its stratigraphic position. It is not in contact with coal and/or limestone beds visible at the surface nearby, which might help to identify it, nor is any identifiable Pennsylvanian stratum present on top of it. It probably cuts down through the limestone and Opdyke Coal that we studied at Stop 3. The Opdyke Coal is most likely to be the coal that was formerly mined from small workings along this creek. If the sandstone does in fact cut through the Opdyke Coal, then we know that it is at least younger than the coal. Willman (1975) notes the presence of the Merom Sandstone Member in the Mattoon Formation and the uncertainty of its stratigraphic position. If this sandstone is the Merom, it has been reported to be as much as 100 feet thick some 85 miles to the northeast.

0.0	59.05	Leave **STOP 6** and Continue ahead (south).
0.3	59.35	Prepare to stop ahead.
0.1+	59.45+	PARK along right road shoulder. Do NOT block driveways. Entrance to the Devil's Prop Natural Area is on the east side of the road.

STOP 7. Examine landforms cut in the underlying Pennsylvanian sandstone (entrance: SW cor. NW SW sec. 25, T1S, R3E, 3rd P.M., Jefferson County, Harmony 7.5-minute Quadrangle [38088D7]).

About 500 feet east of the parking area is a small canyon that has been eroded into Pennsylvanian sandstone at least 30 feet thick. The 15 to 20 foot sandstone cliff is "propped up" in one location with a sandstone column that gives part of the name to this delightful natural area. Behind the "prop" the sandstone has been eroded to produce a small rock shelter. The overhanging cliff forms the shelter's roof. Other small rock shelters are to be found within a short distance down and across the canyon. Heavy rainfall causes small waterfalls along the canyon. The sandstone exposed along this north-northeast flowing tributary to Coal Bank Creek is the same sandstone exposed at Stop 6. Here, we are higher up in the formation and the sandstone is massive and harder than noted earlier. The sandstone member appears to be 60 to 70 feet thick here.

Take the time to hike along the trails and walk the bottom of the canyon. See how many different features you can identify, such as rock shelters, waterfall sites, columns, potholes (round "dishes" or holes that formed where harder rocks than the sandstone were swirled around by water to carve out the feature). Leave ONLY your footprints here. Please, pick up ALL trash you see and carry it back to the waste receptacles.

End of the field trip.

RETURN DIRECTIONS

Mt. Vernon—continue ahead 0.9 miles; turn right for 1 mile, turn left on blacktop for about 6.8 miles to Old Fairfield Road on east side of Mt. Vernon.
Salem and points north and west—turn around and retrace route for about 1.2 miles; turn left at T-road intersection for 1 mile; at 4-way stop, continue straight ahead for about 5.4 miles to Dix and IL 37; turn right to Salem or continue straight ahead for 0.65 mile for I-57 interchanges.

HAVE A SAFE TRIP!!

REFERENCES

Atherton, E., 1971, Tectonic development of the Eastern Interior Region of the United States in Background materials for symposium on future petroleum potential of NPC Region 9 (Illinois Basin, Cincinnati Arch, and northern part of the Mississippi Embayment): Illinois State Geological Survey Illinois Petroleum 96, p. 29-43.

Atherton, E., 1971, Structure (map) on top of Pre-cambrian basement: *in* Bristol, H.M., and T.C. Buschbach, Structural features of the eastern interior region of the United States: *in* Background materials for symposium on future petroleum potential of NPC Region 9 (Illinois Basin, Cincinnati Arch, and northern part of the Mississippi Embayment): Illinois

State Geological Survey Illinois Petroleum 96, p. 21-28.

Clegg, K.E., 1965, The La Salle Anticlinal Belt and adjacent structures in east-central Illinois: Transactions of the Illinois State Academy of Science, v. 58, n. 2, p. 82-94.

Damberger, H.H., S.B. Bhagwat, J.D. Treworgy, D.J. Berggren, M.H. Bargh and I.E. Samson, 1984, Coal industry in Illinois: Illinois State Geological Survey Map; scale, 1:500,000; size, 30"x 50"; color.

Engelmann, H., *in* A.H. Worthen, 1868, Geology and palaeontology-- Jefferson County: Geological Survey of Illinois, v. 3, p. 219-238.

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

Howard, R.H., 1967, Oil and gas pay maps of Illinois: Illinois State Geological Survey Illinois Petroleum 84, 64 p.

Keys, J.N., and W.J. Nelson, 1980, The Rend Lake fault system in southern Illinois: Illinois State Geological Survey Circular 513, 23 p.

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

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

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

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

Pryor, W.A., 1956, Groundwater geology in southern Illinois: A preliminary geologic report: Illinois State Geological Survey Circular 212, 25 p.

Samson, I.E., 1989, Illinois mineral industry in 1986 and review of preliminary mineral production data for 1987: Illinois State Geological Survey Illinois Mineral Notes 101, in press.

Shaw, E.W., 1915, Newly discovered beds of extinct lakes in southern and western Illinois and adjacent states: Illinois State Geological Survey Bulletin 20, p. 139-157.

Treworgy, J.D., 1981, Structural features in Illinois: A compendium: Illinois State Geological Survey Circular 519, 22 p.

Weibel, C.P., D.L. Reinertsen, and P.C. Reed, 1989, Guide to the geology of the Newton area, Jasper county: Illinois State Geological Survey Geological Science Field Trip Guide Leaflet 1989A, 52 p.

Weller, J.M., 1936, Geology and oil possibilities of the Illinois basin: Illinois State Geological Survey Illinois Petroleum No. 27, 19 p.

Weller, J.M., and A.H. Bell, 1937, Illinois basin: Illinois State Geological Survey Illinois Petroleum No. 30, 18 p.

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

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

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

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

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

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

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

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

Effects of Glaciation

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

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

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

Glacial Deposits

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

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

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

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

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

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

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

Loess, Eolian Sand and Soils

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

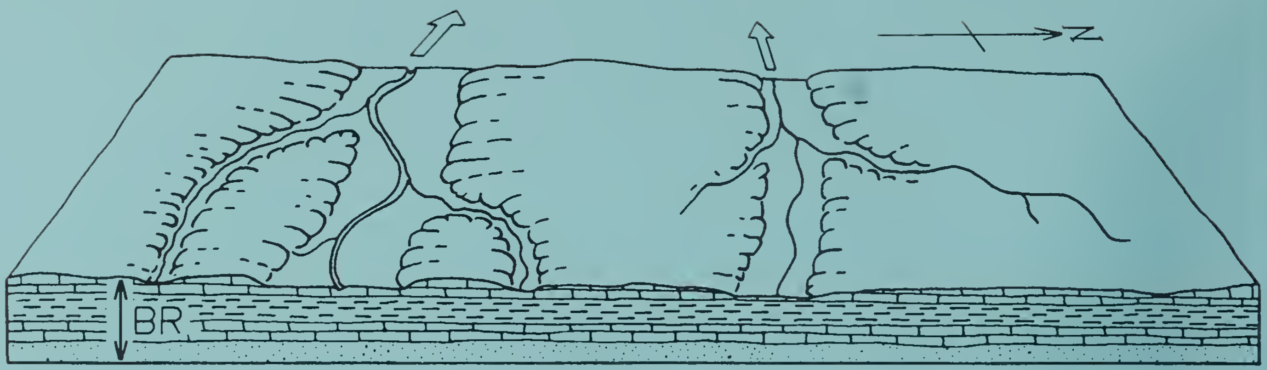
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and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

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

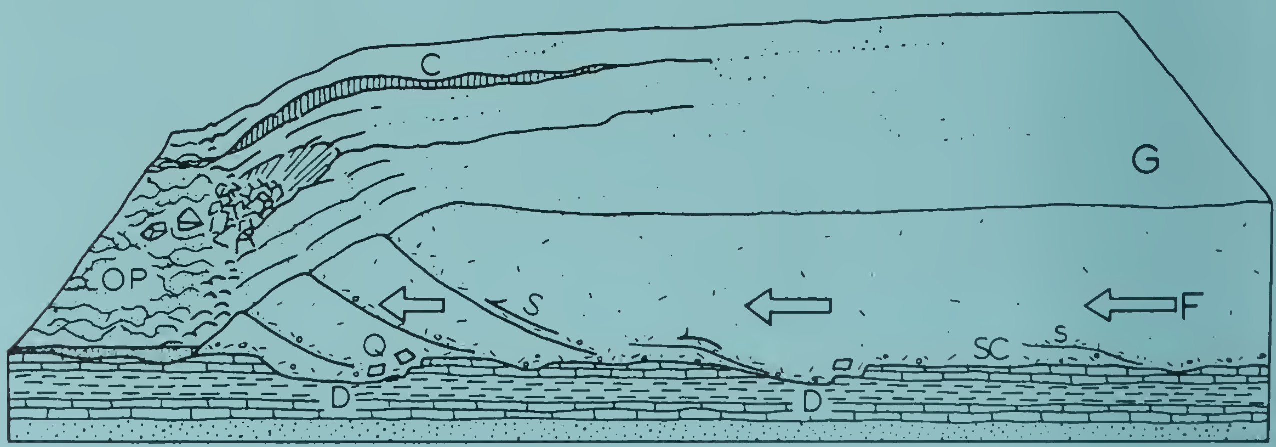
Glaciation in a Small Illinois Region

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

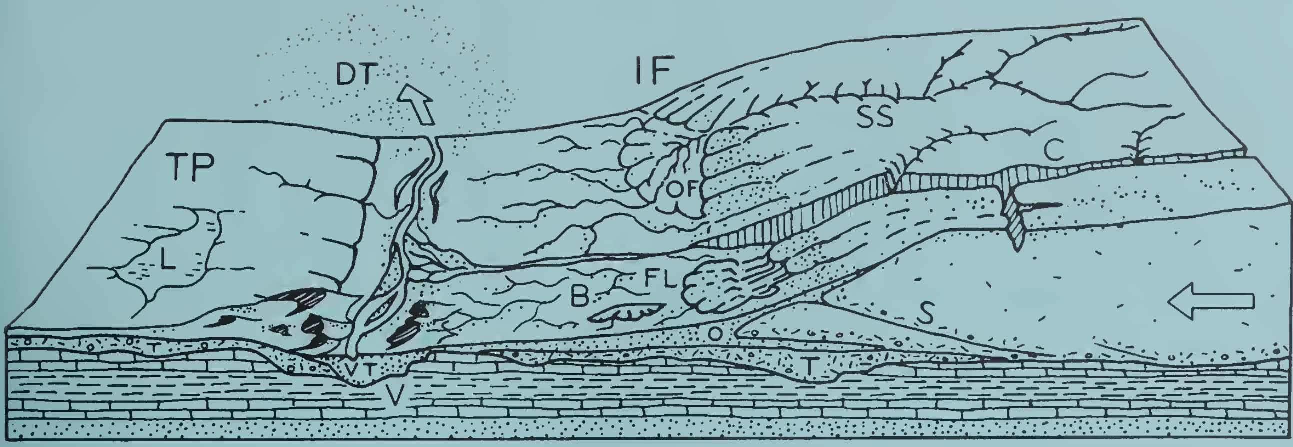
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



