GUIDE TO THE GEOLOGY OF FAIRFIELD AREA, WAYNE COUNTY

C. Pius Weibel
David L. Reinertsen

Field Trip Guide Leaflet 1991A, April 20, 1991
Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

Cover photos by D. R. Reinertsen

(top to bottom)
Pond Creek in flood stage, March 1991
Oil well pumpjack, western Wayne County
Flooded Skillet Fork, flowing along a low sandstone bluff

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 to explore, explain, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers preparing earth science units. Grade-school students are welcome, but each must be accompanied by a parent or other responsible adult. High-school science classes should be supervised by at least one adult for each ten students.

A list of available earlier field trip guide leaflets 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, Illinois 61820. Phone (217) 244-2407 or 333-7372.

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ILLINOIS STATE GEOLOGICAL SURVEY
Morris W. Leighton, Chief

Natural Resources Building
615 East Peabody Drive
Champaign, Illinois 61820

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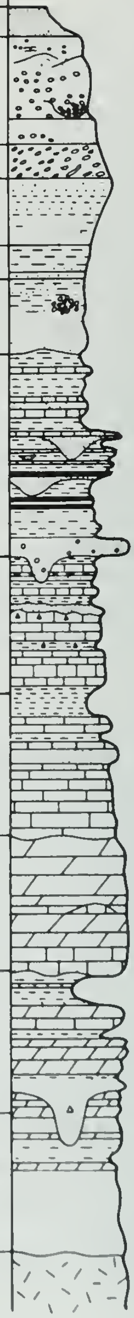
Era		Period or System and Thickness	Epoch	Age (years ago)	General Types of Rocks
CENOZOIC "Recent Life"	Age of Mammals		Holocene	10,000	Recent—alluvium in river valleys
		Quaternary 0-500'	Pleistocene Glacial Age	1.6 m.	Glacial till, glacial outwash, gravel, sand, silt, lake deposits of clay and silt, loess and sand dunes; covers nearly all of state except northwest corner and southern tip
			Pliocene	5.3 m.	Chert gravel; present in northern, southern, and western Illinois
		Tertiary 0-500'	Eocene	36.6 m. – 57.8 m.	Mostly micaceous sand with some silt and clay; present only in southern Illinois
			Paleocene	66.4 m.	Mostly clay, little sand; present only in southern Illinois
MESOZOIC "Middle Life"	Age of Reptiles	Cretaceous 0–300'		144 m.	Mostly sand, some thin beds of clay and, locally, gravel; present only in southern Illinois
PALEOZOIC "Ancient Life"	Age of Amphibians and Early Plants	Pennsylvanian 0-3,000' ("Coal Measures")		286 m. – 320 m.	Largely shale and sandstone with beds of coal, limestone, and clay
		Mississippian 0-3,500'		360 m.	Black and gray shale at base; middle zone of thick limestone that grades to siltstone, chert, and shale; upper zone of interbedded sandstone, shale, and limestone
	Age of Fishes	Devonian 0-1,500'		408 m.	Thick limestone, minor sandstones and shales; largely chert and cherty limestone in southern Illinois; black shale at top
	Age of Invertebrates	Silurian 0-1,000'		438 m.	Principally dolomite and limestone
		Ordovician 500-2,000'		505 m.	Largely dolomite and limestone but contains sandstone, shale, and siltstone formations
		Cambrian 1,500-3,000'		570 m.	Chiefly sandstones with some dolomite and shale; exposed only in small areas in north-central Illinois
ARCHEOZOIC and PROTEROZOIC					Igneous and metamorphic rocks; known in Illinois only from deep wells



Rock succession chart

GEOLOGIC FRAMEWORK OF THE FAIRFIELD AREA

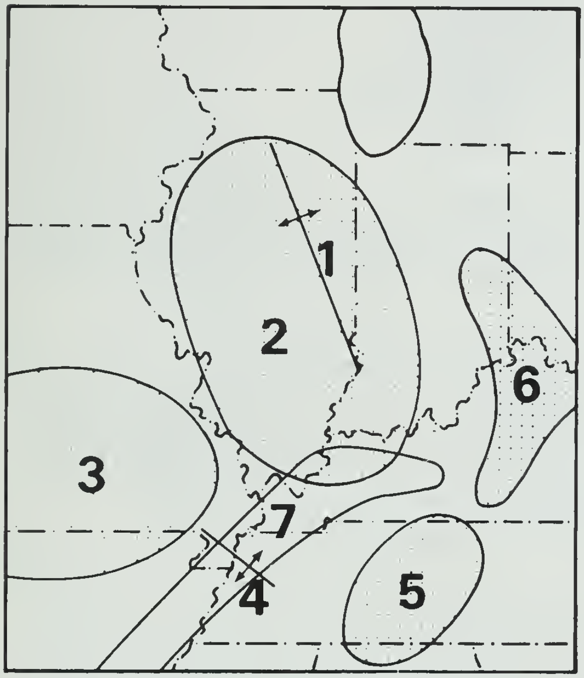
Location

The Fairfield geological science field trip area lies within Wayne County, slightly northeast of the center of southern Illinois. About 260 miles south-southwest of Chicago, nearly 105 miles east-southeast of St. Louis, and about 105 miles northeast of Cairo, this area is one of the nerve centers of the oil industry in Illinois.

Bedrock

Through hundreds of million years of geologic time (see rock succession column, facing page), the Wayne County area has undergone many changes. The ancient Precambrian basement composed of granitic igneous, and possibly metamorphic, crystalline rocks underwent deep erosion that produced a landscape similar to parts of the present-day Missouri Ozarks. During a period when the continental plate—the early North-American continent—was beginning to rip apart (plate tectonic movements), rift valleys formed in what is now southernmost Illinois, near the Kentucky-Illinois Fluorspar Mining District. (Evidence for these plate movements and structural changes in the earth's crust comes from surface mapping, gravity and magnetic field measurements, and seismic exploration for oil.) These rift valleys, now referred to as the Rough Creek Graben and the Reelfoot Rift (fig. 1), filled with sands and gravels shed from the adjacent uplands and with sediments deposited in lakes that formed along the valley floors.

Around the beginning of the Paleozoic Era, some 525 million years ago, the rifting stopped and the hilly Precambrian landscape began to slowly sink on a broad, regional scale. This permitted a shallow sea to invade from the south and southwest. During the several hundred millions of years of the Paleozoic Era, what is now the southern Illinois area continued to receive sediments deposited in shallow seas that repeatedly covered the area. This part of Illinois and adjacent areas of Indiana and Kentucky continued to slowly sink until at least 15,000 feet of sedimentary strata had accumulated (fig. 2). These strata range from about 523 million years old (Cambrian Period) to 288 million years old (Pennsylvanian Period). In Wayne County, Paleozoic sedimentary strata reach thicknesses in excess of 10,500 feet in the northwest and about 13,300 feet in the southeast. Rocks of the Devonian and Mississippian Periods have been successfully drilled for their petroleum resources in Wayne County.



At times during the Paleozoic Era, the seas withdrew and the sediments previously deposited were weathered and eroded. As a result, the sedimentary record in Illinois has some gaps.

Figure 1 Location of some 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.

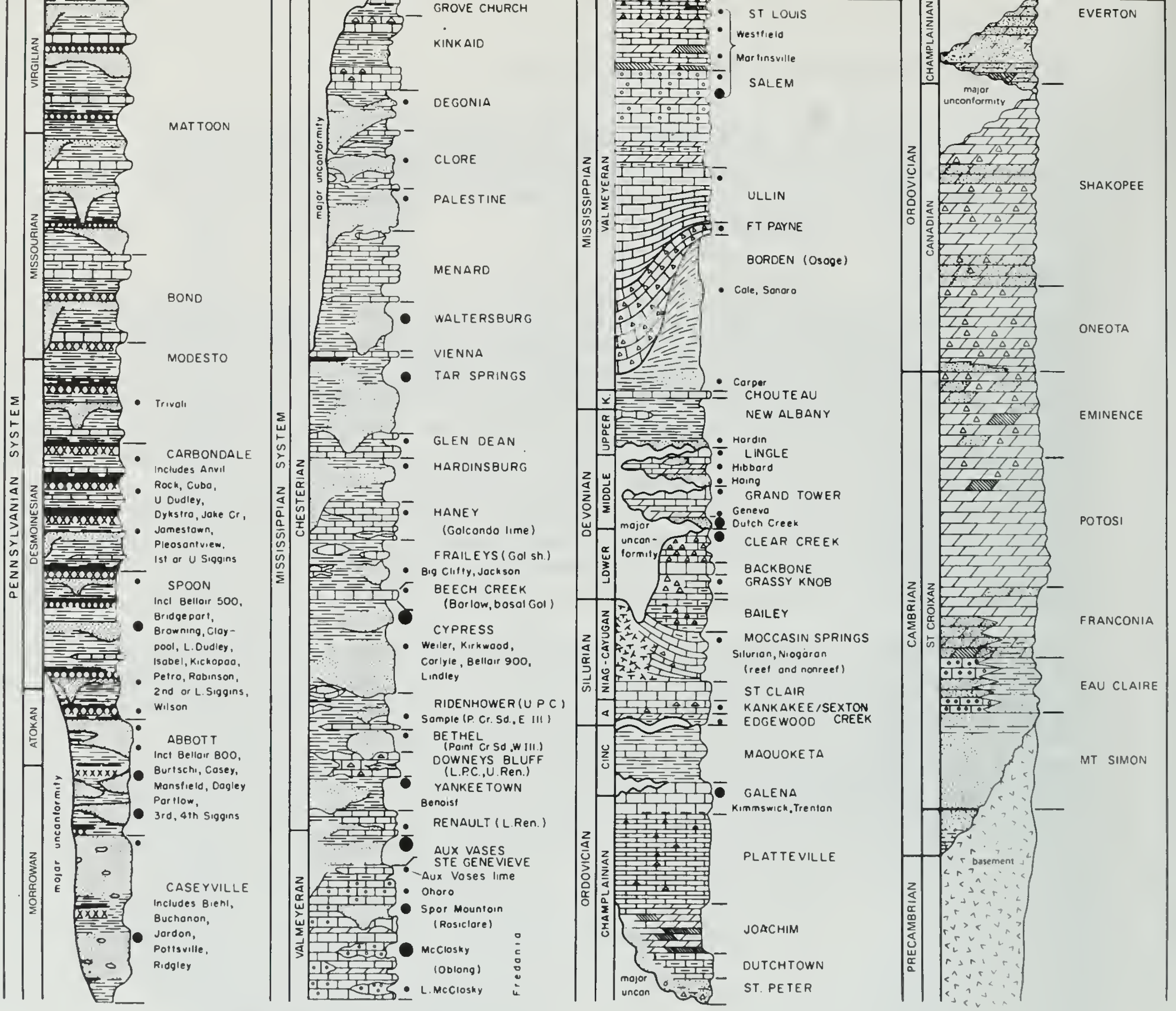


Figure 2 Generalized geologic column of southern Illinois. Black dots indicate oil and gas pay zones. Formation names are in capitals; other pay zones are not. About 4,000 feet of lower Ordovician and upper Cambrian rocks under the St. Peter are not shown. (Originally prepared by David H. Swann.)

The Pennsylvanian-age bedrock that lies directly beneath the cover of glacial till in Wayne County consists of strata or layers of sandstone, siltstone, shale, limestone, coal, and underclay deposited in shallow seas and swamps between about 320- and 288-million years ago. Some of these rocks are exposed in roadcuts and stream banks. The Pennsylvanian strata thicken from slightly less than 1,800 feet in northwestern Wayne County to approximately 2,400 feet in the southeastern. A description of these rocks and their occurrence may be found in *Depositional History of the Pennsylvanian Rocks* (at the back of this guide booklet).

Pennsylvanian rocks younger than those exposed at the bedrock surface in Wayne County are known from other Illinois localities. These strata, and perhaps younger Permian strata overlying them, may have been deposited across this area. However, during the nearly 245 million years between the close of the Paleozoic Era and the onslaught of the Pleistocene ice sheets 1 to 2 million years ago, ample time passed to erode as much as several thousand feet of strata and remove all traces of their presence from this region.

Figure 3 Structural features of Illinois.

Structural and Depositional History

Near the close of the Mississippian Period, gentle arching of the rocks in eastern Illinois initiated the development of the La Salle Anticlinal Belt (figs. 1 and 3). Gradual arching apparently continued through Pennsylvanian time. The La Salle Anticlinal Belt is a complex structure that has smaller structures such as domes, anticlines, and synclines superimposed on the broad upwarp of the belt. It extends from La Salle County in northern Illinois southeastward as far south as Lawrence County. Because of the absence of the youngest Pennsylvanian strata from the area of the anticlinal belt, we cannot know just when movement ceased along the belt. Indirect evidence suggests that the folding and faulting had stopped by about the end of the Pennsylvanian, or perhaps a little later during the Permian Period, near the close of the Paleozoic Era.

After the Paleozoic Era, during the Mesozoic Era, the rise of the Pascola Arch (fig. 1) in southeastern Missouri and western Tennessee separated the Illinois Basin from other basins to the south. The Illinois Basin is a broad, subsided region covering much of Illinois, southern Indiana, and western Kentucky (figs. 1 and 4). Development of this arch in conjunction with the earlier sinking of the deeper parts of the Illinois Basin, gave the Illinois Basin its present asymmetrical, spoon-shaped configuration. The geologic map (fig.5) shows the distribution of the rock systems of the various geologic time periods as they would appear if all the glacial, windblown, and surface materials were removed.

The Fairfield field trip area is located in the southeastern part of the Illinois Basin, which extends into southwestern Indiana and western Kentucky. Smaller subsidiary structures, such as the Fairfield Basin, were superimposed on the larger basin structure at different times during

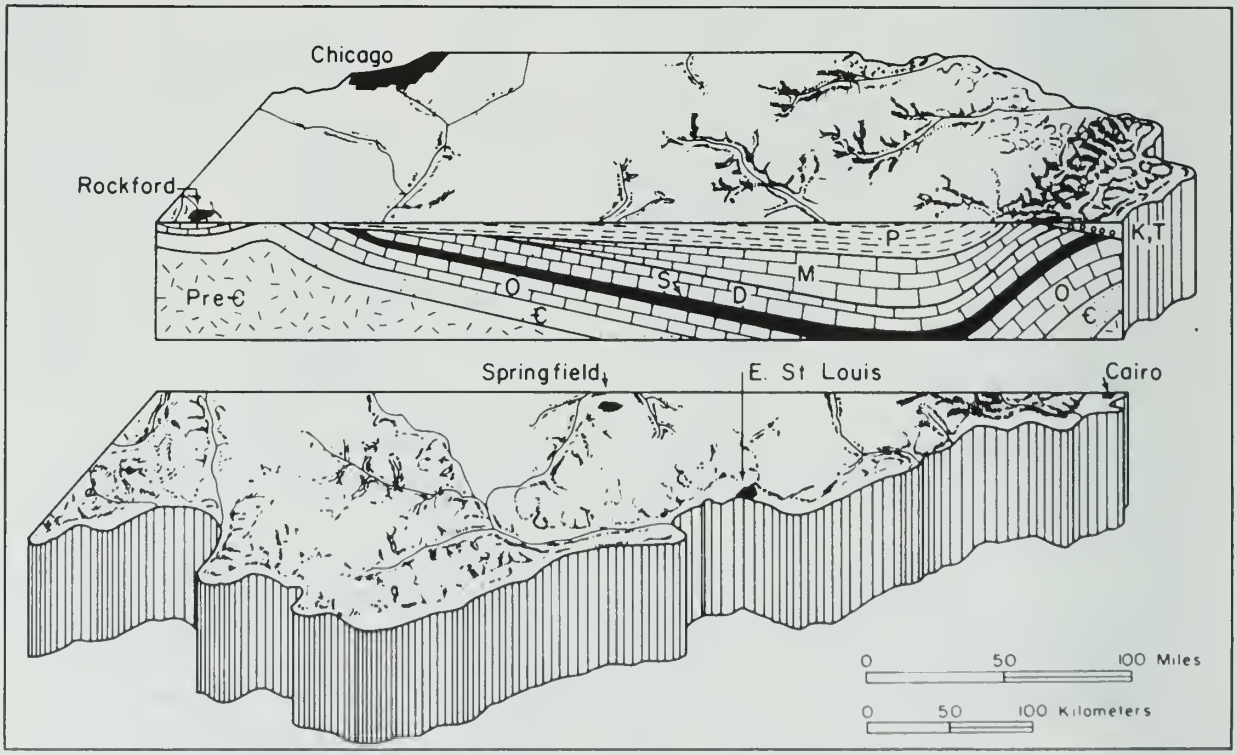


Figure 4 Stylized north-south cross section shows structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks is greatly exaggerated and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks, Precambrian (Pre-C) granites, form a depression filled with layers of sedimentary rocks of various ages: Cambrian (C), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). The scale is approximate.