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



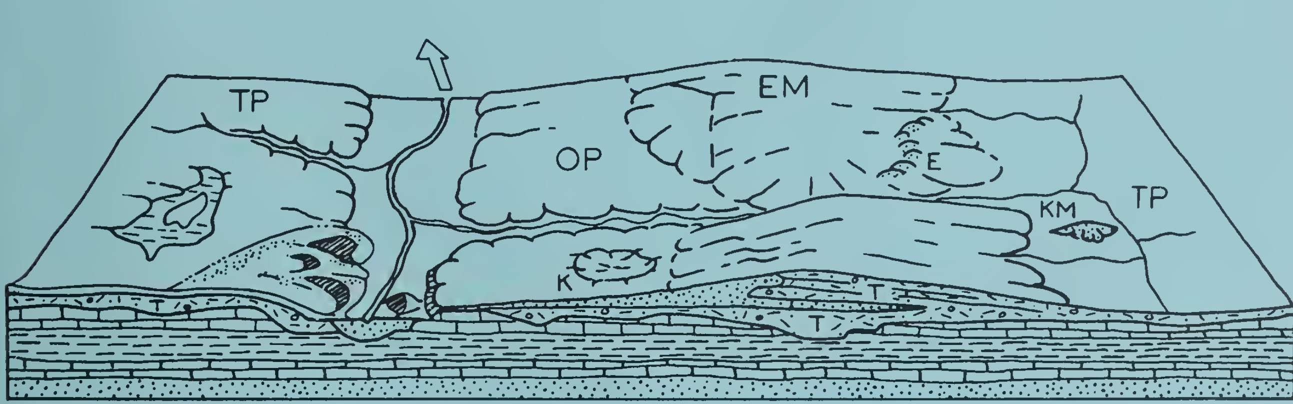
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses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



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

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

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



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

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

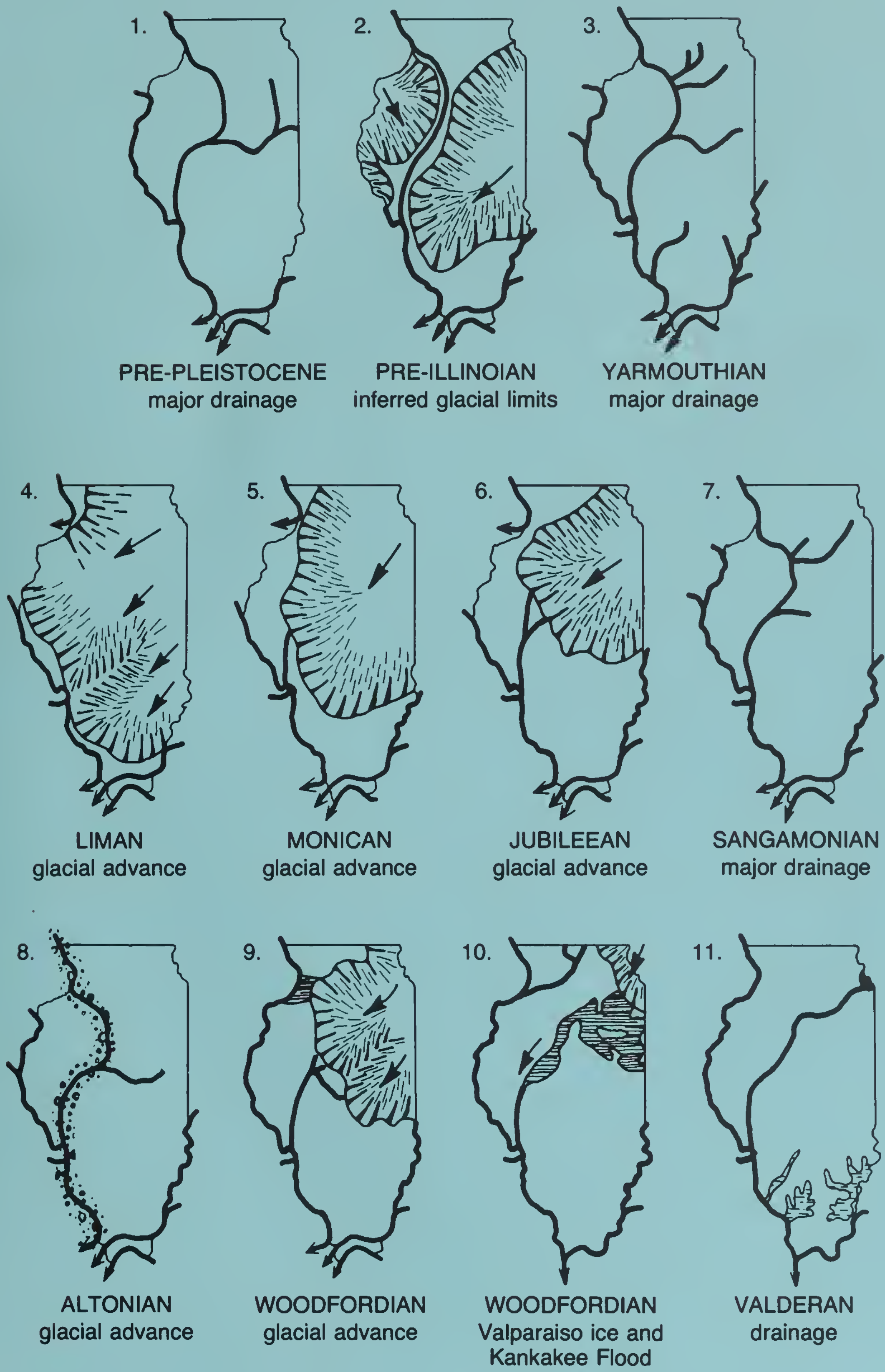
TIME TABLE OF PLEISTOCENE GLACIATION

		STAGE		SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
QUATERNARY		HOLOCENE (interglacial)		Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
				10,000		
	Pleistocene	WISCONSINAN (glacial)	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)		1,600,000 or more	Drift (little known)	Glaciers from northwest invaded western Illinois

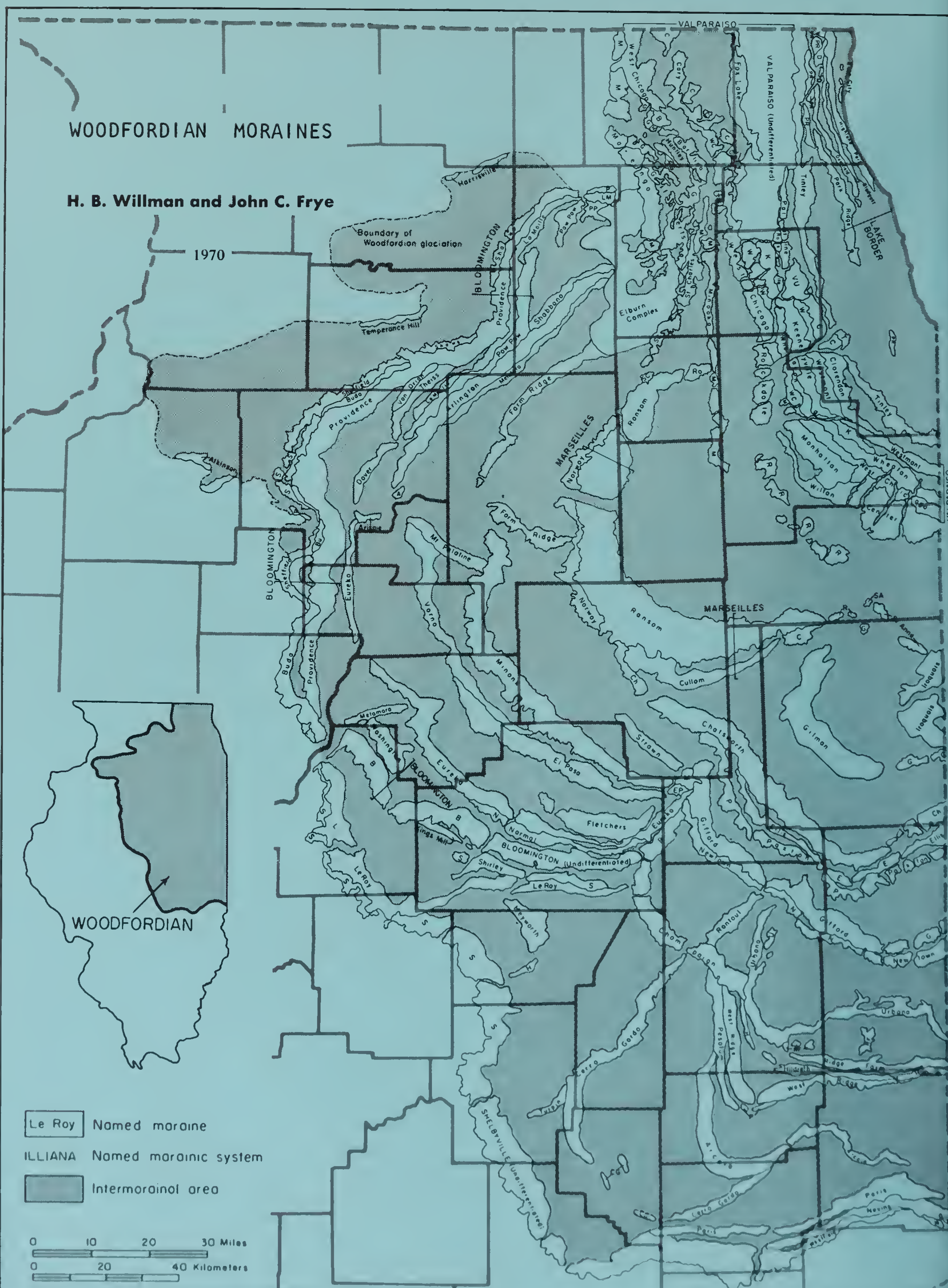
*Old oversimplified concepts, now known to represent a series of glacial cycles.

(Illinois State Geological Survey, 197

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
Le Roy Named moraine
ILLIANA Named morainic system
Intermorainal area
0 10 20 30 Miles
0 20 40 Kilometers
WOODFORDIAN
VALPARAISO
VALPARAISO (Undifferentiated)
LAKE BORDER
BLOOMINGTON
MARSEILLES
ILLIANA
BLOOMINGTON (Undifferentiated)
SHELBYVILLE (Undifferentiated)
Elburn Complex
Temperance Hill
Harrisville
Atkinson
Shabbona
Providence
Farm Ridge
Ransom
Cullom
Chatsworth
Gilman
Iroquois
El Paso
Fletchers
Normal
Shirley
Le Roy
Eureka
Minonk
Varna
Mt. Palatine
Arispie
Dover
Buda
Sheffield
Arlington
Manhattan
Wilton
Wheaton
Westmont
Tinley
Clarendon
Rockdale
Minooka
Norway
Streator
Gifford
Paxton
Newtown
Rantoul
Urbana
Cerro Gordo
Pesotum
West Ridge
Paris
Nevins
Metamora
Washington
Kings Mill
Heyworth
Champaign
Tuscola
Arcola

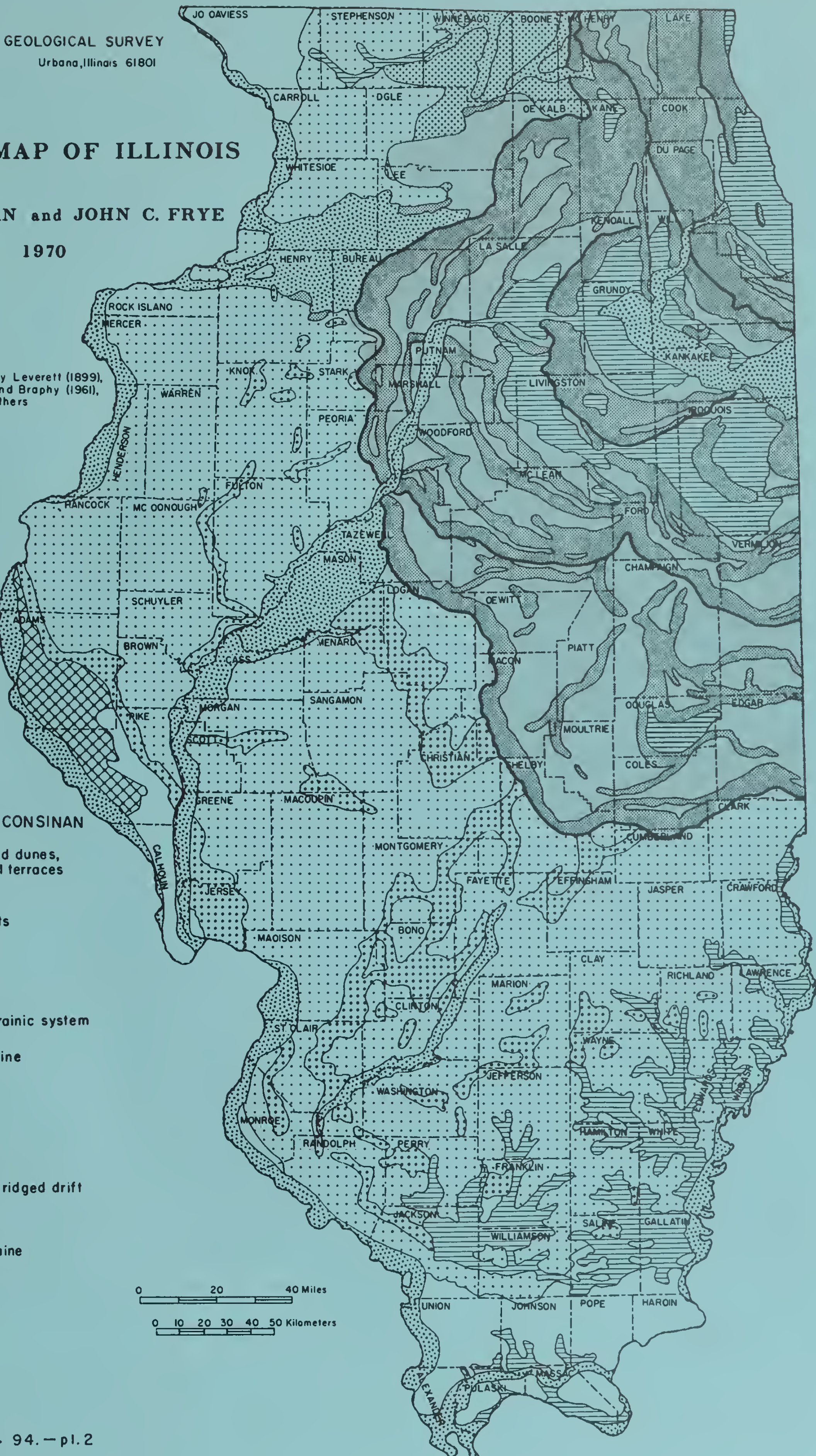
ILLINOIS STATE GEOLOGICAL SURVEY
John C. Frye, Chief Urbana, Illinois 61801