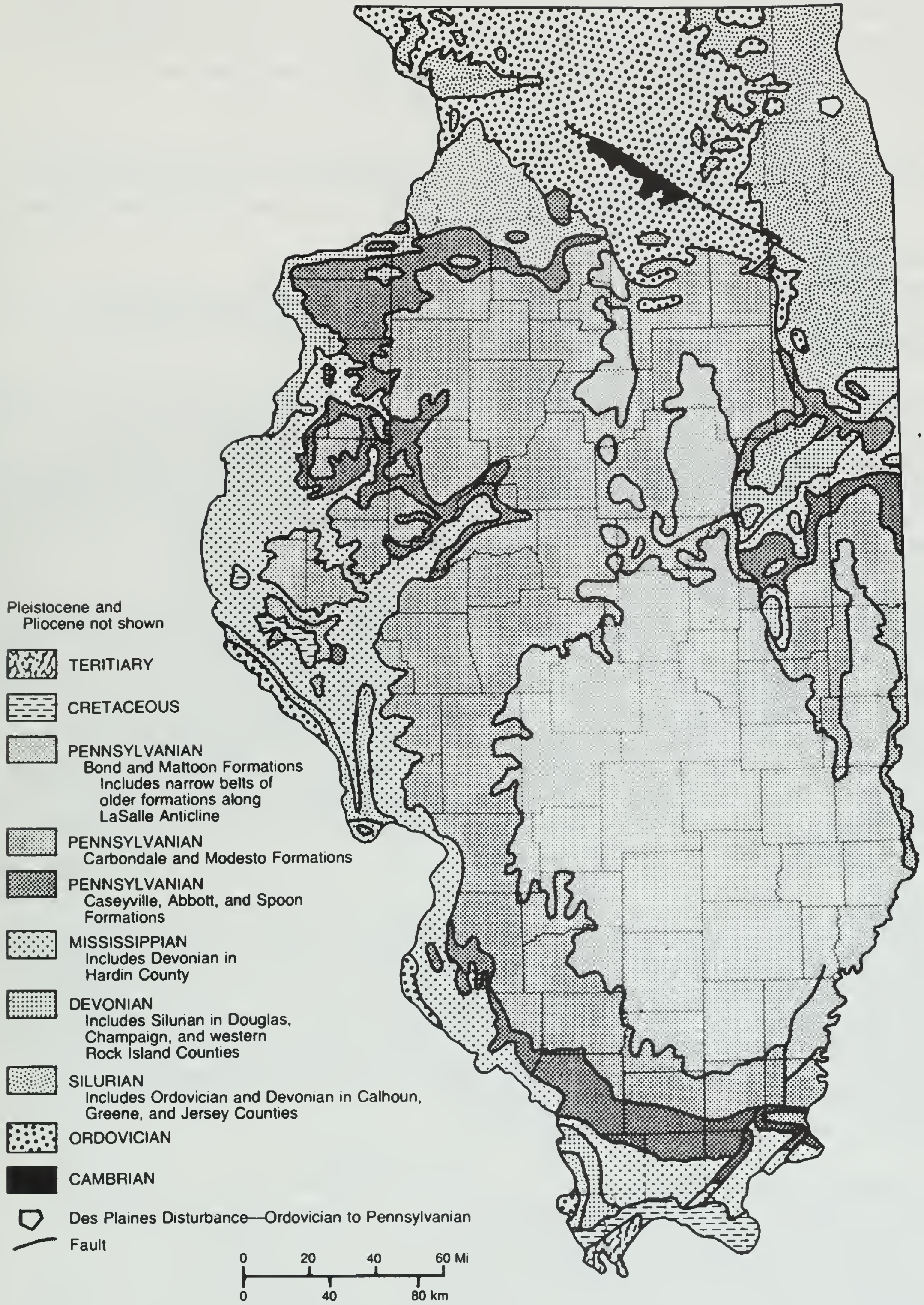


Figure 5 Bedrock geology of Illinois.

the geologic past. Wayne County is on the northern perimeter of the Fairfield Basin, an area that is bounded by the La Salle Anticlinal Belt on the northeast, the Louden Anticline and the Du Quoin Monocline on the northwest and west, and the Cottage Grove Fault System on the south (fig. 3). 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.

Nearly 8,000 wells have been drilled in about the last 50 years in the Clay City Anticlinal Belt, near the center of the Fairfield Basin. This structure extends from about 4 miles south-southeast of Fairfield north-northeastward into central Jasper County, a distance of some 45 miles.

Glacial History

A brief general history of glaciation in North America and a description of the deposits commonly left by glaciers may be found in *Pleistocene Glaciations in Illinois* at the back of the guide booklet.

In the Fairfield 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 extends southeastward from the northwest part of the county through its southeastern part. Drainage northeast of the divide was through the buried Elm River and its tributaries to the buried Little Wabash River. Drainage to the west of the divide flowed southeastward through the buried Skillet Fork and its tributaries to the buried Little Wabash River.

Beginning about 1.6 million years ago, during the Pleistocene Epoch, massive sheets of ice thousands of feet thick—continental glaciers—flowed slowly southward from the far north, now Canada. The last of these glaciers melted from the region that is now northeastern Illinois about 13,500 years before the present. Although ice sheets covered large areas of present-day Illinois several times during the Pleistocene Epoch, it was during the Illinoian glaciation, around 270,000 years before the present, that North American continental glaciers reached their southernmost extent. Advancing from centers of snow and ice accumulation in northern North America (see map in *Pleistocene Glaciations in Illinois* at the back of the guide booklet). The glaciers reached as far south as the northern part of present-day Johnson County, Illinois, a little more than 60 miles southwest of here (fig. 6).

The Illinoian glaciers probably built moraines—that is, ridges or mounds of unsorted rock materials carried along and then left by the ice. Some glacial deposits in the southeastern part of the county have been described as morainal in nature. We will have the opportunity to see part of this area on our field trip. Illinoian moraines were similar to the moraines of the later Wisconsinan glaciers, but apparently not so numerous. Also, they were exposed to weathering and erosion for thousands of years longer than their younger Wisconsinan counterparts. Fairfield lies about 65 miles south of the late Wisconsinan Shelbyville Moraine, the earliest moraine of the Woodfordian Substage that was deposited about 22,000 years before present (see time chart, *Pleistocene Glaciations in Illinois*).

The topography of the bedrock surface throughout much of Illinois is largely hidden from view by glacial deposits (drift) except along the major streams. In many areas, the glacial drift is thick enough to completely mask the underlying bedrock surface. Studies of mine records, water-well logs, and other drill-hole information, coupled with scattered bedrock exposures in some stream valleys and roadcuts, show that the present land surface of the field trip area largely reflects the underlying bedrock surface. Thus the preglacial bedrock surface has been only slightly modified and subdued by a thin mantle of glacial drift. Partly because of the

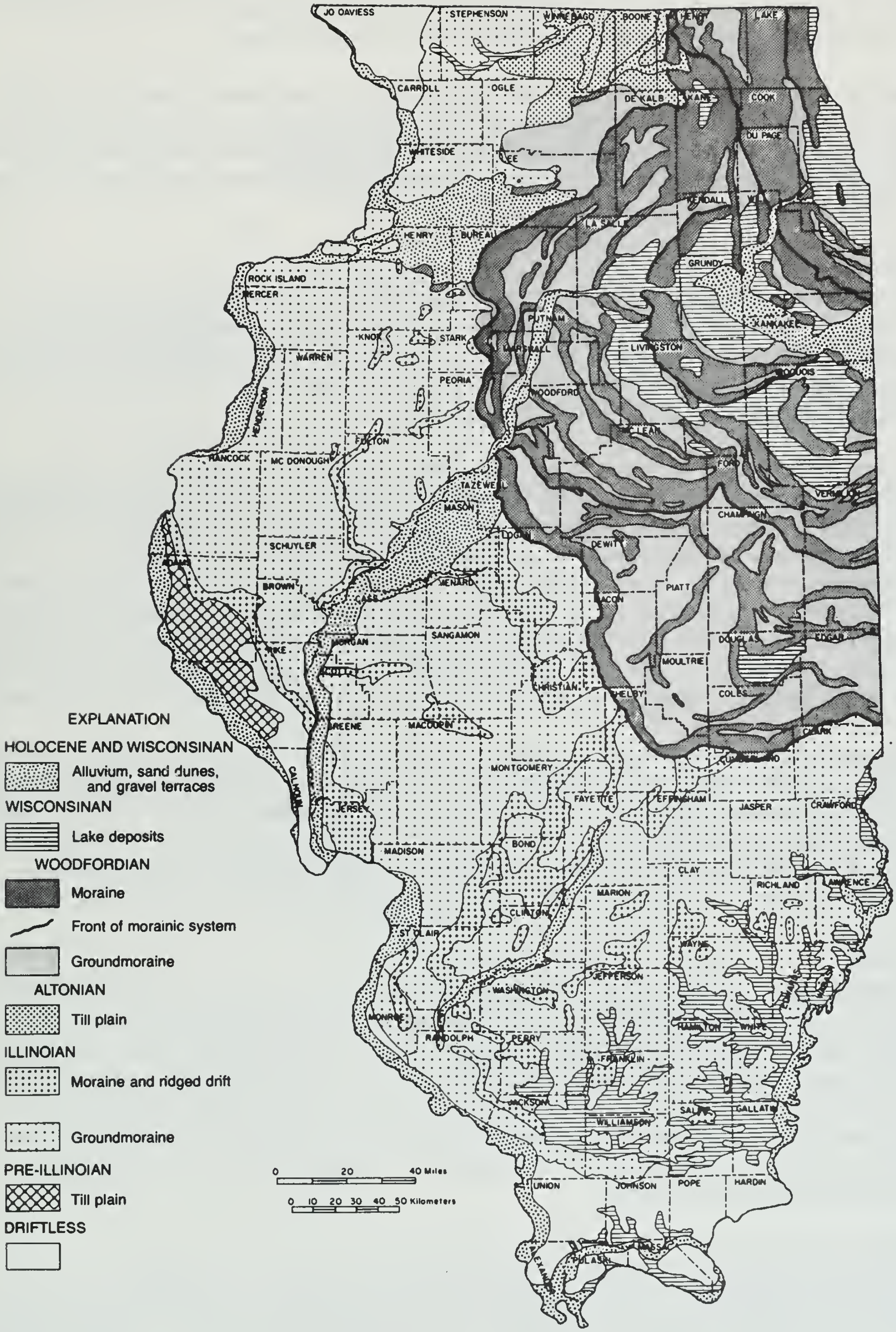


Figure 6 Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

irregular bedrock surface and partly because of erosion, glacial drift is unevenly distributed across Wayne County. In the buried valley of the Little Wabash River, drift is somewhat more than 100 feet thick, but the uplands generally have less than 25 feet.

A thin cover, 4 feet thick or less, of windblown silt called Peoria Loess (pronounced "luss") mantles the glacial drift in Wayne 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.

Physiography

The Fairfield field trip area is situated in the eastern part of the Mt. Vernon Hill Country, the southernmost Illinois division of the Till Plains Section, Central Lowland Province (fig. 7). The Mt. Vernon Hill Country has a mature topography of low relief with limited upland prairies and broad alluviated valleys along the larger streams. Glacial landforms are few and scattered. No pre-Illinoian drift deposits are known in this field trip area.

According to Horberg (1946) and others (Leighton, Ekblaw, and Horberg 1948), prior to glaciation, the relatively weak rocks of Pennsylvanian age east and south of the present-day Illinois River eroded into an extensive lowland called the "central Illinois peneplain." The surface appears to have been one of low relief and sloped gently from about 550 feet in the northwestern corner of Wayne County to somewhat more than 450 feet in the southeastern part. Apparently, just before glaciation began, an extensive system of bedrock valleys was entrenched below the central lowland surface. Although the floors of the bedrock valleys may have been a couple of hundred feet below the higher parts of the upland surface, slopes were quite gentle, generally less than 1°, not unlike what we see across much of the landscape now.

The gross features of the Till Plains Section, as well as local features of the Mt. Vernon Hill Country, are determined largely by this preglacial topography. As glaciation began, streams probably changed from erosion to aggradation—that is, the streams began to build up and fill in their channels because the flow or volume of water was insufficient to carry increasing loads of sediments. No evidence indicates that the early fills in these preglacial valleys were ever completely flushed out of their channels by succeeding deglaciation meltwater torrents.

Drainage

The present-day drainage system is relatively complete; most streams have broad terraced valleys and low gradients (bottom slopes). The uplands generally have fairly good natural drainage, but the larger valley bottoms are poorly drained. The Elm River and its tributaries drain the north-central part of the field trip area southeastward to the Little Wabash River in the east-central part of the county. The Skillet Fork and its tributaries drain northwestern and western Wayne County south and eastward to the Little Wabash River. Pond Creek drains the southeast part of the county. The larger streams are sluggish and occupy the preglacial bedrock valleys for the most part.

Relief

The highest land surface in Wayne County is at Powers Church, 2.5 miles east and 1 mile south of the northwest corner of the county, where the surface elevation is 603 feet above mean sea level (msl). The lowest elevation is a little less than 360 feet msl on Skillet Fork east

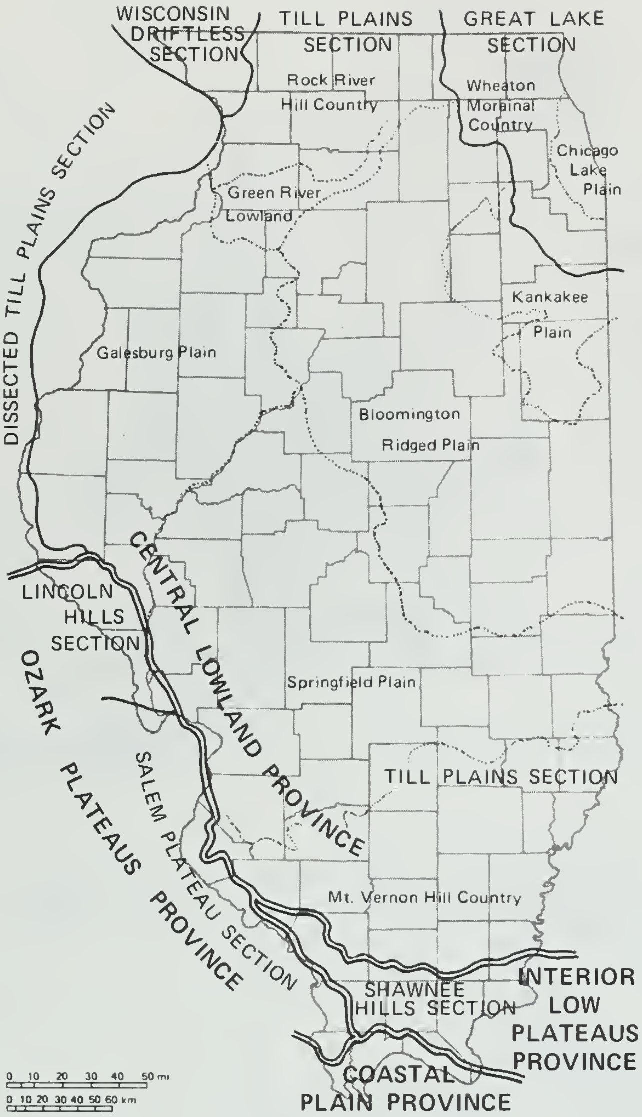


Figure 7 Physiographic divisions of Illinois.

of the center of the south county line. The surface relief of Wayne County, calculated as the difference between the highest and lowest surfaces, is thus slightly more than 240 feet. Local relief is generally 30 to 40 feet except for a few scattered areas in the northwest, northeast, and the southeast where the relief ranges from about 60 feet to more than 140 feet overlooking the Little Wabash Valley.