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

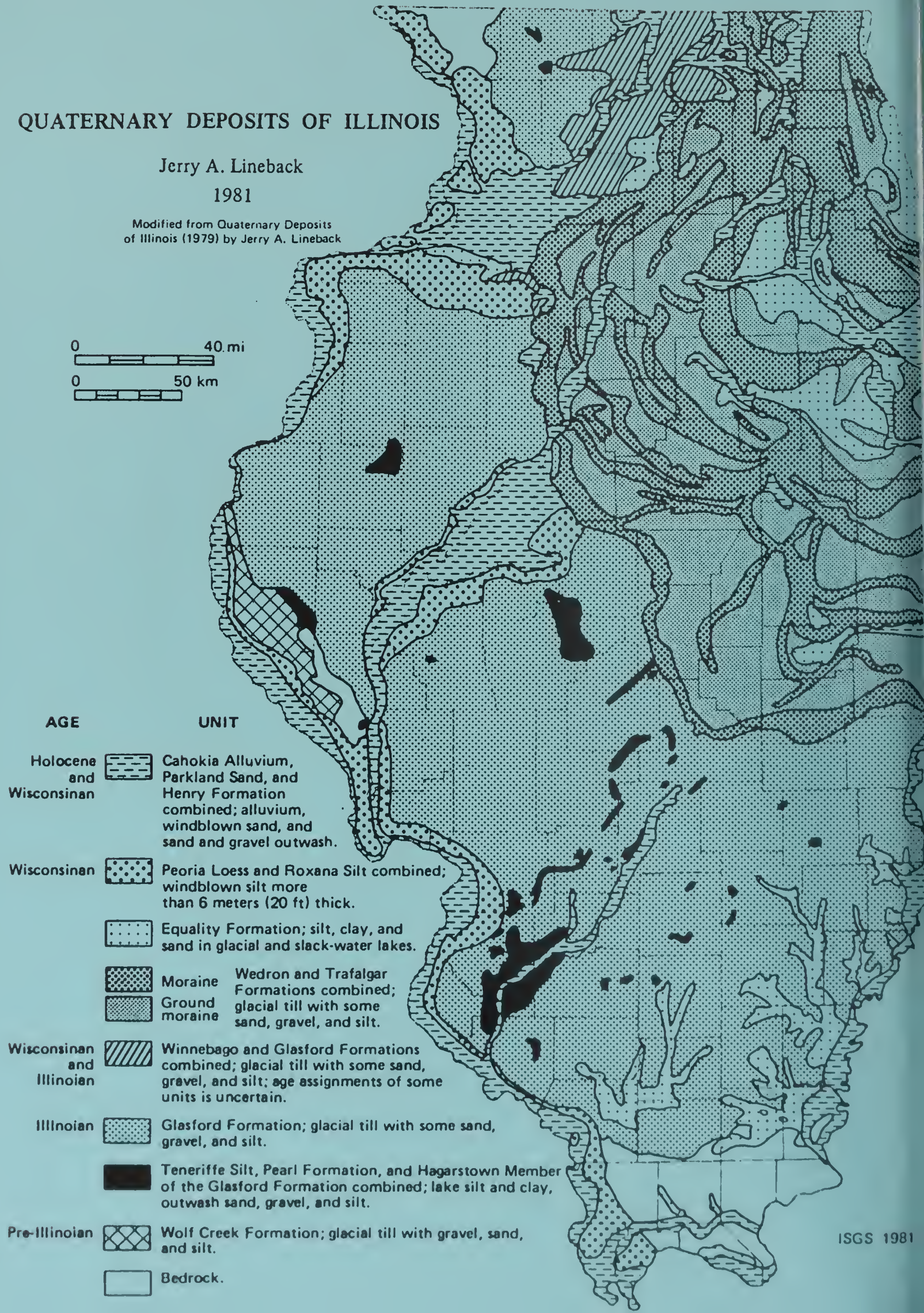
ALTONIAN
- Till plain

ILLINOIAN
- Moraine and ridged drift
- Groundmoraine

KANSAN
- Till plain

DRIFTLESS

Modified from Bull. 94.—pl. 2


QUATERNARY DEPOSITS OF ILLINOIS
Jerry A. Lineback
1981
Modified from Quaternary Deposits of Illinois (1979) by Jerry A. Lineback
0 40 mi
0 50 km
AGE
UNIT
Holocene and Wisconsinan
Cahokia Alluvium, Parkland Sand, and Henry Formation combined; alluvium, windblown sand, and sand and gravel outwash.
Wisconsinan
Peoria Loess and Roxana Silt combined; windblown silt more than 6 meters (20 ft) thick.
Equality Formation; silt, clay, and sand in glacial and slack-water lakes.
Moraine
Ground moraine
Wedron and Trafalgar Formations combined; glacial till with some sand, gravel, and silt.
Wisconsinan and Illinoian
Winnebago and Glasford Formations combined; glacial till with some sand, gravel, and silt; age assignments of some units is uncertain.
Illinoian
Glasford Formation; glacial till with some sand, gravel, and silt.
Teneriffe Silt, Pearl Formation, and Hagarstown Member of the Glasford Formation combined; lake silt and clay, outwash sand, gravel, and silt.
Pre-Illinoian
Wolf Creek Formation; glacial till with gravel, sand, and silt.
Bedrock.
ISGS 1981

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS IN ILLINOIS

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

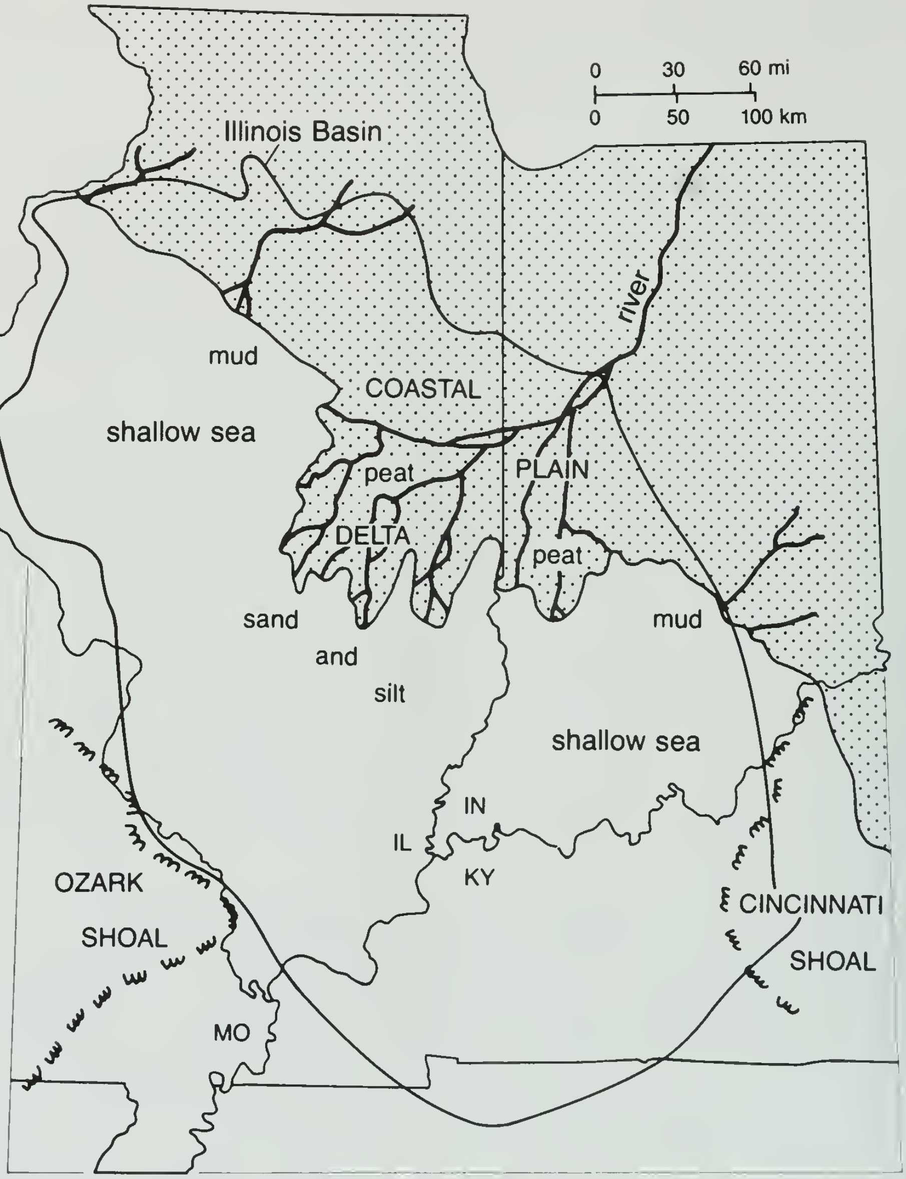
Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those of the preceding Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands to the northeast. This river system formed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

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

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

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

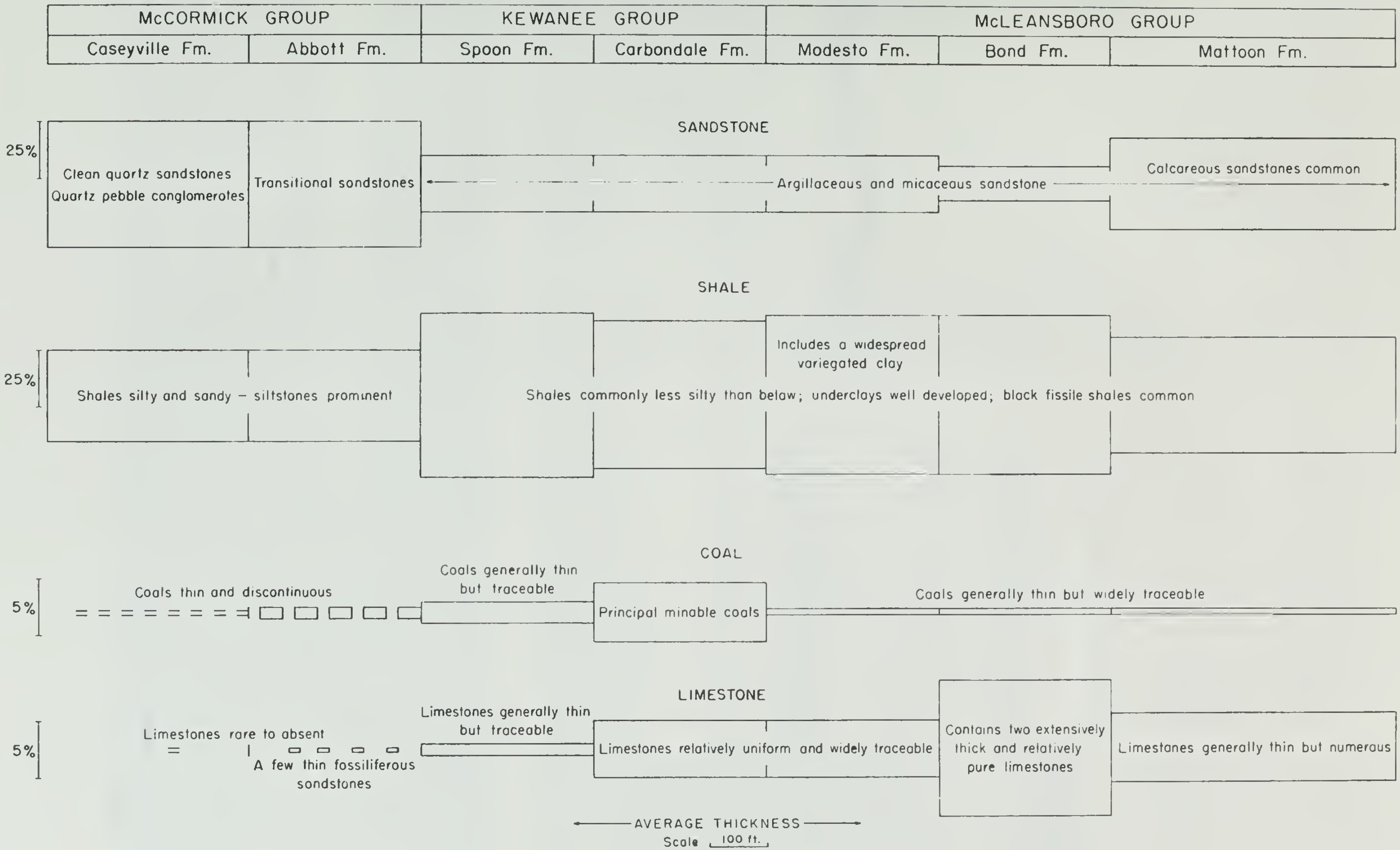
Beneath the quiet water of extensive swamps that prevailed for long intervals on the emergent coastal lowland, peat was formed by accumulation of plant material. Lush forest vegetation covered the region; it thrived in the warm, moist Pennsylvanian-age climate. Although the origin of the underclays beneath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



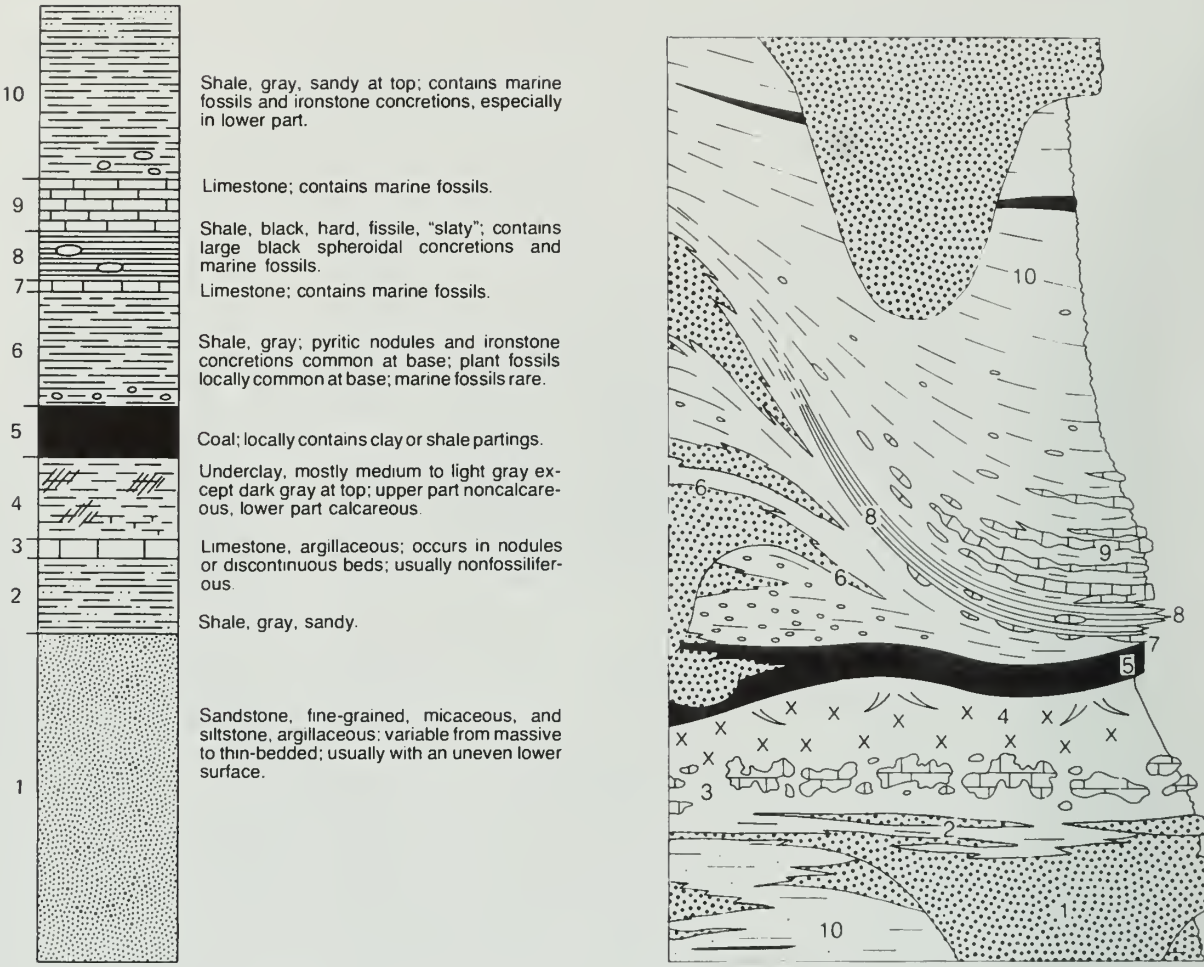
Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows a Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

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



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



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

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

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

Origin of Coal

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

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

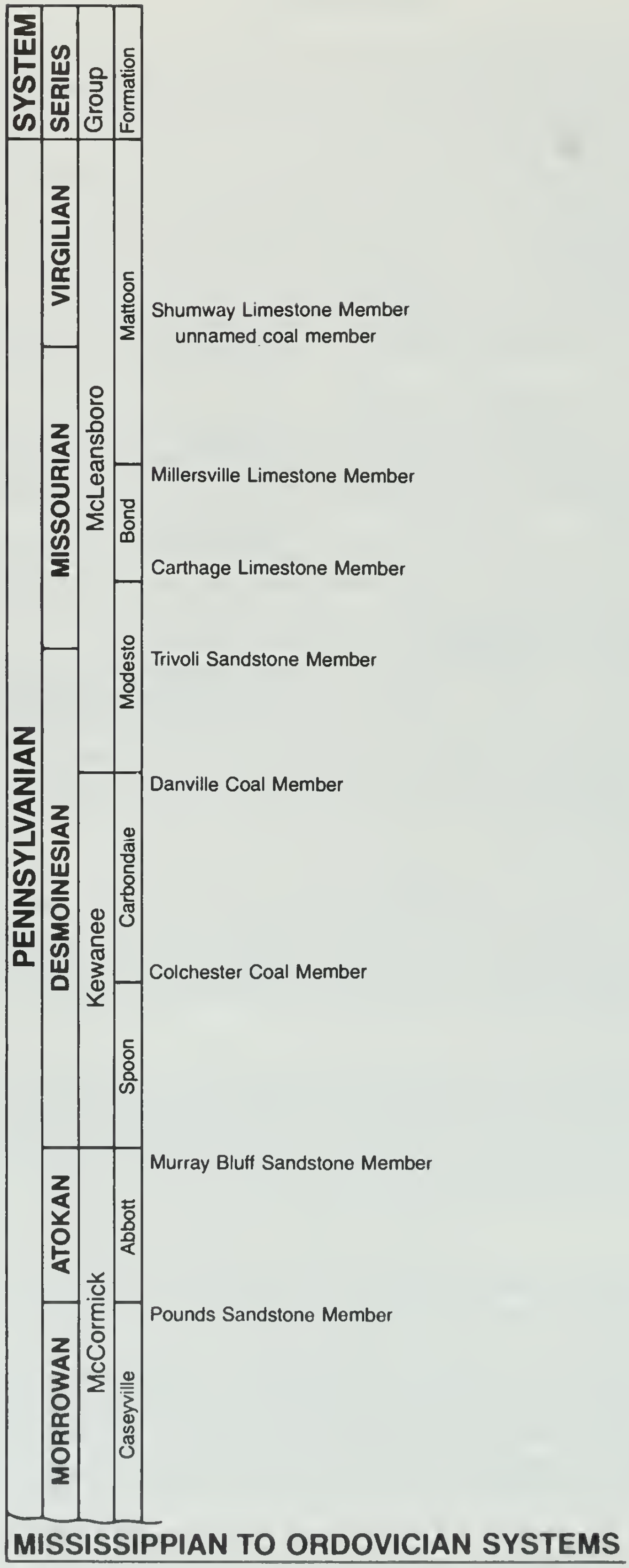
The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests, and the peat deposits were often buried by marine sediments. After the marine transgressions, peat usually became saturated with sea water containing sulfates and other dissolved minerals. Even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

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

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

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

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



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

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

References

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

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

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

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

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

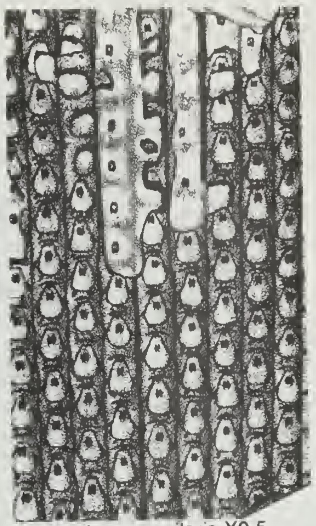
Willman, H. B., et al., 1967, Geologic Map of Illinois: Illinois State Geological Survey map; scale, 1:500,000 (about 8 miles per inch).

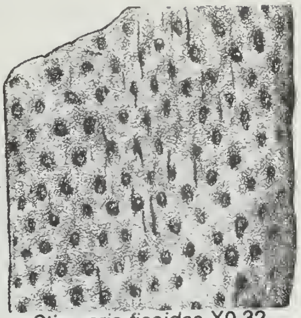
Willman, H. B., E. Atherton, T. C. Buschbach, C. W. Collinson, J. C. Frye, M. E. Hopkins, J. A. Lineback, and J. A. Simon, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