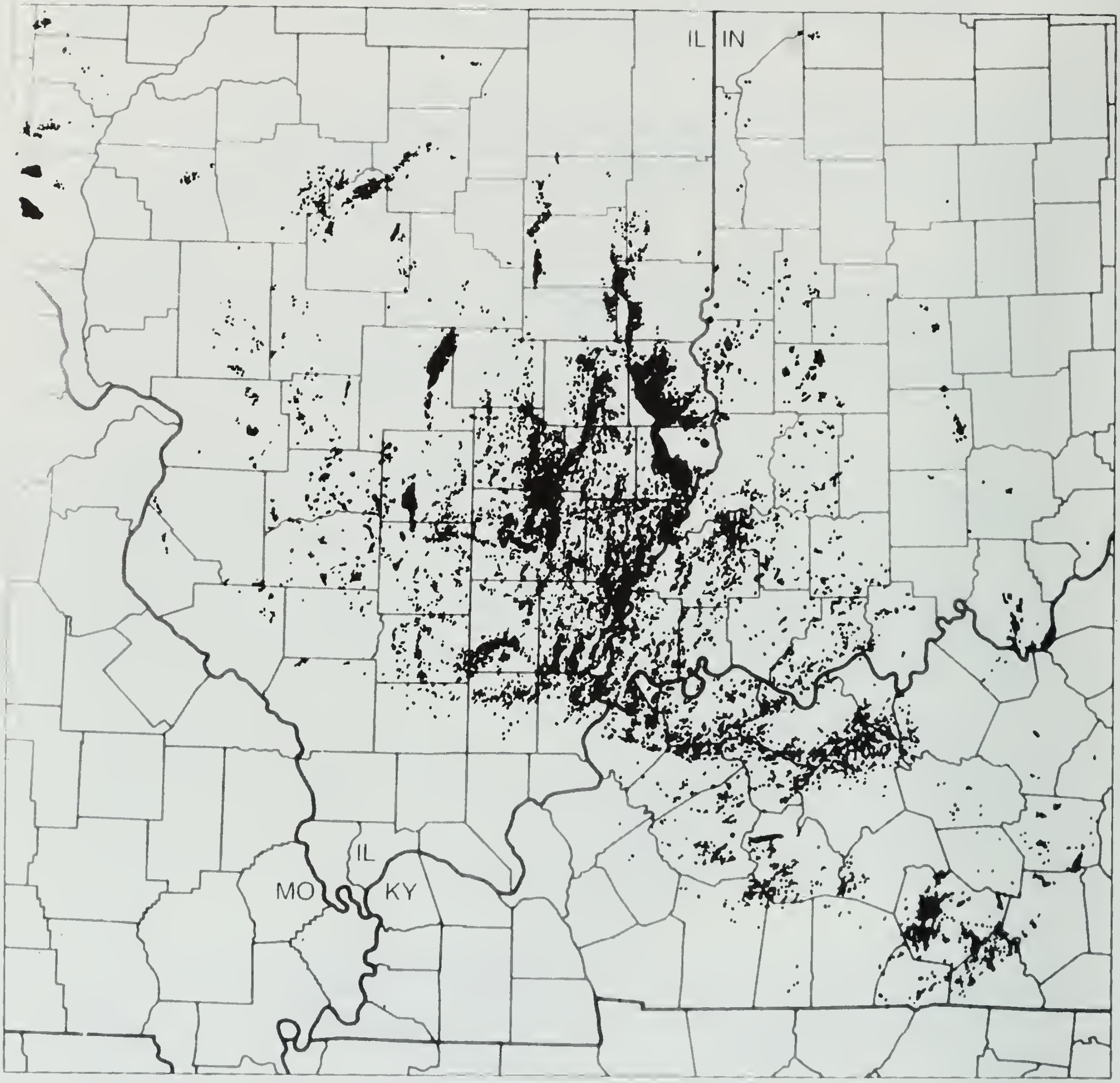


Figure 8 Oil fields of the Illinois Basin.

0 30 60 mi
0 50 100 km

MINERAL PRODUCTION

Among all counties in Illinois, Wayne County ranked 28th in 1988 for total value of minerals extracted—crude oil and natural gas. The county placed fourth in oil production within the state; Wayne County production amounted to 1,740,000 barrels valued at $25,735,000, equivalent to 7.7 percent of the state's total oil production. The cumulative total oil production reported from 1888 through 1988 for the county amounted to 274,483,000 barrels. The Keenville Field yielded 170,400,000 cubic feet of natural gas, which ranked it third in production within the state. It was the only field in the county that produced 50 million cubic feet or more.

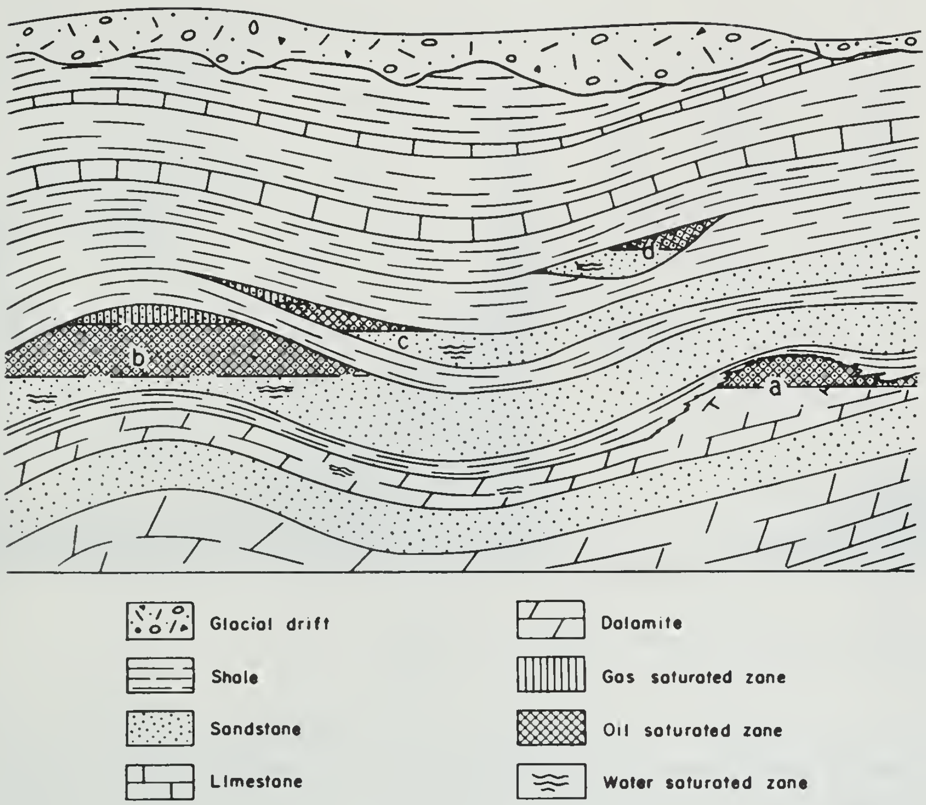


Figure 9 Stratigraphic traps—subsurface occurrences of oil in Illinois: (a) coral reefs, (b) anticlines, (c) pinchouts, and (d) channel sandstones.

Of the 102 counties in Illinois, 99 reported mineral production during 1988, the last year for which complete records are available. (Stone production is reported only for odd-numbered years, and sand and gravel production is reported only for even-numbered years). The total value of all minerals extracted, processed, and manufactured in Illinois during 1988 was $2,807,600,000, a decline of some $418 million from the previous year.

During 1988, the value of minerals extracted in Illinois was $2,492,200,000, a decline of 4.9 percent from 1987. Mineral fuels (coal, crude oil, and natural gas) made up 82 percent of the total. Illinois ranked 17th among the 50 states in total production of nonfuel minerals, but continued to lead all other states in production of fluorspar, industrial sand, and tripoli. The state ranked 15th of 31 oil-producing states in 1988. Oil was produced from 47 counties (figs. 8 and 9). Nine counties produced more than 1 million barrels each, which accounted for about 66 percent of the state's total oil production (fig. 10).

GROUNDWATER

Most of us generally do not think of groundwater as a mineral resource in assessing the natural resource potential of an area. Yet the availability of groundwater 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.

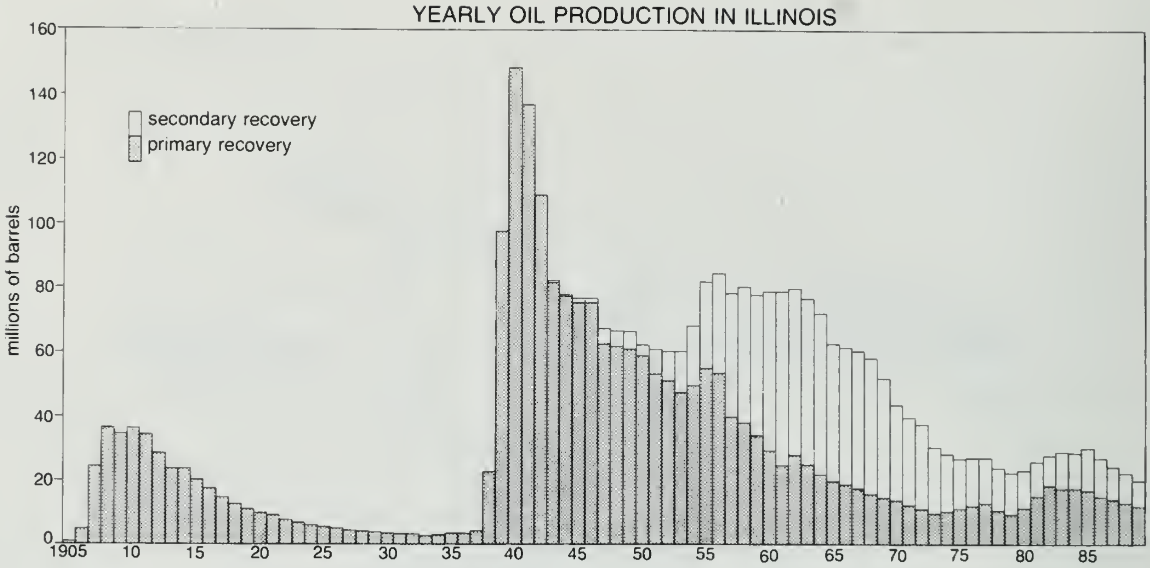
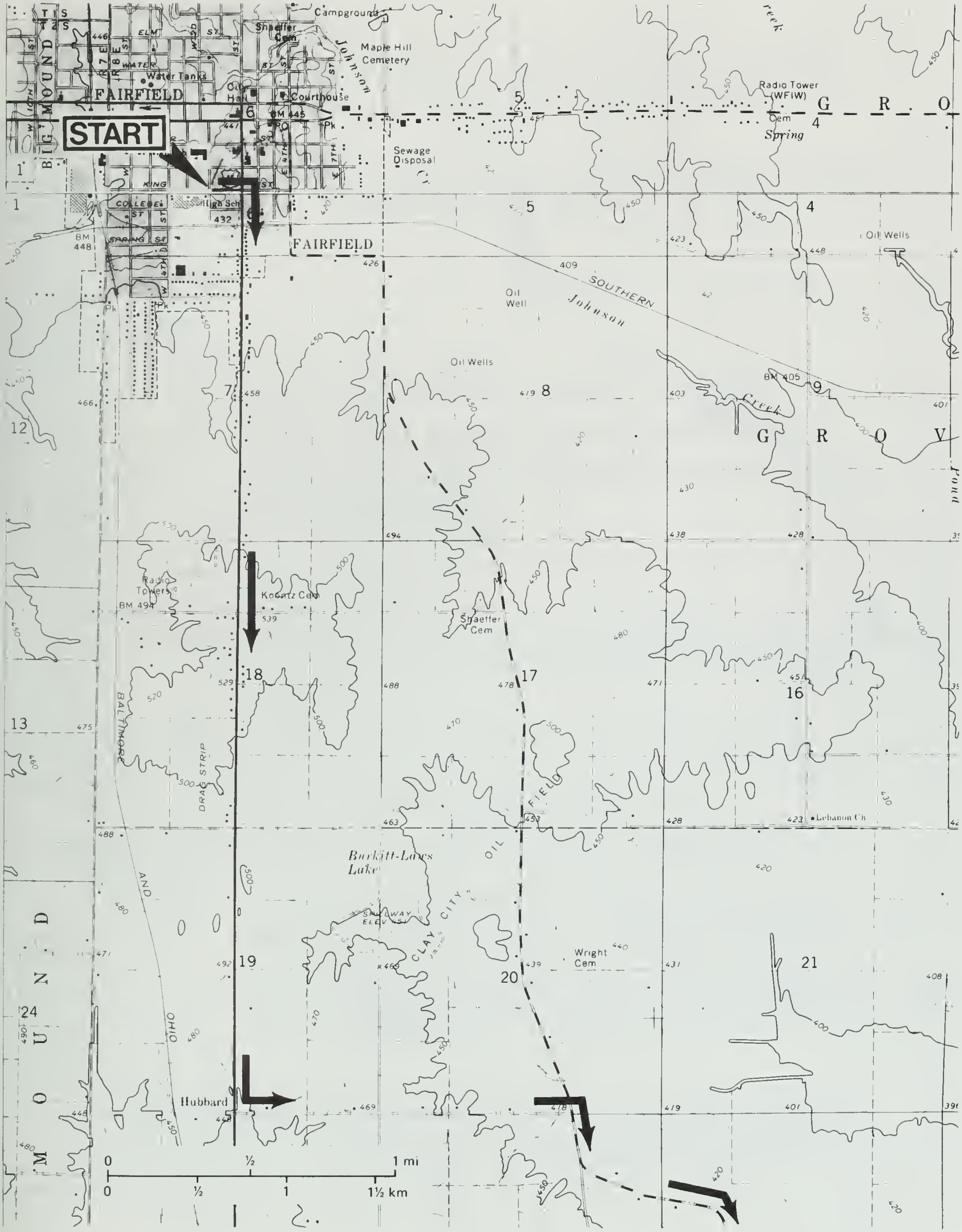


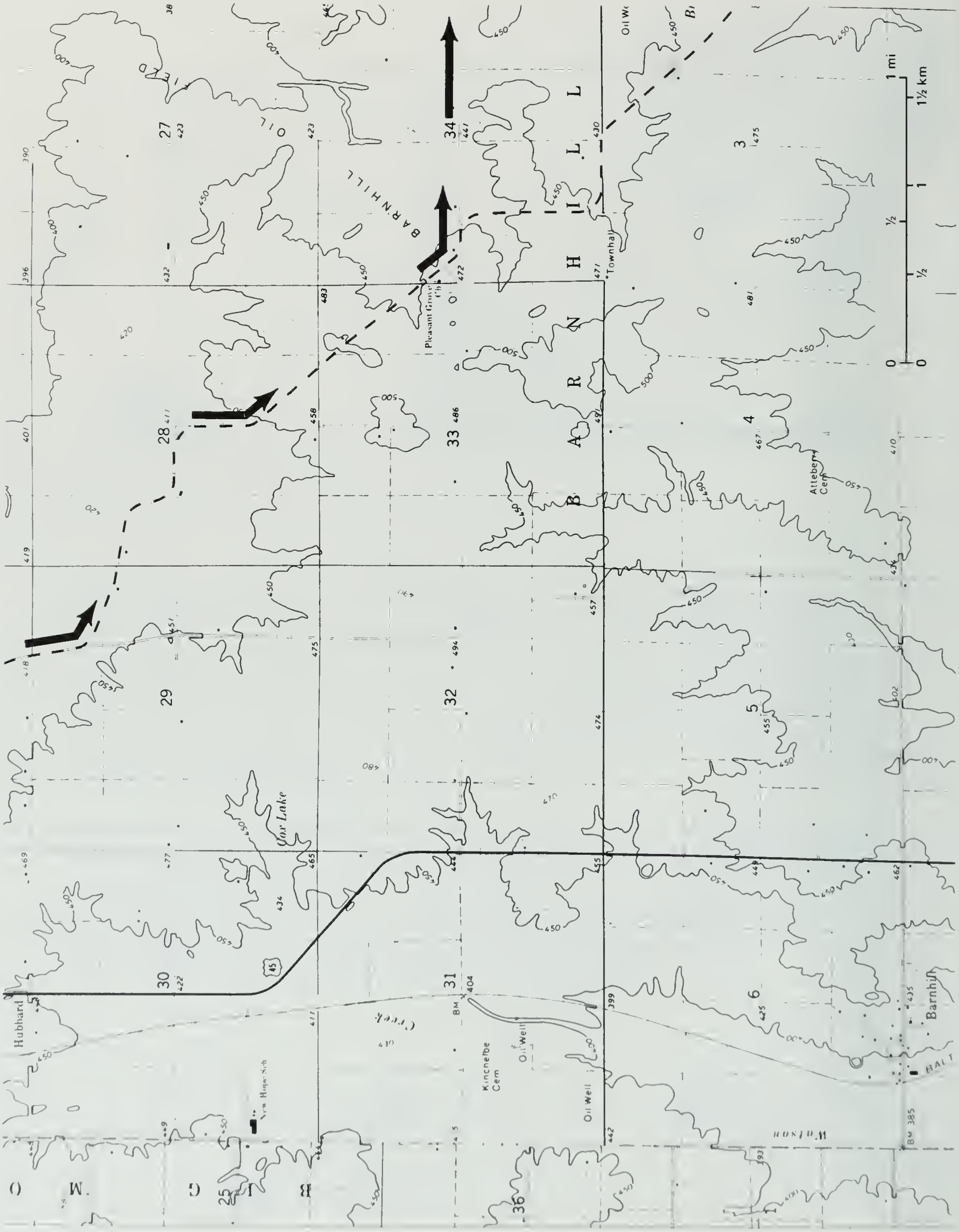
Figure 10 Annual crude oil production in Illinois, 1905-1988.

The source of groundwater in Illinois is precipitation that infiltrates the soil and percolates downward into the groundwater system, which lies below the water table in the zone of saturation. Groundwater is stored in and transmitted through saturated earth materials called *aquifers*. An aquifer is a body of variable thickness of saturated earth materials that will yield sufficient water to serve as a water supply for some use. The pores and other void spaces in the earth materials must be permeable, that is, they must be large enough and interconnected so that water can overcome confining friction and move readily toward a point of discharge, such as a well, spring, or seep. Generally, the water-yielding capacity of an aquifer can be evaluated by constructing wells into it. The wells are then pumped to determine the quantity and quality of groundwater available for use.