Common Pennsylvanian plants: lycopods, sphenophytes, and ferns

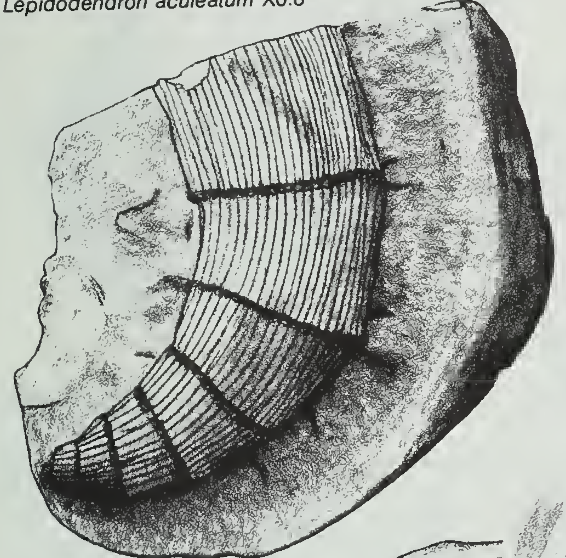

Lepidodendron aculeatum X0.8


Lepidophloios laricinus X0.63


Sigillaria mammilaris X0.5


Stigmaria ficoides X0.32


Lepidostrobus ovatifolius X0.8

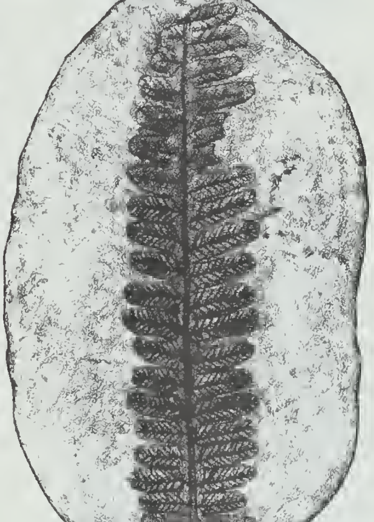

Calamites suckowii X0.5


Annularia stellata X0.63


Sphenophyllum cuneifolium X0.4


Pecopteris sp. X0.32

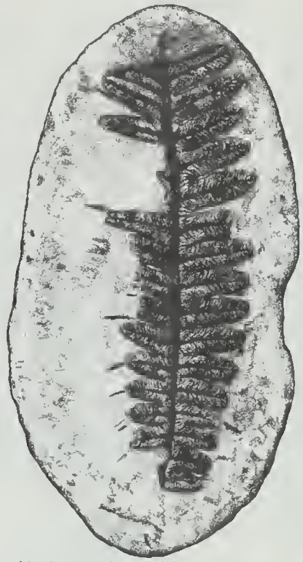

Pecopteris miltonii X2.0


Pecopteris hemitelioides X1.0

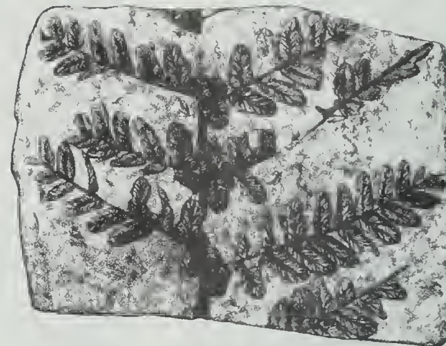
J. R. Jennings, ISGS

Common Pennsylvanian plants: seed ferns and cordaiteans

Alethopteris serlii X0.63



Alethopteris ambigua X0.63



Neuropteris rarinervis X0.5

Mariopteris nervosa X0.8

Neuropteris scheuchzeri X0.63

Sphenopteris rotundiloba X0.8

Trigonocarpus parkinsonii X1.25

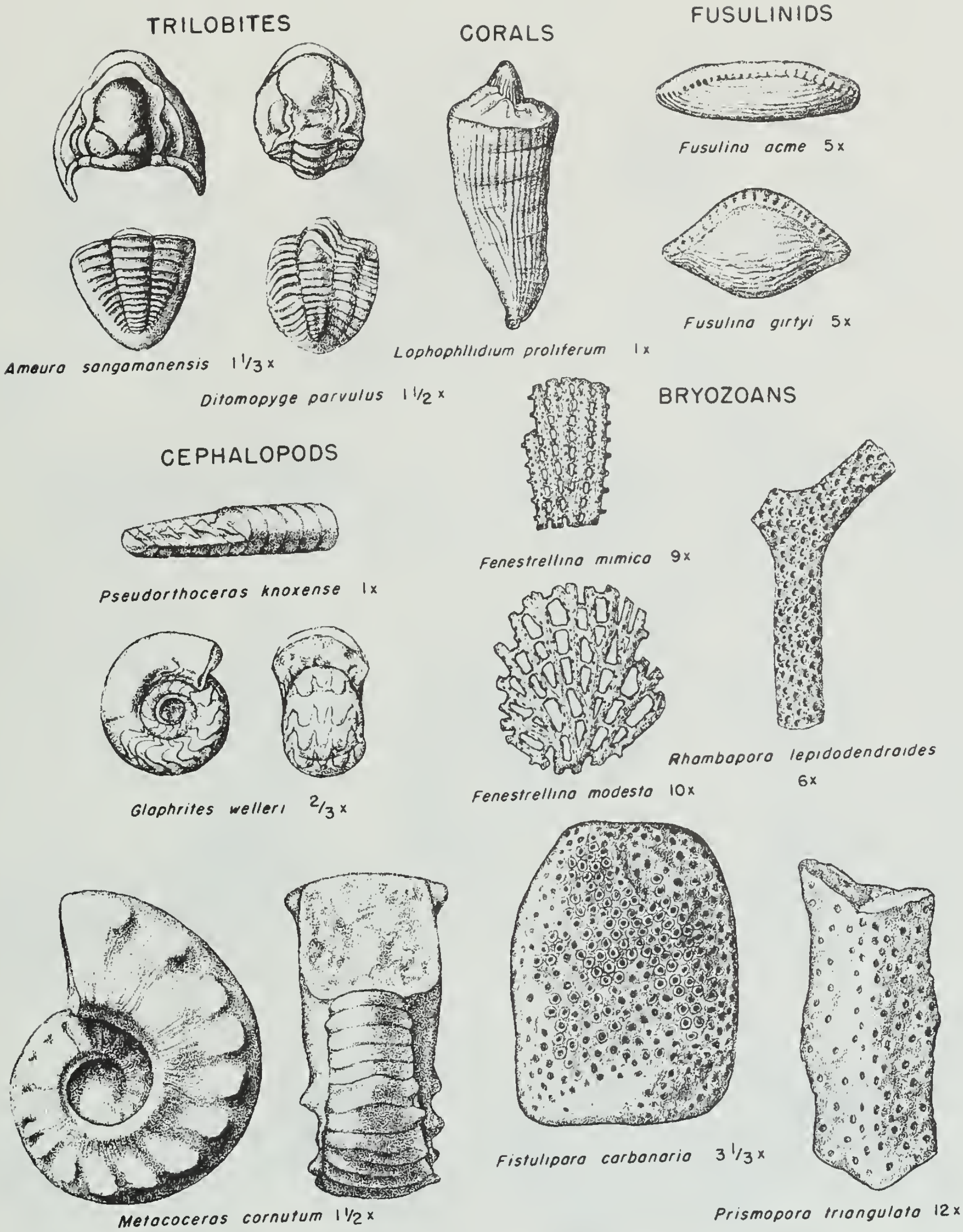
Cordaicladus sp X1.0

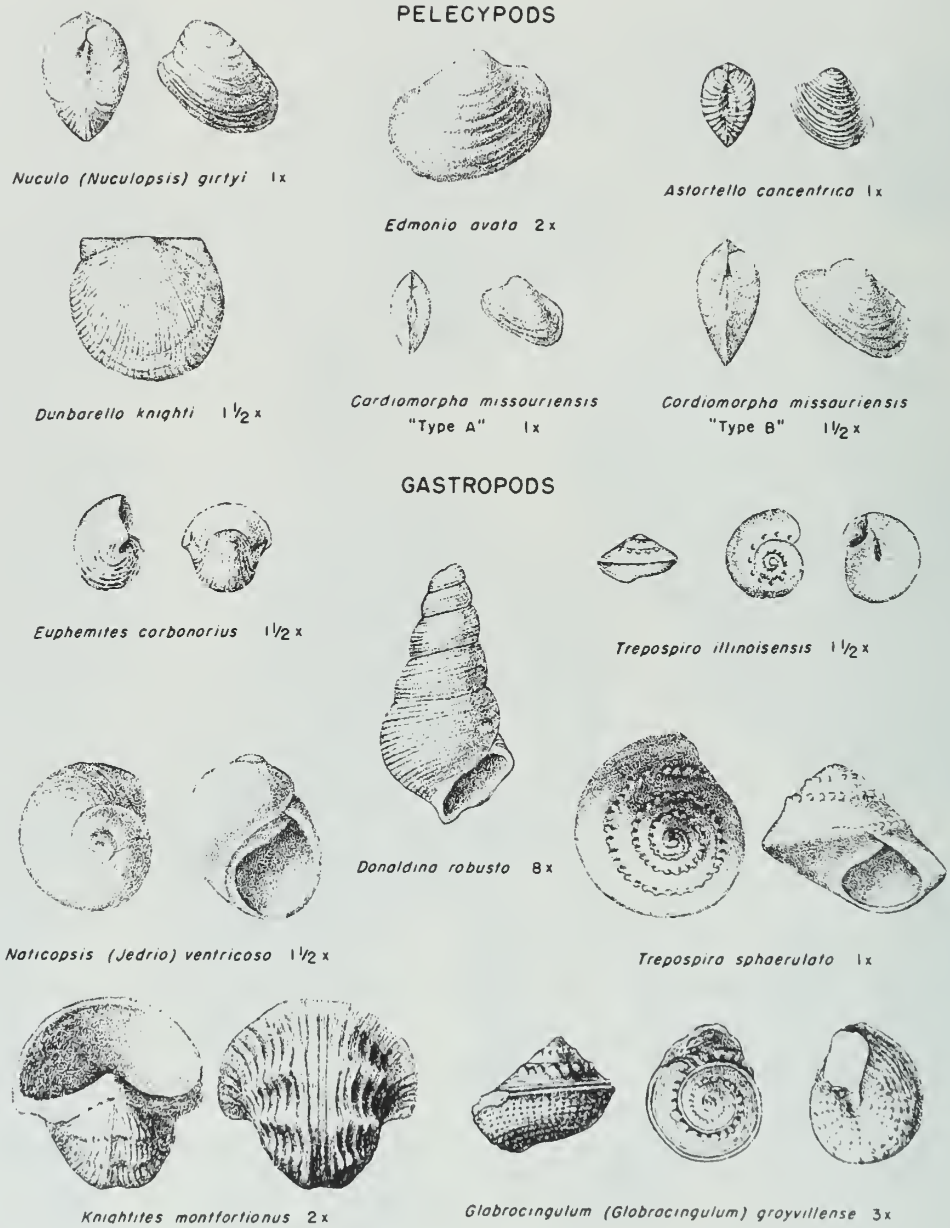
Artisia transversa X0.63

Cordaicarpon major X2.0

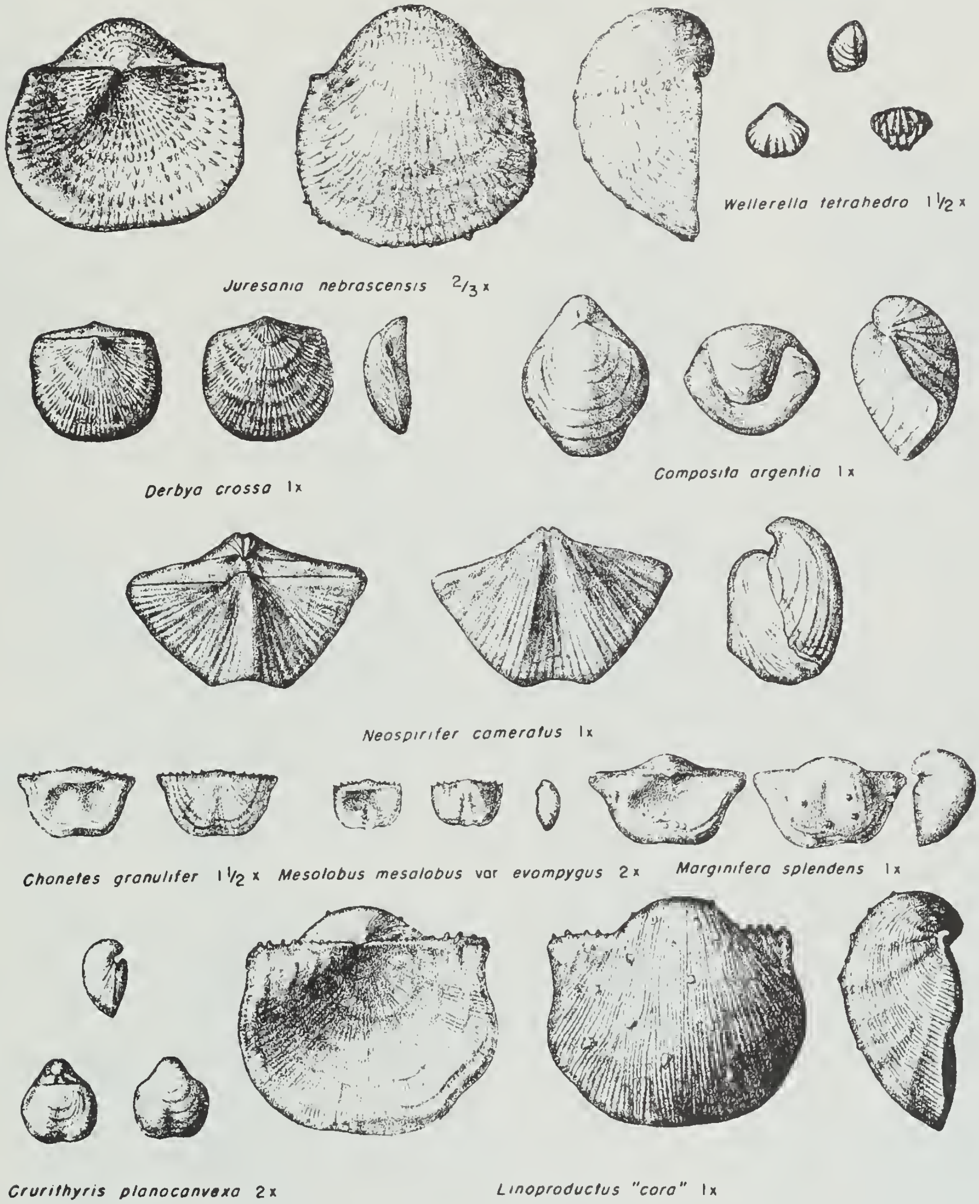
Cordaites principalis X0.63

J R Jennings, ISGS


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


PELECYPODS
Nucula (Nuculopsis) girtyi 1x
Edmonia ovata 2x
Astartella concentrica 1x
Dunbarella knighti 1 1/2 x
Cardiomorpha missouriensis "Type A" 1x
Cardiomorpha missouriensis "Type B" 1 1/2 x
GASTROPODS
Euphemites carbonarius 1 1/2 x
Trepospira illinoisensis 1 1/2 x
Donaldina robusta 8x
Naticopsis (Jedria) ventricosa 1 1/2 x
Trepospira sphaerulata 1x
Knightites montfortianus 2x
Glabrocingulum (Glabrocingulum) grayvillense 3x

BRACHIOPODS



FOSSIL PLANTS, FRANCIS CREEK SHALE

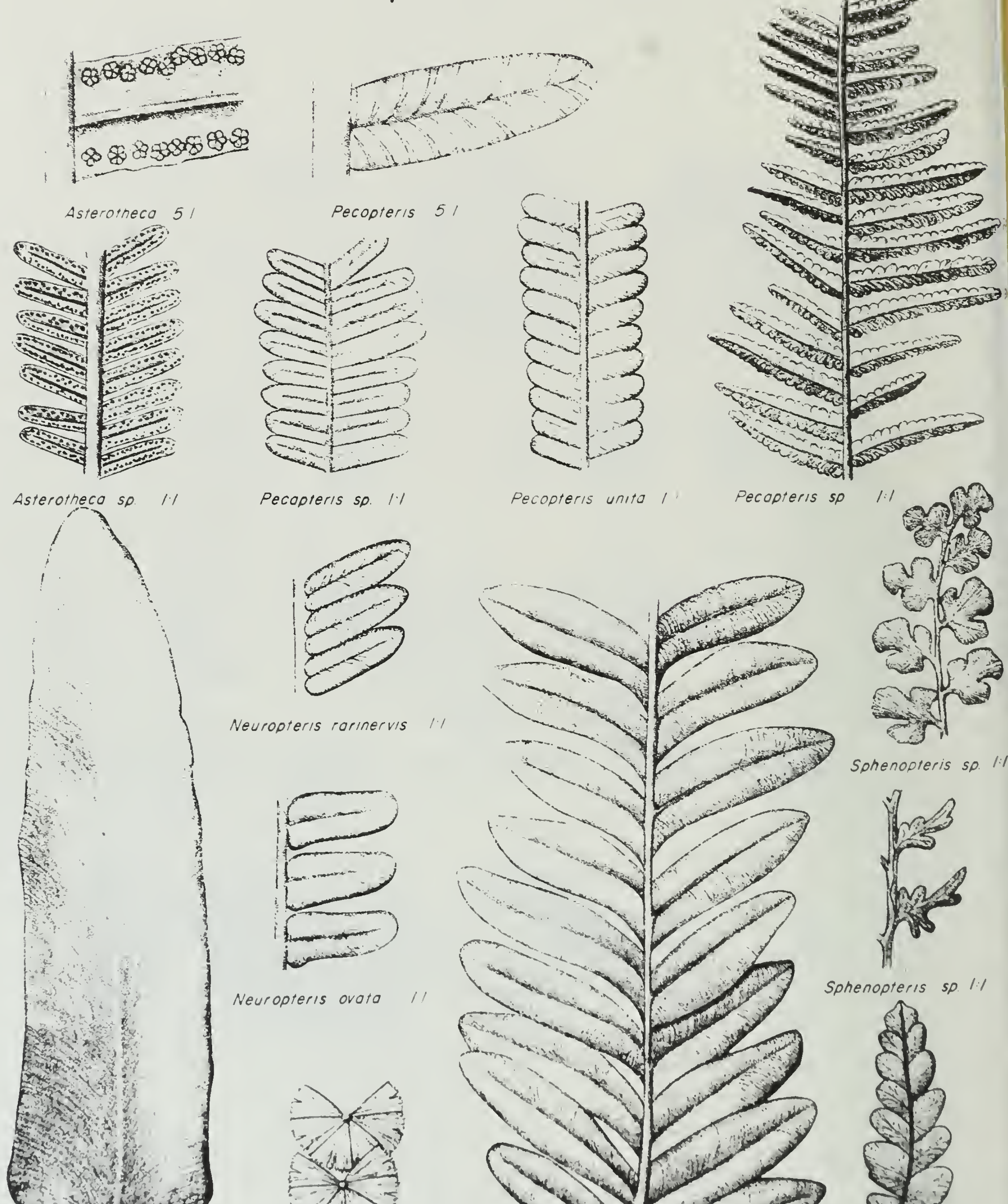


PLATE 3
(corrected)

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.