Because glacial deposits are thin throughout Wayne County, deposits of water-yielding sand and gravel generally are also thin. However, thick permeable sand and gravel deposits that are potential sources of groundwater for municipal and industrial supplies occur in the bottomlands of the Little Wabash River in the eastern part of the county. Thin, discontinuous sand and gravel deposits that may yield some groundwater supplies are found in Skillet Fork Valley. Sandstone layers that occur in the Pennsylvanian System of rocks in Wayne County may yield domestic supplies of groundwater from the upper 250 feet of bedrock.



START
FAIRFIELD
Campground
Shaeffer Cem
Maple Hill Cemetery
Johnson
Courthouse
Water Tanks
Sewage Disposal
Radio Tower (WFIW)
Spring
High Sch
FAIRFIELD
SOUTHERN
Johnson
Oil Well
Oil Wells
Creek
G R O V
Radio Towers
Koontz Cem
Shaeffer Cem
BALTIMORE
DRAG STRIP
OIL FIELD
Burkitt-Laws Lake
SPILLWAY ELEV 451
CLAY CITY
Wright Cem
Hubbard
AND
OHIO
M O U N D
Lebanon Ch
0 ½ 1 mi
0 ½ 1 1½ km


BARNHILL
OIL FIELD
Pleasant Grove Ch
Townhall
Attebery Cem
Cox Lake
Hubbard
Barnhill
Kinchelbe Cem
Oil Well
Creek
45
0 ½ 1 mi
0 ½ 1 1½ km

GUIDE TO THE ROUTE

Assemble at Fairfield Community High School (NW NE SE SW Sec. 6, T2S, R8E, 3rd P.M., Fairfield 7.5-Minute Quadrangle [38088D3]*). Line up along the south side of W. King Street heading east in front of the school. The starting point is just northeast of the building. Mileage calculations start at the intersection of W. King Street and S. West Second Street.

Please drive with your headlights on while in the caravan. Drive safely but stay as close as you can to the car in front of you. Please obey all traffic signs unless the road crossing is protected by an emergency vehicle with flashing lights and flags. When we stop, park close to the car in front of you.

Miles to next point	Miles from start	
0.0	0.0	STOP: 4-way at this intersection. CONTINUE AHEAD (east).
0.1+	0.1+	STOP: 2-way at S. First Street (US 45). TURN RIGHT (south).
0.1+	0.2+	CAUTION: 3-track, guarded Norfolk Southern (NS) Railroad crossing. CONTINUE AHEAD (south).
0.45+	0.7+	Leave Fairfield.
2.5	3.2+	Prepare to turn left.
0.1	3.3+	CAUTION: TURN LEFT (east) at crossroad (500N/1850E). The oil wells and tank batteries that you see in this area are part of the Clay City Consolidated Oil Field.
0.5	3.8+	CAUTION: crossroads (500N/1900E). CONTINUE AHEAD (east).
0.3	4.1+	The oil well pumpjacks on either side of the road are on the southeast limit of the Clay City Consolidated Oil Field.
0.35+	4.45+	STOP: 1-way at T-intersection (500N/1970E). TURN RIGHT (south).
0.15+	4.65+	CAUTION: Y-intersection (480N/1970E). TURN LEFT (southeast). According to the 1955 geological science field trip, if you continued ahead southward at this intersection for 0.6 mile, you could see an area where an old strip mine was located. We don't find any evidence of it now, so all of that material has been reclaimed to the point where you can't see it easily from the road. Apparently this was a very small strip mine that operated in the early 1930s just for the local market.

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* The number in brackets [38088D3] after the topographic map name 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 two numbers refer to the latitude of the southeast corner of the block; the next three numbers designate the longitude. The blocks are divided into sixty-four 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.

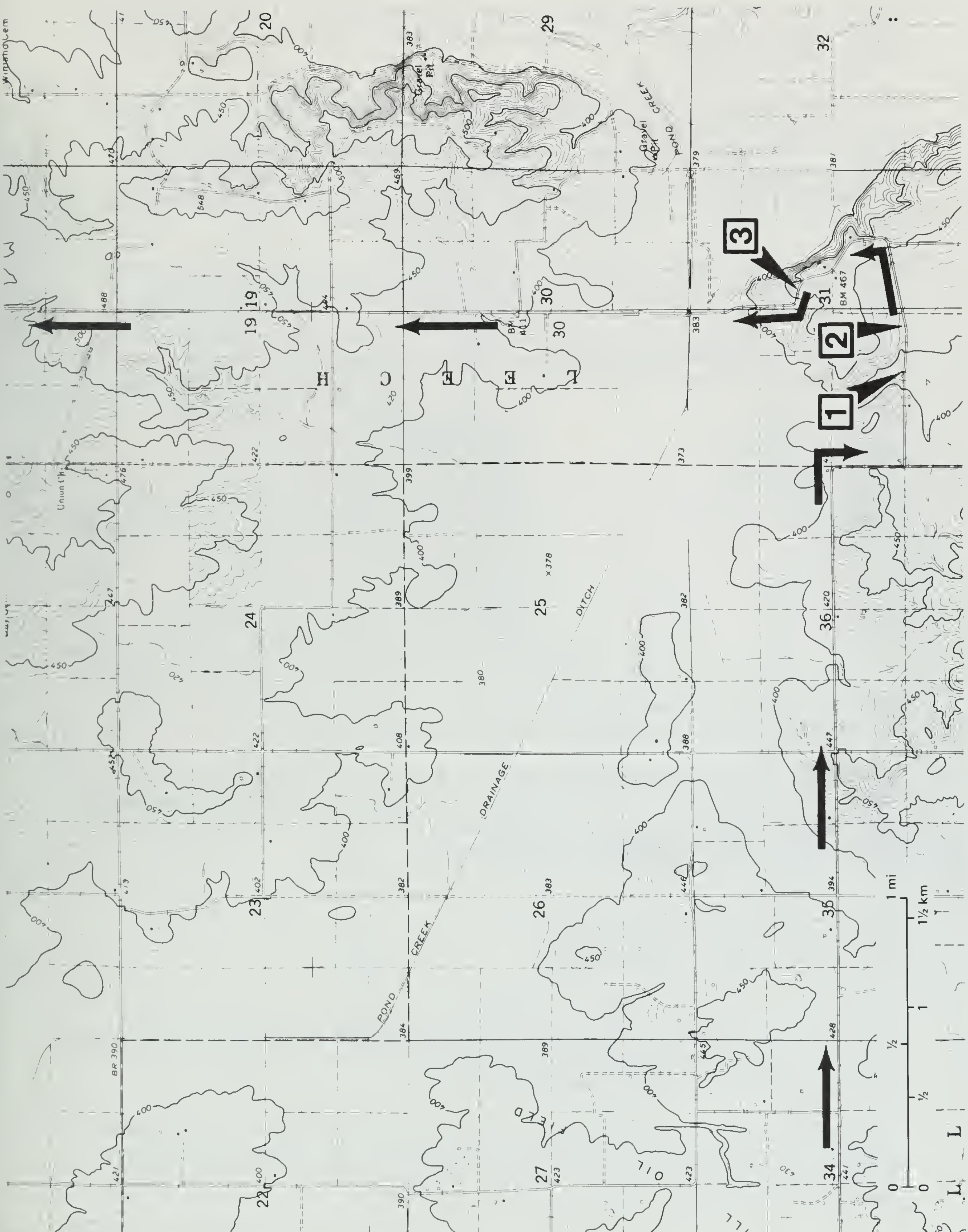
The following section was described here:

	Thickness
Surface soil	1 ft
Gray shale	3 ft
Coal, impure and shaly	8 in.
Underclay, gray, with plant fossils	10 in.
Sandstone, gray, fine	10 in.

0.8+	5.5+	CAUTION: r-intersection (450N/2050E). BEAR RIGHT (south).
0.25+	5.75+	CAUTION: Y-intersection (425N/2050E). BEAR LEFT (southeast). Along the north side of the road, the ditch has been partially dug out, exposing some grey and yellow-brown mottled till.
0.05+	5.8+	To the left, the tank battery at the top of the hill is in the Barn Hill Oil Field. The well is the R. Vaughan No. 2, B. Podolsky lease. Total depth is 4,180 feet; initial production was 8 barrels of oil and 86 barrels of water from the Mississippian Salem Limestone (fig. 2) at a depth from 3,807 to 4,097 feet.
0.7+	6.55+	View Pleasant Grove Church to the right.
0.2+	6.8+	CAUTION: r-intersection (350N/2120E). CONTINUE AHEAD (east).
1.25+	8.1+	CAUTION: crossroad (350N/2250E). CONTINUE AHEAD (east).
0.2	8.3+	Weathered Pennsylvanian sandstone shows in the roadcut.
0.3	8.6+	CAUTION: crossroad (350N/2300E). The wells here are in the Barn Hill Oil Field. CONTINUE AHEAD (east).
0.65+	9.25+	To the left, on the north side of the road, is a highly weathered sandstone exposure. Weathering is bringing out its thin-bedded and crossbedded character; it may be a channel sandstone.
0.05+	9.35	On this side of the hill, you'll see a large block of resistant sandstone sticking out of the ditch on the right side of the road.
0.35	9.7	Highly weathered sandstone appears in the ditch on either side of the road.
0.1+	9.8+	CAUTION: T-road (300N/2400E). TURN LEFT (east).
0.3+	10.15+	PARK along roadside as far off the roadway as you safely can. Do NOT block driveway and culvert.

STOP 1 Discuss backwater deposits filling the larger valleys in the area (SW SW NE SW Sec. 31, T2S, R9E, 3rd P.M., Burnt Prairie 7.5-Minute Quadrangle [38088C3]).

The history of the streams in this area is closely related to that of the Wabash River into which they drain about 30 miles in a straight line slightly east of south. Pre-Illinoian glacial deposits have been found in the ancient watershed of the Wabash, but the oldest deposits found in the


1
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POND CREEK
DRAINAGE DITCH
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ancient lower valley itself are Illinoian in age. So it seems likely that the Lower Wabash Valley was formed by erosion beginning perhaps as early as the late Pliocene or early Pleistocene, nearly 2 million years ago.

Wisconsinan glaciation, beginning about 20,000 years before the present, profoundly changed the watershed of the Lower Wabash Valley. As the ice front stood at the head of the Lower Wabash Valley to form the Shelbyville Moraine, large volumes of gravel, sand, silt, and mud were melted from the ice front and carried downstream, half filling the valley. Much of this glacial debris remains in the valley at present, forming the extensive valley train deposits that are important sources of sand and gravel for construction purposes.

Filling of the Lower Wabash Valley by the valley train deposits raised the valley floor, blocking the mouths of tributary streams. Lakes, some quite extensive, formed behind the valley train dams. The present valleys of Elm River, Pond Creek, Skillet Fork, and the Little Wabash River owe their wide, flat bottoms to the lakes that formed in them. Because the streams were very sluggish and only carried fine silts and muds this far from the glacier front, these fine sediments mostly make up the backwater deposits in this area. The following section is exposed here:

Surface soil, gray	*Thickness* 8 in.
Organic soil, dark gray	18 in.
Silt, tan to light gray	20 in.
Silt, as above but with "iron" nodules	10 in.
Silt, light gray, hard, sandy	24 in.

0.0	10.15+	Leave Stop 1. CONTINUE AHEAD (east).
0.15+	10.3+	PARK along the road shoulder as far off the roadway as you safely can.

STOP 2 Discuss glacial deposits exposed on the north side of the road (SE NE NE SW Sec. 31, T2S, R9E, 3rd P.M., Burnt Prairie 7.5-Minute Quadrangle [38088C3]).

The high area before us is a rarity for this part of Illinois because it has been described as an Illinoian glacial moraine. At this location, the front of the glacier was at a standstill long enough for this large feature to form from the ice-carried debris that melted out and accumulated close to the ice front. The following section was described here:

Surface soil, sandy	*Thickness* 2 ft
Till, reddish brown, pebbly, sandy, weathered, with coarse bands of weathered pebbles	12 ft
Sand, reddish, clayey, with bands of pebbles	3+ ft

Less than 0.5 miles ahead, 15 feet of gravel overlies at least 10 feet of fine-grained sand. Because the sand appears to be present all the way to the bottom of the hill, there must be an additional 30 feet or so of sand. The area is overgrown and covered with refuse, so it is extremely difficult to see any of these deposits now.

The tank battery (fig. 11) belongs to the Friend Oil Company and is situated on the Cynthia Laws property. The nearby No. 5 well was drilled to a total depth of 3,460 feet in 1989. Initial production was 35 barrels of oil and 20 barrels of water pumped from the Mississippian Aux Vases Sandstone (fig. 2) at a depth from 3,282 to 3,308 feet.

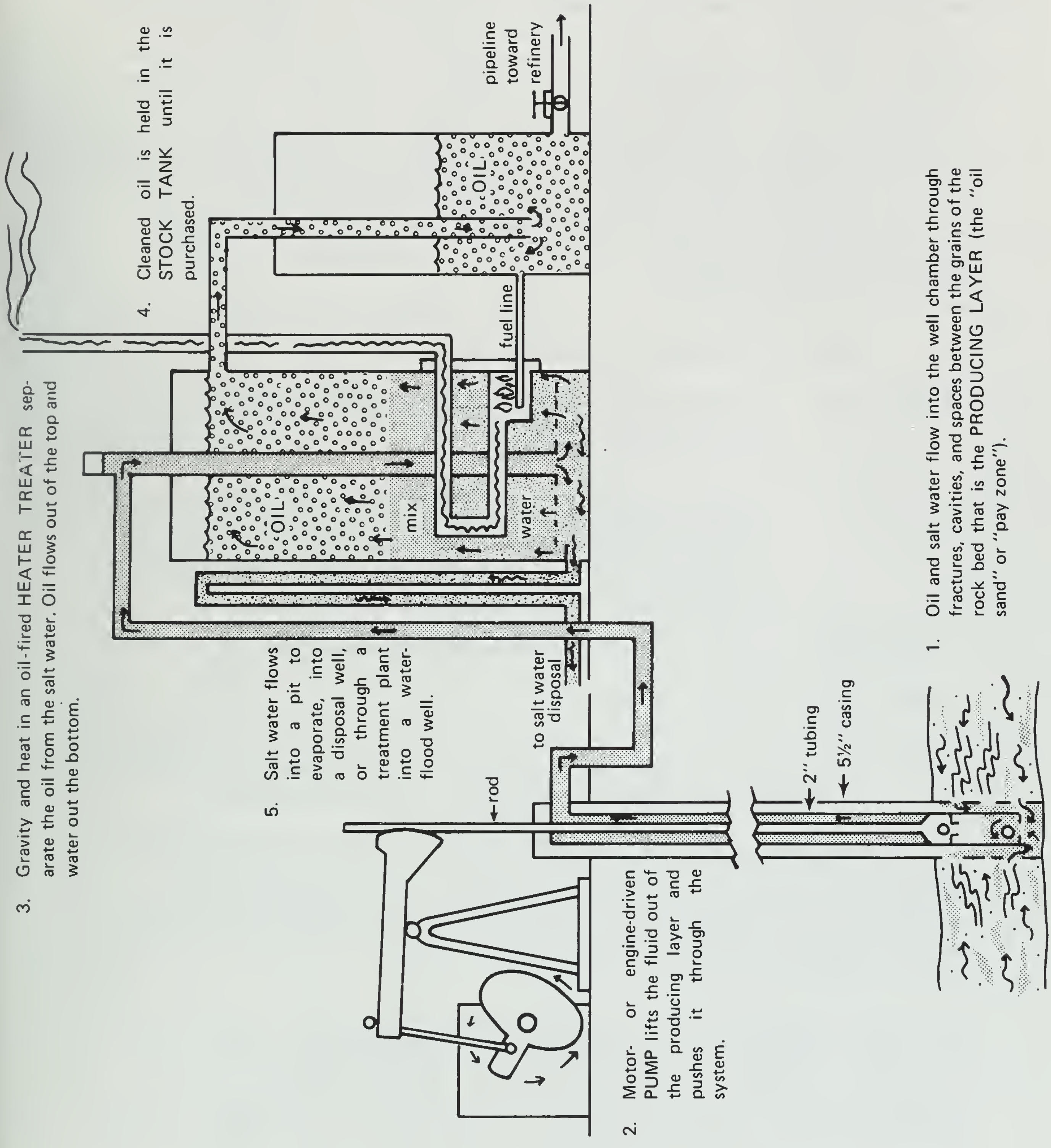


Figure 11 Schematic diagram of a common type of oil production unit used in Illinois.

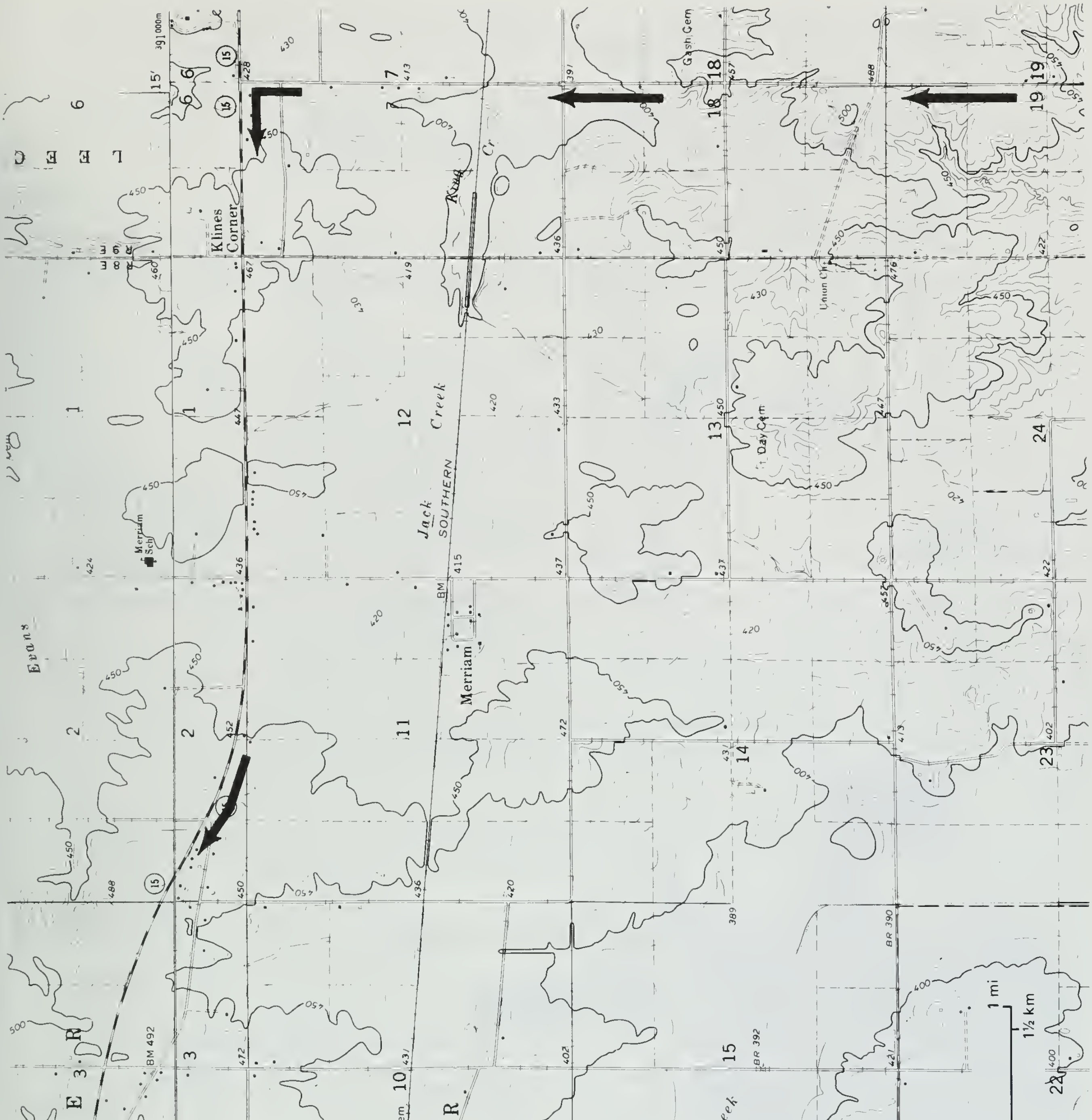
The Aux Vases is one of the most prolific petroleum reservoirs (oil-saturated porous rock) in Illinois, yielding 11 percent of the state's total oil production. Petroleum geologists, petroleum engineers, clay mineralogists, and other scientists at the Illinois State Geological Survey (ISGS) are currently studying the Aux Vases Sandstone in several oil fields; they expect to learn more about the environment in which this sand was originally deposited. By developing a more complete understanding of the character of the Aux Vases Sandstone and other oil-producing reservoirs, and their variability from one place to another, the ISGS is helping the independent oil producers of Illinois extract more of the oil that we already know is present. The U.S. Department of Energy has estimated that as much as 1.5 billion barrels of oil that could be recovered with today's technology has not yet been produced from the state's existing petroleum reservoirs. In some instances, this "unswept mobile oil" may have been trapped in unsuspected pockets formed by shifts in the depositional environment, or differences in the character of the cement that altered the porosity of the reservoir. Infill drilling at a spacing closer than the customary minimum 10-acre drilling unit may be necessary to recover this significant resource of domestic oil.

0.0	10.3+	Leave Stop 2 and ascend moraine.
0.25+	10.6+	CAUTION: At the beginning of the curve uphill to the left is a T-intersection with a road to the right. CONTINUE AHEAD UPHILL (north) and stay on top of the ridge. The top of the moraine about 0.3 miles southeast of this corner is more than 50 feet higher than here, at an elevation somewhat more than 510 feet msl. The Little Pond Creek lowlands less than 0.5 mile to the east are about 130 feet lower. We are in one of the areas of high relief in Wayne County, as noted in the introductory material.
0.3+	10.95+	Note the open dumping in the deep ravine on the right.
0.05-	11.0+	PARK along the roadway.

STOP 3 View the uplands and some drainage features from this vantage point (NE SW SW NE Sec. 31, T2S, R9E, 3rd P.M., Golden Gate 7.5-Minute Quadrangle [38088C2]).

From this vantage point, about 80 feet above the Pond Creek bottoms, you will note that the higher elevations in the distance are only slightly lower than here. The scuplturing of the landscape due the erosion of the thin glacial cover over the relatively soft Pennsylvanian bedrock strata has produced more gentle slopes to the northwest and west. To the north and northeast, you can see more of the morainal topography where the slopes appear more rugged and steep, especially on the river side of the ridges.

The Pond Creek bottom stretches northwestward from here about 7 miles toward Fairfield. The lower 6 miles, beginning at the Little Wabash River 2 miles east-northeast from here, have been ditched and dredged to straighten and contain the flow, thus making more bottomland available for farming. The flat bottomlands are up to 0.6 miles wide. During times of high seasonal stream levels in this area, the bottoms are flooded and it is not too difficult to get an approximation of what the area looked like when the glacial lakes occupied these valleys.


Klines Corner
Merriam
Merriam Sch
Jack Creek
King Cr
SOUTHERN
Evans
GROVER
Pond
Creek
Cem
Oil Wells
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Day Cem
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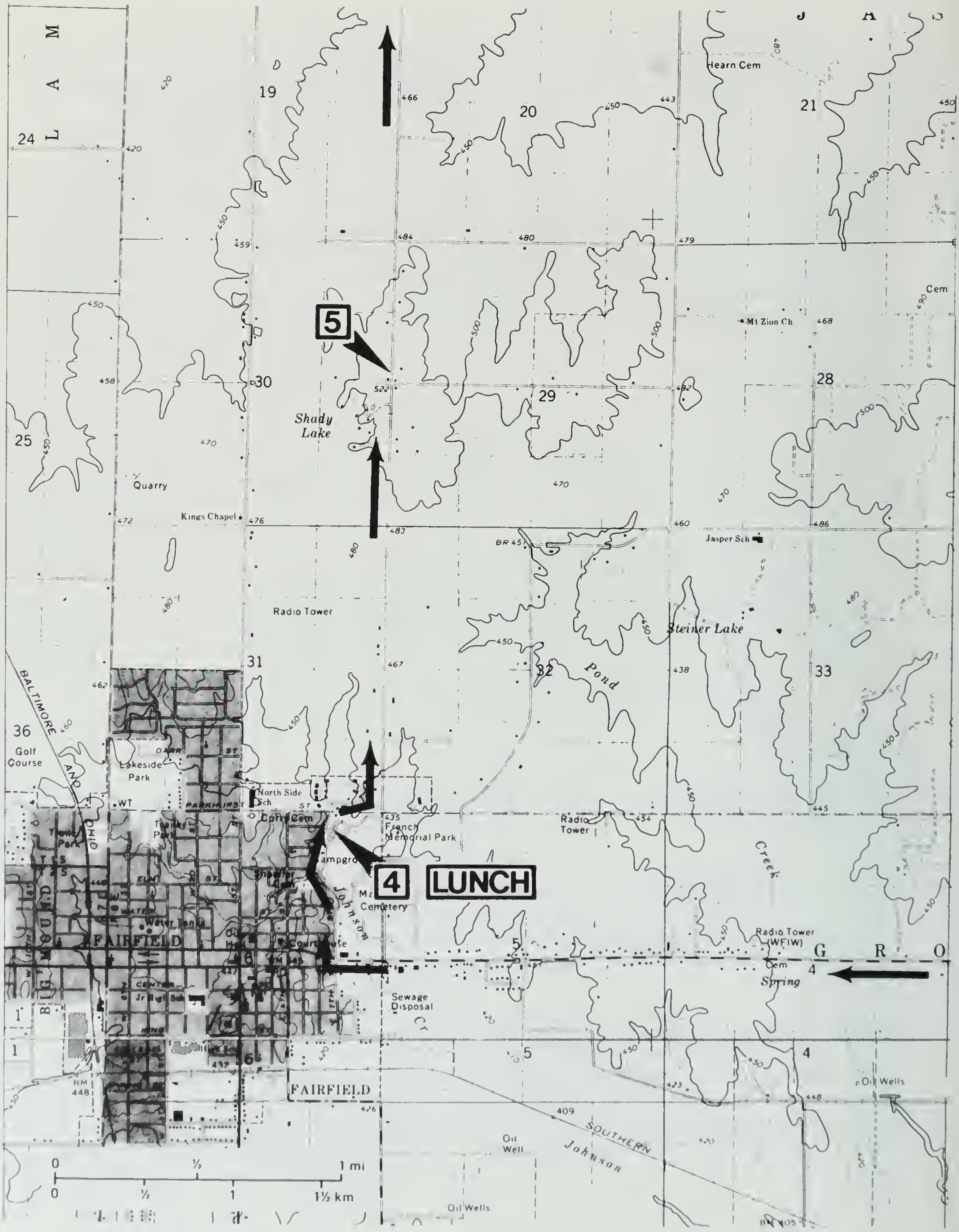

5
4
LUNCH
Shady Lake
Hearn Cem
Mt Zion Ch
Cem
Quarry
Kings Chapel
Radio Tower
Jasper Sch
Steiner Lake
Pond
Creek
Golf Course
BALTIMORE AND OHIO
Lakeside Park
North Side Sch
French Memorial Park
Radio Tower
Cemetery
FAIRFIELD
Sewage Disposal
Radio Tower (WFIW)
Spring
Oil Wells
Oil Well
SOUTHERN
Johnson
FAIRFIELD
0 ½ 1 mi
0 ½ 1 1½ km

0.0	11.0+	Leave Stop 3 and CONTINUE AHEAD downhill to the west and north.
0.4+	11.4+	CAUTION: cross Pond Creek Drainage Ditch; this is the lowest elevation on the route. The wells to the northeast are the northwestern part of the Golden Gate Consolidated Oil Field. A short distance to the north, the wells will be in the southeastern part of the Golden Gate North Field.
1.45	12.85+	Thin-bedded sandstone is poorly exposed on both sides of the road.
0.85	13.7+	Sandstone is exposed in the ditch on the right side of the road at the culvert.
0.95	14.65	CAUTION: unguarded 1-track NSRR crossing.
0.7+	15.35+	STOP: 1-way at T-intersection with SR 15. TURN LEFT (west). CAUTION: fast cross traffic.
4.05+	19.45+	Cross Pond Creek.
0.2	19.65+	CAUTION: enter Fairfield.
1.35	21.0+	Prepare to turn right.
0.1+	21.15+	TURN RIGHT (north) on East 7th Street where SR 15 splits into one-way streets.
0.15+	21.3+	STOP: 1-way. TURN RIGHT (east), cross Johnson Creek, and immediately TURN LEFT (north) BEFORE the entrance to Maple Hill Cemetery.
0.05	21.35+	CAUTION: Y-intersection. BEAR LEFT (northwest) and enter French Memorial Park. Stay on the park road until you reach the swimming pool parking area.
0.3+	21.7	PARK where directed. Do NOT park on the grass or block driveways.

STOP 4 Enjoy LUNCH in French Memorial Park (N/2 NE NE Sec. 6, T2S, R8E, 3rd P.M., Fairfield 7.5-Minute Quadrangle [38088D3]).

0.0	21.7	Leave Stop 4 and follow park road northeastward.
0.15+	21.85+	STOP: 1-way at T-intersection. TURN LEFT (north) on Enterprise Highway/Clay City Road.
0.15	22.0+	Leave Fairfield.
1.4	23.4+	PARK well off the roadway. CAUTION: fast traffic.

STOP 5 View the upland to the north and west and discuss the topography (W edge SW SW SW NW Sec. 29, T1S, R8E, 3rd P.M., Fairfield 7.5-Minute Quadrangle [38088D3]).

The field trip area is located in the Mt. Vernon Hill Country (fig. 7), part of the Till Plains Section where the topography is largely controlled by the underlying bedrock surface. Illinoian glacial deposits generally are less than 25 feet thick across the uplands. This indicates the ice was probably only several hundred feet thick here and did not plane down or bulldoze the surface as a much thicker body of ice would. The ice probably did not cover the region for very long, which would account partially for the thin drift. Some bedrock valleys have fill of glacial materials that are, however, in excess of 100 feet.

The surface elevation at this stop is slightly above 520 feet msl. Here the bedrock surface has an elevation of slightly less than 450 feet msl and the present land surface intersects bedrock in some of the valleys.

A thin Pennsylvanian limestone (most likely the Omega Limestone Member of the Mattoon Formation; fig. 12) was quarried about 1 mile west-southwest from here. Worthen (1875) mentions the limestone occurring over "the 18-inch coal seam" has been quarried almost every place that it crops out. The quarry operated in the early 1900s, and stone was used to surface 0.5 mile of a Fairfield street, according to ISGS geologists who studied the area in the late 1920s. The stone ranged up to 4 feet thick but commonly was thinner. The upper part was thin bedded, impure, and shaly, so it was only used locally for building stone and in making mortar. Another ISGS geologist noted the limestone was quarried in the SE Sec. 30, just southwest of us. He does not mention whether the quarry was active at that time, but the section he described would not have lasted long in an abandoned quarry. He reported about 4 feet of limestone separated from the underlying coal by 1 to 2 inches of soft shale. The contact was not well exposed. The coal was reported to be about 15 inches thick.

About 0.5 miles south of here, a narrow band of glacial drift thickens to somewhat more than 50 feet toward the east-northeast.

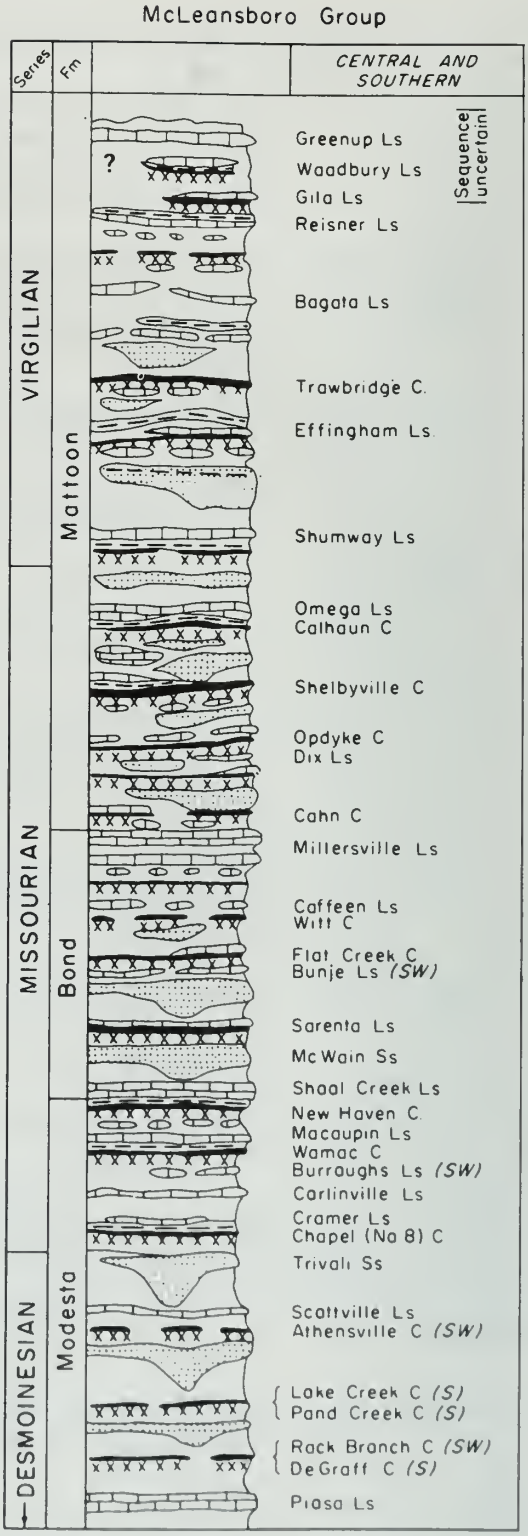


Figure 12 Classification of the McLeansboro Group of the Pennsylvanian System.