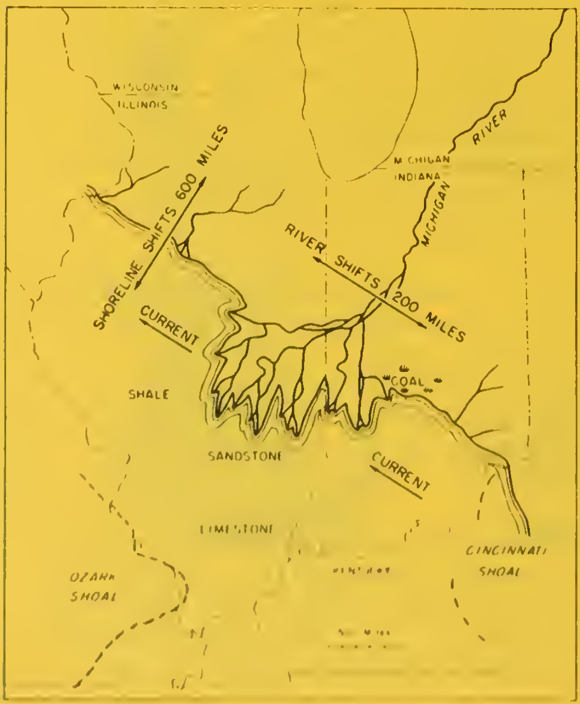
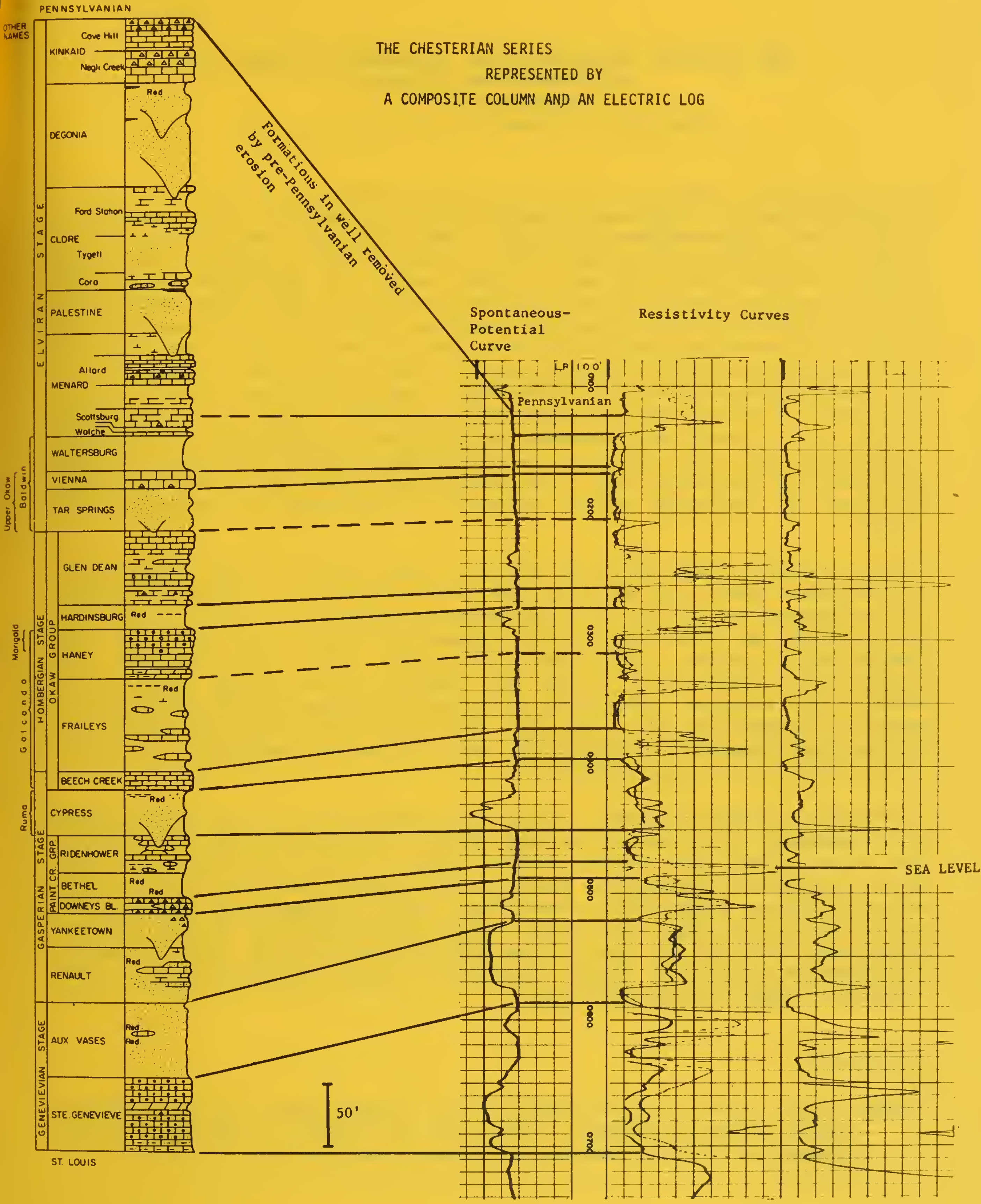


Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.

THE CHESTERIAN SERIES
REPRESENTED BY
A COMPOSITE COLUMN AND AN ELECTRIC LOG



THE TYPICAL MISSISSIPPIAN CHESTERIAN SERIES IN SOUTHWESTERN ILLINOIS

REPRESENTED BY
A COMPOSITE COLUMN AND AN ELECTRIC LOG

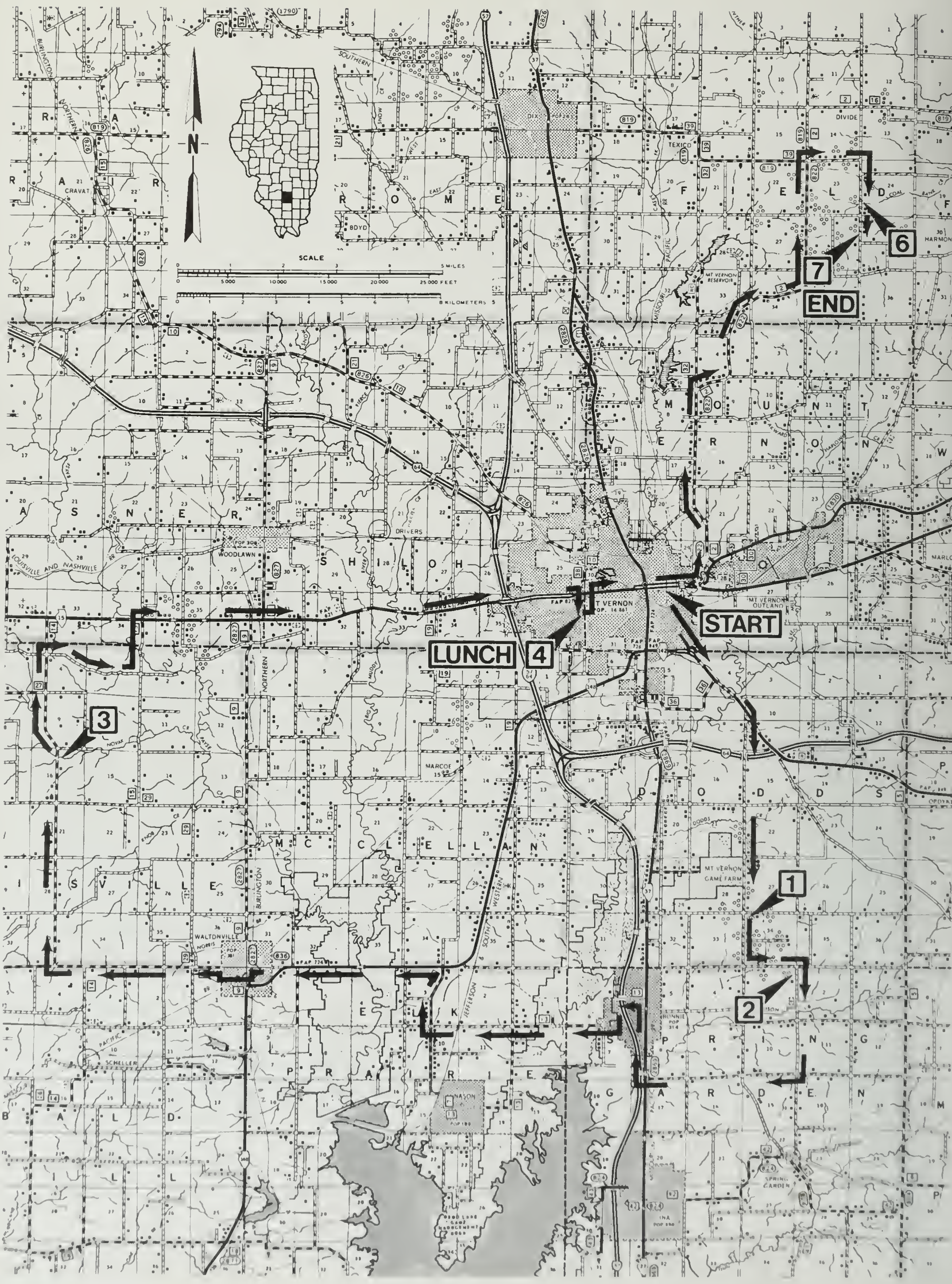
The composite column on the following page (RI 216, Pl 1) is a diagram drawn to represent certain rocks layers as they appear in a part of southwestern Illinois. The electric log (e-log) is a record made from instrument observations and recordings of rock layers in the bore of an oil-test well. A geologist made the column, using symbols to briefly express the significant rock unit qualities he could observe. In contrast, the e-log was made by an electrical sensing device lowered and raised in the test well to measure only two specific qualities of the rock layers: resistivity and spontaneous-potential. Together, the correlated column and e-log show in a concise way what the isolated outcrops in the area cannot, i.e., what thicknesses, variations in lithology, and mutual relations the sub-divisions of the Chesterian Series have across the country. In addition, the correlated e-log is a key that may be used to interpret other e-logs in this part of the Illinois Basin.

Cross-sections consisting of several corrlelated e-logs reproduced at the same scale are used to demonstrate that: (1) thicker layers of sandstone or shale or limestone--a particular rock unit--are delineated as characteristic shapes by the pair of S-P and resistivity curves, (2) the rock units vary in thickness and composition from one place to another, but many points of similarity persist (the unique curves of some units persist for several hundred miles), and (3) the seemingly abstract curves of the e-log create a pciture in many ways as readable as other illustrations of rock columns.

Because Illinois has been a major oil producer for many years, tens of thousands of e-logs have been made of wells drilled throughout the state. They are the principal tool of the geologists who map deep subsurface geological units (rock layers) and structures, such as anticlines, synclines, monoclinal folds, domes, etc. Because of their value, e-logs and other types of well logs are filed as permanent records at the Illinois State Geological Survey, where they may be examined. NOTE: copies of e-logs may be purchased from companies that reproduce them.

REFERENCE

Swann, D.H., 1963, Classification of Genevievian and Chesterian (Late Mississippian) rocks of Illinois: Illinois State Geological Survey Report of Investigations 216, 91 p.


START
END
LUNCH
1
2
3
4
6
7
SCALE
MT VERNON
MT VERNON RESERVOIR
MT VERNON OUTLAND
MT VERNON GAME FARM
DIX
TEXICO
DIVIDE
HARMONY
CRAVAT
WOODLAWN
DRIVERS
MARCOE
WALTONVILLE
NASON
BONNIE
SPRING GARDEN
INA
SCHELLER
NOVAK
MARLOW
SHILOH
McCLELLAN
DODDS
ROME
FIELD
MOUNT VERNON
SPRING GARDEN
PRAIRIE
ELK
LOUISVILLE AND NASHVILLE RR
MISSOURI PACIFIC
SOUTHERN
BURLINGTON NORTHERN