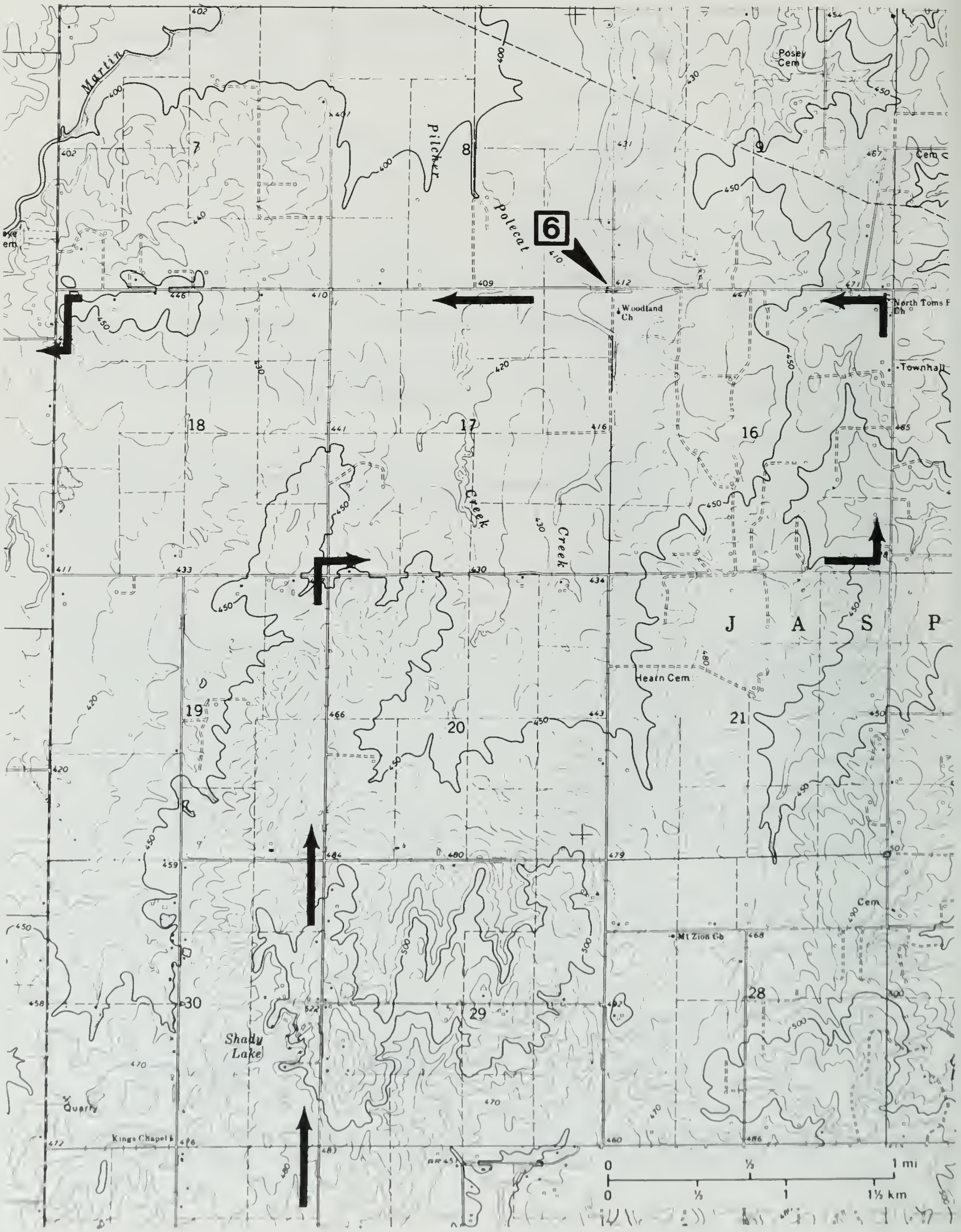
0.0	23.4+	Leave Stop 5 and CONTINUE AHEAD (north). Use CAUTION in pulling back onto the roadway.
1.35	24.75+	Prepare to turn right.
0.1	24.85+	TURN RIGHT (east) at crossroad (1200N/1900E).
0.6	25.45+	Cross Pilcher Creek.
0.2	25.65+	Cross Polecat Creek.
1.15+	26.85	STOP: 1-way at T-intersection (1200N/2100E). TURN LEFT (north).
0.2	27.05	Cross creek. Note the natural gas pipes just above the stream bed to the right (east).
0.8-	27.85-	STOP: 1-way at T-intersection (1300N/2100E). TURN LEFT (west).
0.95+	28.8+	Crossroad (1300N/2000E).
0.05-	28.85	PARK along the roadway. CAUTION: narrow road. Do NOT block the intersection and field entrances.

STOP 6 Examine a restored saltwater disposal pit and discuss land survey practices (NE NE NE Sec. 17, T1S, R8E, 3rd P.M., Fairfield 7.5-Minute Quadrangle [38088D3]).

Much of the oil produced from oil wells in the Illinois Basin is accompanied by saltwater (oil field brine). At the surface, the oil is separated from the water and shipped to the refinery. Until the enactment and enforcement of laws to regulate the disposal of the saltwater, the water often was drained into a nearby ditch or dumped adjacent to the well. Later, as the environmental damage to creeks and fields became obvious, pits were constructed as evaporating ponds for the saltwater. Although this method was an improvement over direct drainage into creeks and fields, the saltwater from the open and unlined evaporation pits still trickled into the soil. The consequence of saltwater contamination in soil is that plants die. High levels of soluble salts in the soil deprive plants of needed moisture by osmosis. If the contamination is serious, the soil is barren and exposed to severe erosion by water and wind.

In 1971, Bernard Podolsky, a local oil producer, and the University of Illinois Agronomy Department, selected this site as part of a pilot study on the restoration of salt water pits. The following restoration procedure was used:

- The field was tiled for better drainage.
- Gypsum was applied at 10 tons per acre.
- Three tons of straw per acre was spread over the surface and plowed in.
- A second layer of 3 tons per acre of straw was applied. The incorporation of straw ensured water intake and internal movement, and prevented surface encrusting of salts.
- The field was left idle for several years to permit penetration of rainfall and the slow movement of salt through the tile lines. Salt moves at such a slow rate that the addition of this slightly saline water to the creeks and rivers was considered negligible.


Martin
Pilcher
Polecat
Creek
Creek
Posey Cem
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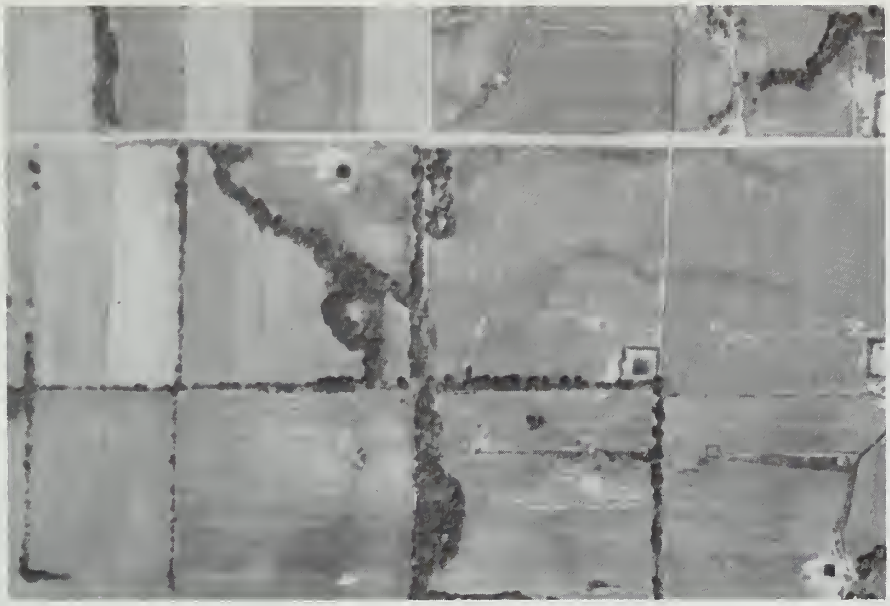


a.

b.

Figure 13 Aerial views of Stop 6: (a) September 2, 1965, and (b) April 7, 1988.

The results of this restoration procedure are obvious when the two aerial photos of the area are compared (fig. 13a, b). The saltwater pit is not present in aerial photos taken in 1952, but is present on the 1959 photos, indicating a post-1952 construction of the pit. The pit is also present on the 1971 photo when the restoration project was initiated. On the 1988 aerial photo, however, there is virtually no trace of the pit.

The field trip area also affords the opportunity to examine the system of land surveys in Illinois. An examination of the 15- and 7.5-Minute quadrangles shows that section lines do not form an even grid pattern over the whole area. You will note that some sections are considerably larger or smaller than others. Some sections are somewhat misshapened because of slanted section and quarter-section lines.

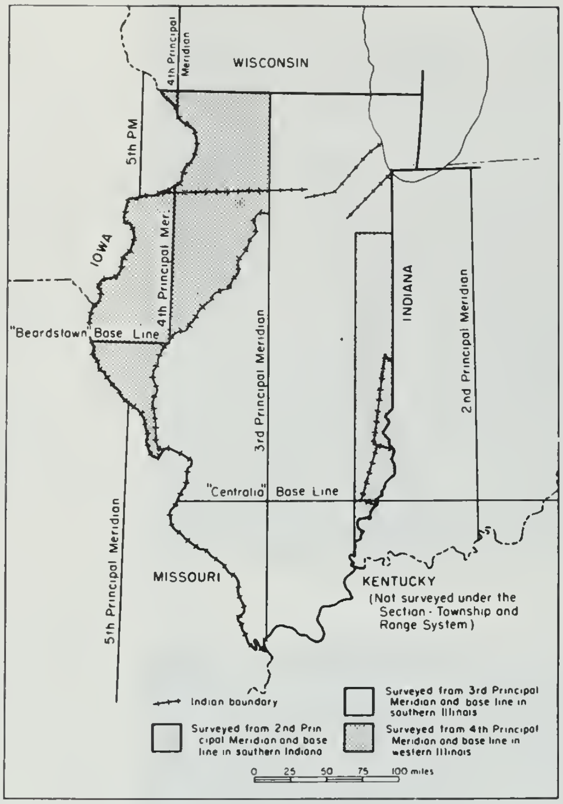


Figure 14 (left) Principal meridians and base lines of Illinois and surrounding states (Cote 1978).

Figure 15 (right) Index map (Cote 1978).

In 1804, initial surveying from the 2nd P.M. (fig. 14) continued westward from Vincennes, Indiana; this survey became the basis for surveying about 10 percent of what is now eastern Illinois. Because the western boundary of this tract had not been established with certainty, it was decided in 1805 to designate the 3rd P.M. as beginning at the mouth of the Ohio River and extending northward to facilitate surveying new land cessions. By late 1805, a base line had been run due east to the Wabash River and due west to the Mississippi River from the 3rd P.M. During March 1806, surveying commenced northward on both sides of the 3rd P.M. Sometime after the selection of an initial point from which to establish a base line, and from which the surveys were to be laid out, the base line apparently was arbitrarily moved northward 36 miles, where it roughly coincides with the base line of the 2nd P.M.

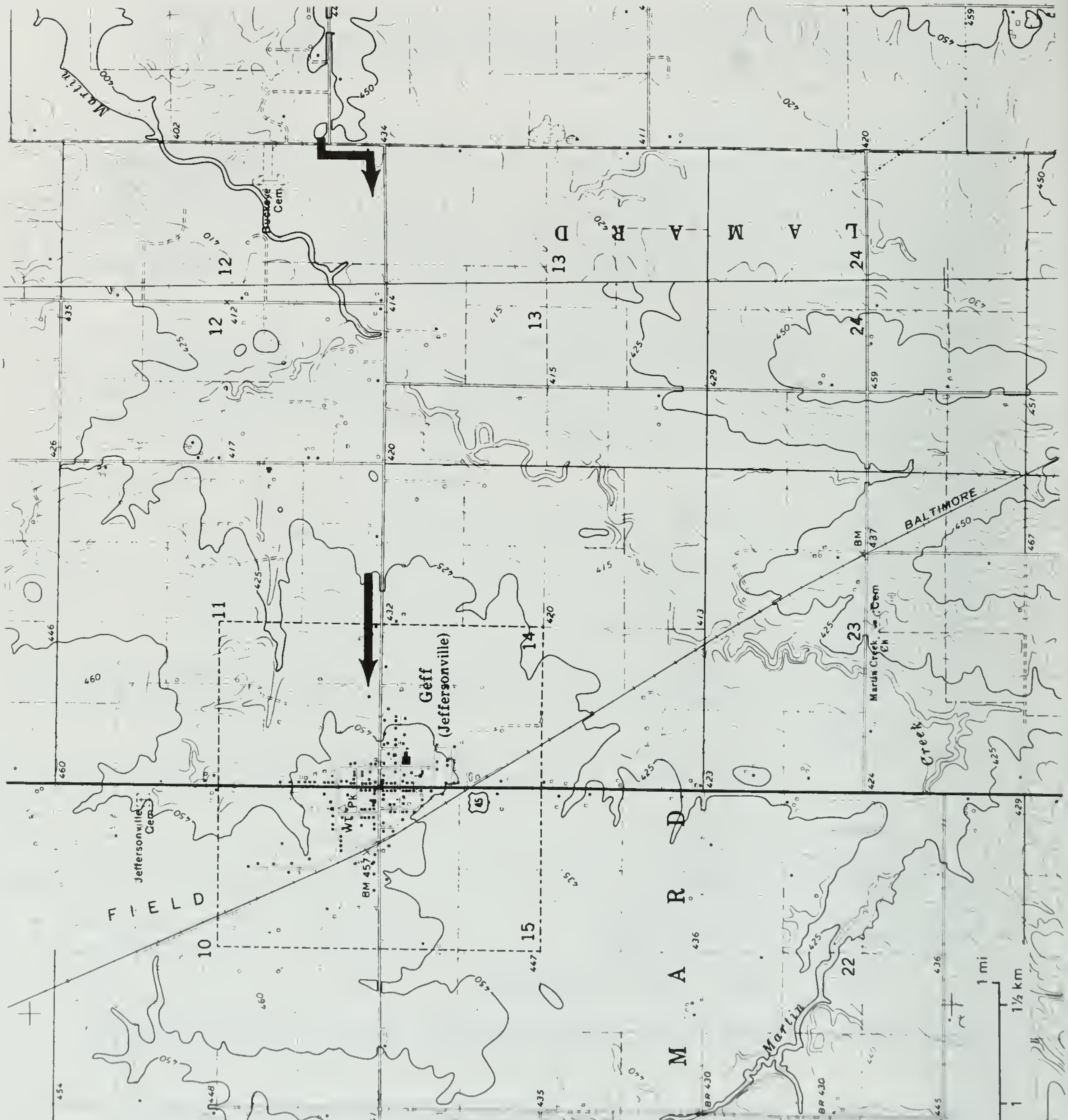
The township and range system permits the accurate identification of most parcels of land in Illinois and facilitates the sale and transfer of public and private lands. In the early 1800s, each normal township was divided (to the best of the surveyor's ability) into 36 sections, each of which was 1 mile square and contained 640 acres (see route maps).

Township and range lines in figure 15 do not form a perfect rectangular grid over the state because of the use of different base lines and principal meridians, and because minor offsets were necessary to compensate for the earth's curvature. The surveying corrections that produced the minor offsets were usually made at regular intervals of about 30 miles. Figure 15 shows what happened when the survey from the 2nd P.M. met the survey from the 3rd P.M. From Iroquois County south to White County, only narrow partial townships could be made where the two surveys met. These partial townships are all located in R11E, 3rd P.M., and in most places, are less than one section wide.

Closer at hand, about 1 mile north of us here in T1S, R8E, the top tier of sections is slightly more than 0.6 mile from north to south. The width of each section is 1 mile except for section 6, which is 0.95 mile. The other sections that occur south of section 6 also have the same width. Also, you can see what happens to the base line that separates T1S from T1N just to the north of us. At the western edge of R8E the base line is 0.2 miles south of the base line at the eastern edge of R7E. Section 1, T1S, R7E, is 1 mile from north to south. The offset is obvious when we turn south in 1.9+ miles. Do you find other oddities on your maps?

(Note: get out your quadrangle maps at home and have some fun. If your supply of topographic maps is limited, the Illinois State Geological Survey will be happy to furnish you with a free index to topographic maps of Illinois. When you decide which ones you want or need, you may purchase them by phone or mail order, or just over the counter at the ISGS: 615 East Peabody Drive, Champaign Il 61820, (217) 333-4747.)

0.0	28.85	Leave Stop 6. CONTINUE AHEAD (west).
0.25+	29.1+	Cross Polecat Creek.
0.35+	29.5+	Cross Pilcher Creek.
0.25+	29.8+	STOP: 2-way at Enterprise Road. CAUTION: fast cross traffic. CONTINUE AHEAD (west).
0.95+	30.75+	STOP: 1-way at T-intersection (1300N/1800E). TURN LEFT (south) along the dividing line between R7E and R8E mentioned at Stop 6.
0.15+	30.95+	TURN RIGHT (west) at T-intersection.
0.3	31.25+	Cross creek.
0.25+	31.55	Cross Martin Creek.
0.9	32.45	CAUTION: enter Geff town limits.
0.5	32.95	STOP: 2-way at US 45 (1300N/1600E). CAUTION: CONTINUE AHEAD (west).
0.5	33.45	Geff municipal water well on right (north) side of the road. Leave Geff town limits.
0.45	33.9	Cross Martin Creek.
0.95	34.85+	Prepare to turn left.
0.05+	34.95	TURN LEFT (south) at crossroads (1300N/1400E).
1.75	36.7+	TURN RIGHT (west) at crossroads (1125N/1400E).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Jeffersonville Cem
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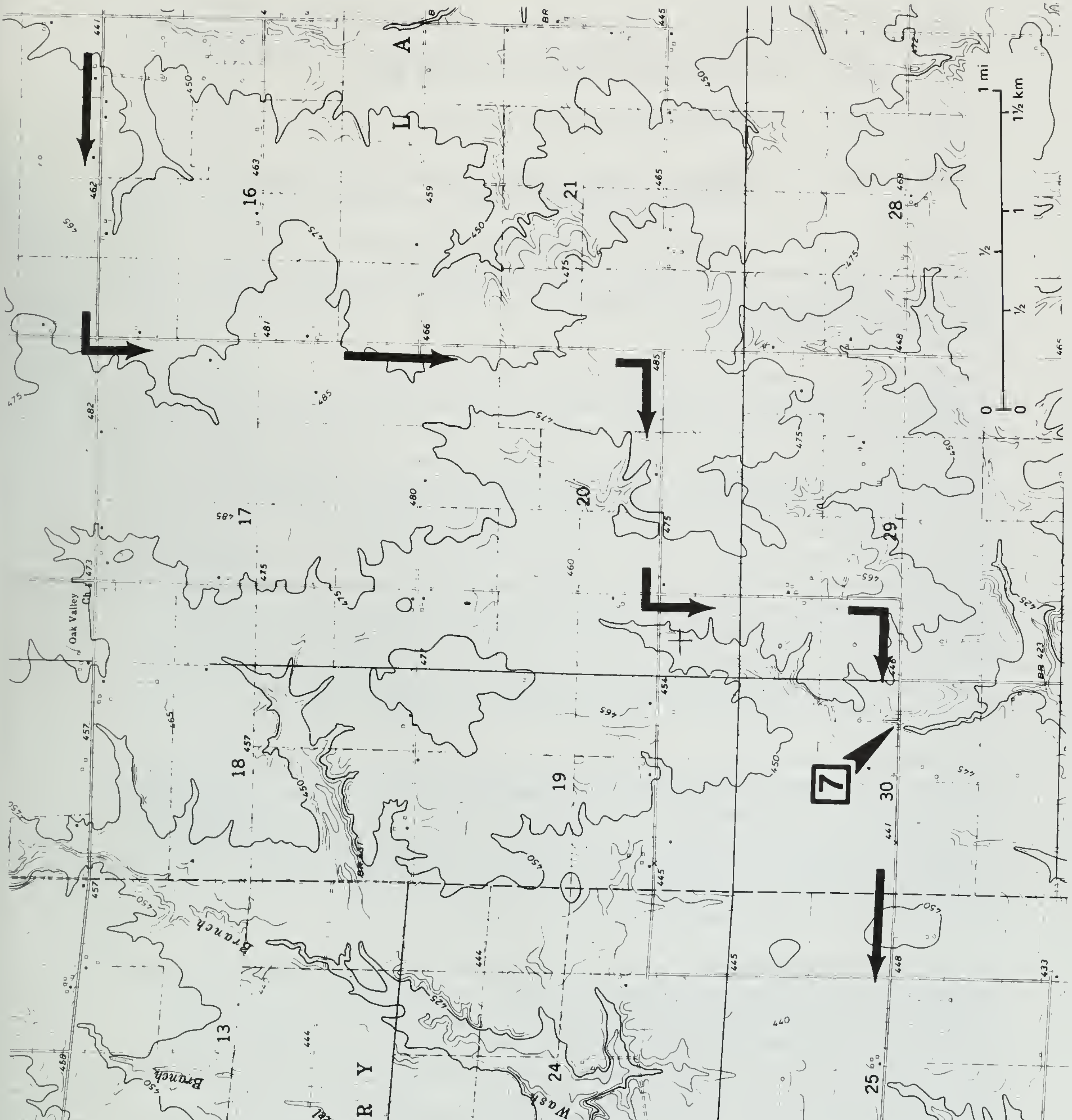
BERRY
LA
Oak Valley Ch
Hazel
Branch
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0.75	37.45+	STOP: 2-way at crossroads (1125N/1325E). TURN LEFT (south).
0.5	37.95+	Note collapsing oil holding tank on the right.
0.25	38.2	TURN RIGHT (west) (1050N/1325E).
0.35+	38.55+	PARK along roadway. Do NOT block fence openings and do NOT park on the bridge. Walk north along the lane that is just east of the bridge.

STOP 7 Examine Pennsylvanian-age cyclothem and Pleistocene deposits (550 feet from east line, 1,550 feet from north line or NE SE NE irregular Sec. 30, T1S, R7E, 3rd P.M., Geff 7.5-Minute Quadrangle [38088D4]).

The bedrock strata throughout Wayne County are Middle Pennsylvanian in age and comprise numerous cyclothems (see *Depositional History of the Pennsylvanian Rocks in Illinois* in back of guide booklet). A cyclothem is a series of beds resulting from a single sedimentary cycle. The cycle can be viewed as either nonmarine deposits in the lower part overlain by marine deposits in the upper part, or as marine deposits in the lower part overlain by nonmarine deposits in the upper part. The cyclothem (fig. 16) exposed here is probably the best example in Wayne County. Cyclothems are often named, primarily for ease of communication. This one has not been named, however, nor has it been correlated with an equivalent, named cyclothem located elsewhere in the Illinois Basin. Drilling investigations as part of the site characterization study of the proposed Geff low-level radioactive waste disposal site indicated that the cyclothem is present in the subsurface throughout the area toward the northeast. Because the stata dip gently towards the northeast, these rocks are younger than the sandstone exposed at Rock Bluff Bridge (Stop 8). Stratigraphic studies indicate that this cyclothem is older than the rocks that were exposed in the abandoned quarry just north of Fairfield.

The basal unit of this exposure is a claystone generally referred to as an underclay (fig. 16) because it occurs directly under a coal bed. These beds often contain roots of coal plants that penetrated into the unit from above. This underclay contains a few coal laminae that may be the remains of lateral roots. The overlying coal, as mentioned above, is persistent in the subsurface to the north. The coal is not named. Spores from this coal have been examined (the science of palynology) in an attempt to determine its age relationship to other coals in the basin; however, the results were inconclusive.

The boundary between the coal and the overlying strata is important because it marks the change from strata deposited in nonmarine (terrestrial) environments to strata deposited in marine environments. The very dark gray shale that overlies the coal is calcareous and fossiliferous. The fossils indicate deposition in marine waters and the dark color indicates preservation of abundant organic material. (Under the right conditions, organic-rich rock similar to this could be a source rock for petroleum deposits. In the Illinois Basin, however, Pennsylvanian dark gray to black shales are not considered to be petroleum source rocks.) The overlying calcareous mudstone also contains marine fossils, but they are less common. The top of the calcareous mudstone is marked by a layer of iron carbonate (siderite) nodules. The origin of these nodules is not well understood. The nodules had to form after deposition of the mudstone; deposition may be related to the presence of a fluctuating water table. The overlying noncalcareous mudstone lacks fossils, indicating that the marine influence of the environment was overshadowed by the depositon of deltaic sediments.

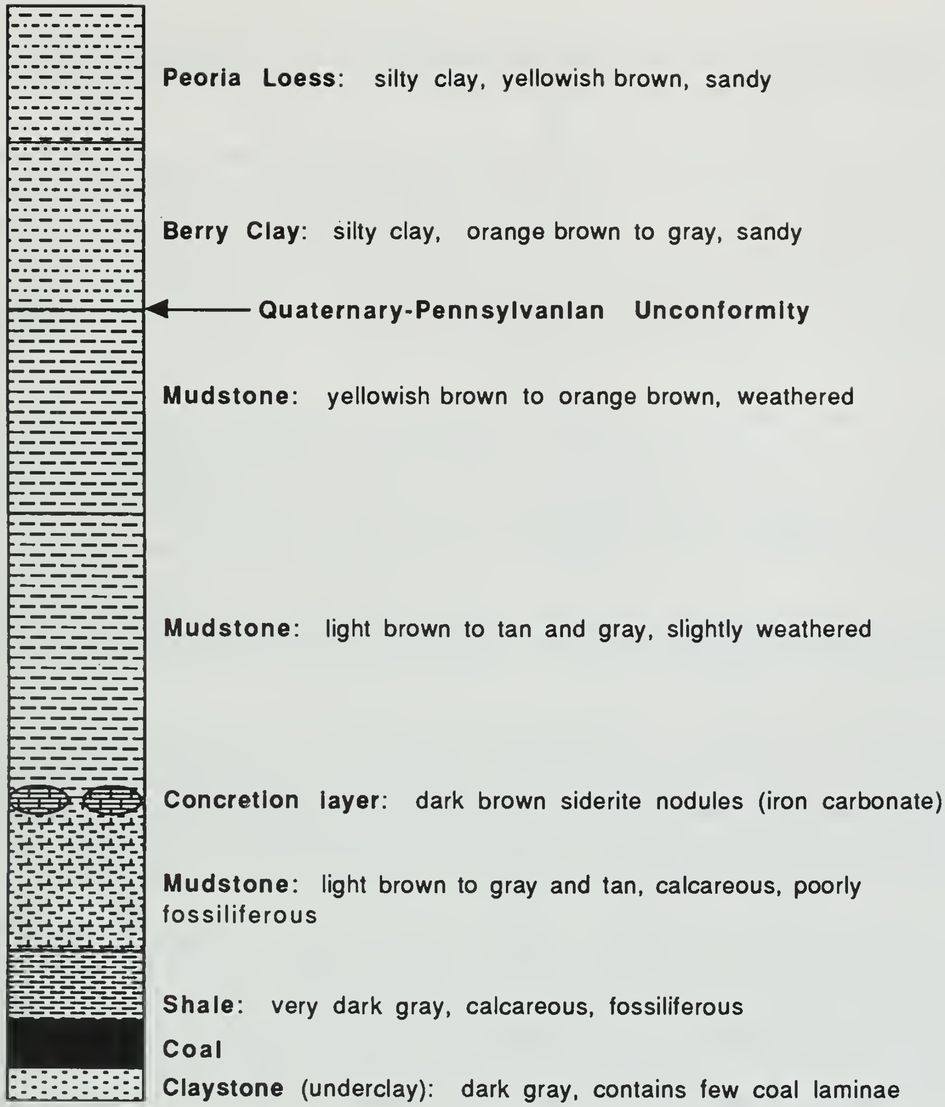


Figure 16 Exposed section of strata (rock layers) at Stop 7.

In summary, the geologic history is interpreted from the bedrock exposure:

- Deposition of the claystone (which evolved into the underclay) probably in a deltaic floodplain. Rapid and lush growth of plants and trees in a swamp environment. As the plants died and fell over, they were buried, compressed and preserved as coal.

- Inundation of the coal swamp by marine water, depositing first the very dark gray shale and second, the calcareous mudstone.

- As the input of terrestrial sediment increased, the marine influence waned and noncalcareous mudstone was deposited. These strata indicate the generally gradual change from marine to nonmarine deposition. At some unknown time, the siderite nodules precipitated out of the groundwater to form the layer.

Prior to erosion at the top of the bedrock here, succeeding strata probably consisted of a combination of sandstone, siltstone, and shale beds, which in turn were succeeded by an underclay, marking another, similar cycle of deposition.

The contact between the Pennsylvanian bedrock and the overlying Pleistocene deposits is an unconformity—a surface of erosion that separates younger strata from older strata. In this case, the unconformity is a type known as a disconformity, which is the surface of erosion between parallel strata: the bedding orientation of the older strata is the same as that of the younger strata. This disconformity is a significant one; the gap in the rock record here is about 285 million years. Only a few of the several Pleistocene units present in the area are exposed here. The unexposed units are included in this discussion.

The Pleistocene Glasford Formation underlies the area covered by the Illinoian glaciers. The Illinoian-age Vandalia Till Member of the Glasford Formation, although not exposed here, is a regionally extensive unit that underlies the Berry Clay and overlies the Pennsylvanian bedrock. It is present throughout the area except along stream valleys, such as this. The Vandalia is a silty clay till containing scattered gravel-sized clasts and small, fine-grained sand lenses.

The Berry Clay is a late Illinoian to early Wisconsinan accretion gley—a soil horizon consisting of leached deposits that slowly accumulated in a poorly drained area. The soil in which the Berry Clay formed is the Sangamon Soil.

Two Wisconsinan loess deposits are present in the area: Peoria Loess and Roxana Silt. The two deposits are difficult to differentiate lithologically without close examination. The Roxana Silt (not present here) generally contains 30-percent sand, whereas the Peoria Loess contains less than 15-percent sand and more clay. The Peoria Loess is predominantly eolian (wind deposited) in orgin, whereas the Roxana is a combined eolian and stream deposit.

Two oil wells are located west of Walton Creek in this vicinity. The A. McNeil-J. E. Friend No. 1 Well is closest to the road. It was drilled in October 1984 to a depth of 4,010 feet. Initial production from this well was 55 barrels of oil and no water pumped from the Mississippian Ohara horizon at a depth from 3,172 to 3,185 feet. The McNeil-Friend No. 2 Well is located about 600 feet north of No. 1; it was drilled in December 1984 to a depth of 3205 feet. Initial production from Well No. 2 was 25 barrels of oil and 5 barrels of water pumped from the Ohara at a depth from 3,191 to 3,196.

(Note: Again you have the opportunity to see some of the discrepancies in the land surveys of Illinois in this vicinity. Section 30 and other sections in this north-south tier are slightly more than 0.65 mile wide.)

0.0	38.55+	Leave Stop 7 and CONTINUE AHEAD (west) across Walton Creek.
1.55+	40.15+	STOP: 1-way at T-intersection (1050N/1100E). TURN LEFT (south).
0.5+	40.65+	TURN RIGHT (west) at T-intersection (1000N/1100E). Here the route is through the Clay City Consolidated Oil Field.
0.7+	41.4	Cross Dry Fork.
1.35+	42.75+	STOP: 2-way at crossroads (1000N/900E). Here the route is near the eastern edge of the Sims Oil Field.


FARRINGTON
SIMS
OIL FIELD
Dry Fork
Miller Creek
Pin Oak Ch
Cincinnati Cem
Bull Cem
Johnson Cem
Farrington Prairie Ch
0 ½ 1 mi
0 ½ 1 1½ km

1.1	43.85+	Cross Miller Creek, which has been straightened in part of its course.
1.15	45.0	Natural gas pumping station is located to the right.
0.8+	45.8+	STOP: 1-way at T-intersection (1000N/600E). TURN RIGHT (north). You are in the Keenesville East Oil Field.
1.0+	46.85	TURN LEFT (west) at T-intersection (1100N/600E).
0.5+	47.35+	Cross Crooked Creek.
1.0+	48.4	STOP:1-way at T-intersection (1100N/450E). TURN LEFT (south).
0.15+	48.55+	Note Pleistocene exposures in the roadcut.
0.4+	49.0	PARK along the roadside east of the bridge. Do NOT park on the bridge.

STOP 8 Examine Pennsylvanian-age sandstone outcrop, Rock Bluff Bridge (NW SE SW NW Sec. 26, T1S, R5E, 3rd P.M., Crisp 7.5-Minute Quadrangle [38088D5]).

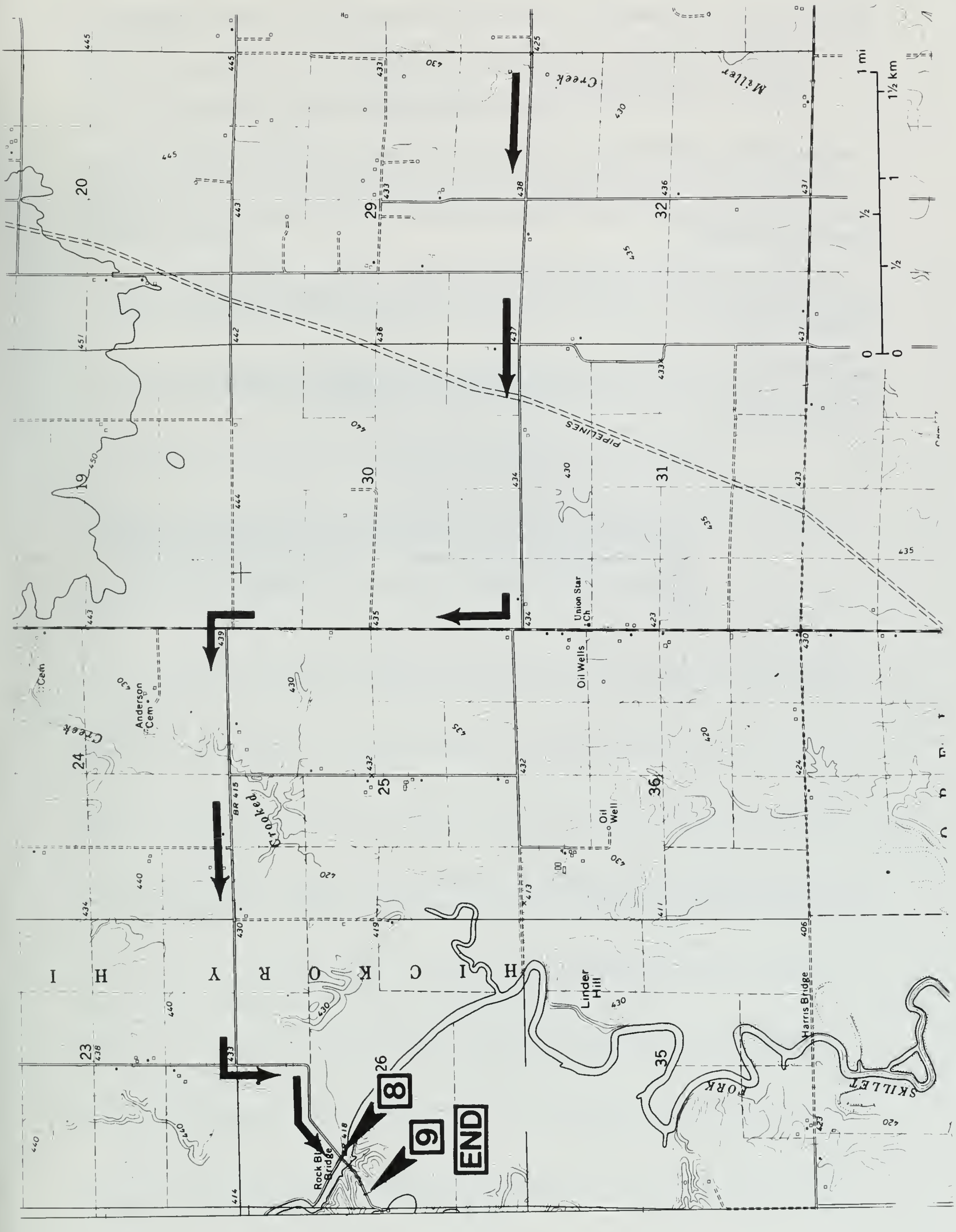
This outcrop is a good exposure of a Middle Pennsylvanian sandstone. These sandstones are fine grained and composed mostly of quartz, mica, calcite, and ferro-magnesian minerals. Conglomeratic layers composed of clasts of shale, coal, and claystone commonly are present at the base of sandstones like this. At this site, however, the base of the sandstone is not exposed and the presence of any conglomeratic layers can only be conjectured.

Sandstone bodies in the Middle Pennsylvanian are variable in thickness and lateral persistence. They generally occur either as thick, sinuous, and narrow deposits (fluvial in origin), or as thin, widespread deposits (floodplain in origin), or a combination of both. The outcrop here probably is part of a fluvial deposit because it is relatively thick and only forms a local ridge, indicating that it is not laterally extensive.

These rocks commonly are used as aquifers in this area. Sandstones characteristically are porous and permeable, which means the voids between grains (pores) are connected. Thus these rocks commonly contain water that is extractable. The removal of water (discharging) from aquifers requires that the water be replaced (recharged) in the rock in order to maintain a constant supply. This sandstone probably is being partly recharged by the water of Skillet Fork as it flows along the outcrop.

A water well 98 feet deep was drilled in 1973 in the vicinity of the oil well noted at Stop 9. The driller reported 86 feet of sandstone in the water well. The static water level in the well was at 40 feet. After pumping this well for 1 hour at 1,200 gpm, the level was drawn down to 80 feet. This would be a good supply of water for irrigation purposes, as well as for waterflooding operations. It seems likely that Skillet Fork is recharging this sandstone.

Unless they are fairly extensively jointed (fractured along a series of planes), Pennsylvanian sandstones commonly do not produce the quantity of water that is produced here. In general, the porosity and permeability that exists between the individual mineral grains in these sandstones is relatively low. Open fractures formed by joints allow water to move relatively rapidly toward a well that is discharging large quantities of groundwater.



8
9
END
Union Star Ch
Oil Wells
Oil Well
Anderson Cem
Cem
Linder Hill
Harris Bridge
PIPELINES
HICKORY
SKILLET FORK
Crooked
Creek
Miller
0
½
1
1 mi
1½ km

As you can see, a natural gas pipeline and oil well collector pipelines are attached to either side of the bridge.

0.0	49.0	Leave Stop 8 and CONTINUE AHEAD (southwest) up the hill.
0.15	49.15	PARK along the roadway. Do NOT block driveways or field openings.

STOP 9 View the oil well pump (SW SW NW Sec. 26, T1S, R5E, 3rd P.M., Crisp 7.5-Minute Quadrangle [38088D5]).

This well, on the G. Brown farm, was drilled by C. T. Evans in June 1977 to a depth of 3,639 feet. Initial production was 50 barrels of oil from the Mississippian Salem Limestone at a depth of 3,562 to 3,625 feet.

The pumpjack is powered by natural gas from this well. The toothed, adjustable cam on the side of the pumpjack is a design that is not commonly used in Illinois.

End of the Fairfield geological field trip.

To return home from here: CONTINUE AHEAD (west) for 1.35 miles to Wayne County Route 13. TURN LEFT (south) and follow that route for about 4.85 miles to Keenes and SR 15. Mt. Vernon (I-57) is about 15 miles west (right); US 45 on the west side of Fairfield is 15 miles east (left).

REFERENCES

Atherton, E., 1971, Tectonic development of the Eastern Interior Region of the United States, 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, 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. 24.

Bell, A. H., 1943, Subsurface Structure of the Base of the Kinderhook-New Albany Shale in Central and Southern Illinois: Illinois State Geological Survey Report of Investigations 92, 13 p.

Bell, A. H., E. Atherton, T. C. Buschbach, and D. H. Swann, 1964, Deep Oil Possibilities of the Illinois Basin: Illinois State Geological Survey Circular 368, 38 p.

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, no. 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 (color), scale 1:500,000, size 30×50 inches.

Fidlar, M. M., 1948, Physiography of the Lower Wabash Valley: Indiana Division of Geology Bulletin 2, 112 p.

Frye, J. C., A. B. Leonard, H. B. Willman, and H. D. Glass, 1972, Geology and Paleontology of Late Pleistocene Lake Saline, Southeastern Illinois: Illinois State Geological Survey Circular 471, 44 p.

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.

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., and others, 1979, Quaternary Deposits of Illinois: Illinois State Geological Survey Map (color), scale 1:500,000, size 40×60 inches.

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.

Reinertsen, D. L., S. T. Whitaker, and L. R. Follmer, 1989, Guide to the Geology of the Mt. Vernon Area, Jefferson County: Illinois State Geological Survey Geological Science Field Trip Guide 1989D, 67 p.

Samson, I. E., and S. B. Bhagwat, 1990, Illinois Mineral Industry in 1988 and Review of Preliminary Mineral Production Data for 1989: Illinois State Geological Survey Illinois Mineral Notes 105, 43 p.

Shaw, E. W., 1915, Newly discovered beds of extinct lakes in southern and western Illinois and adjacent states, Year-Book for 1910: Administrative Report and Various Economic and Geological Papers: 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 1989A, 52 p.

Weller, J. M., 1936, Geology and Oil Possibilities of the Illinois Basin: Illinois State Geological Survey Illinois Petroleum 27, 19 p.

Weller, J. M., and A. H. Bell, 1937, Illinois Basin: Illinois State Geological Survey Illinois Petroleum 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., and others, 1967, Geologic Map of Illinois: Illiois State Geological Survey Map (color); scale 1:500,000, size 40×56 inches.

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.

Wilson, G. M., 1955, Fairfield Area: Illinois State Geological Survey Geological Science Field Trip 1955A, 11 p.

Worthen, A. H., 1875, Geology of Wayne and Clay Counties, Geology and Palaeontology: Geological Survey of Illinois, Vol. VI, p. 82-97.

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.

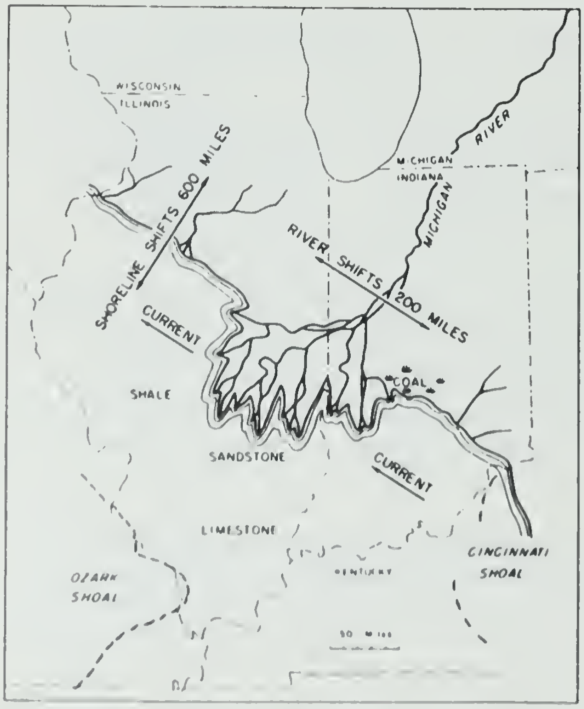


Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.

THE 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.

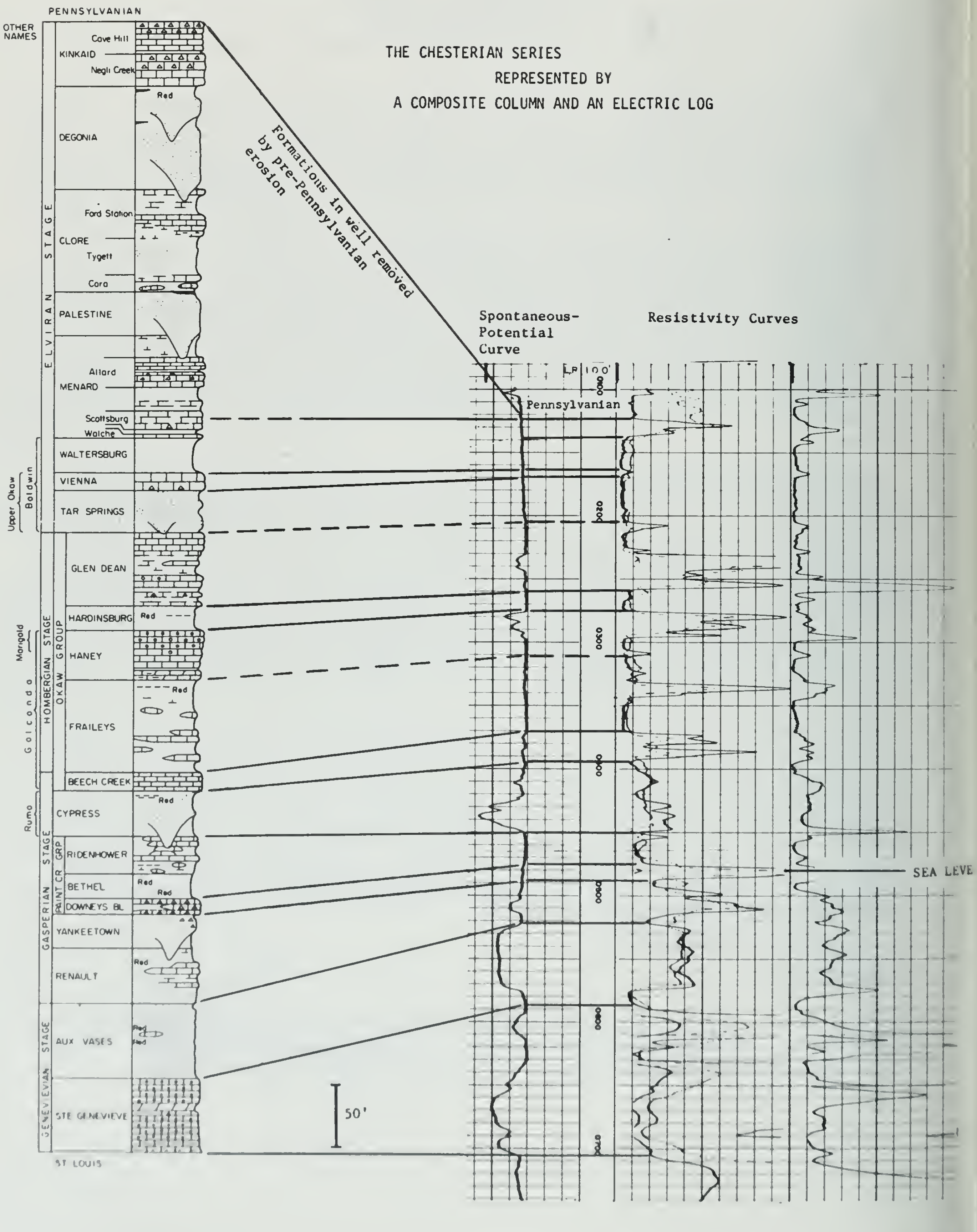
Cross-sections consisting of several corrlelated e-logs reproduced at the same scale are used to demonstrate that: (1) thicker layers of sandstone or shale or limestone--a particular rock unit--are delineated as characteristic shapes by the pair of S-P and resistivity curves, (2) the rock units vary 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.

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



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.

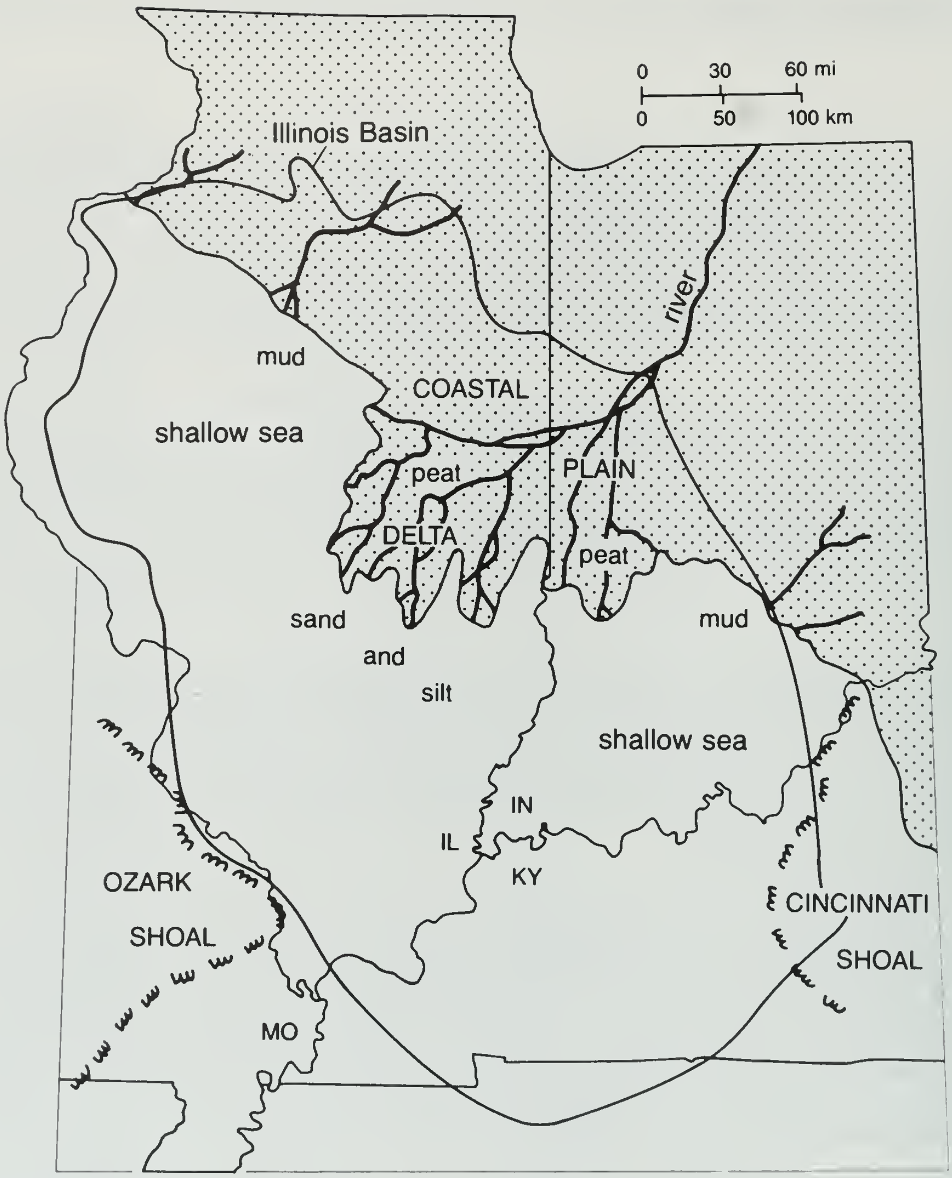
Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those of the preceding Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands to the northeast. This river system formed 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.

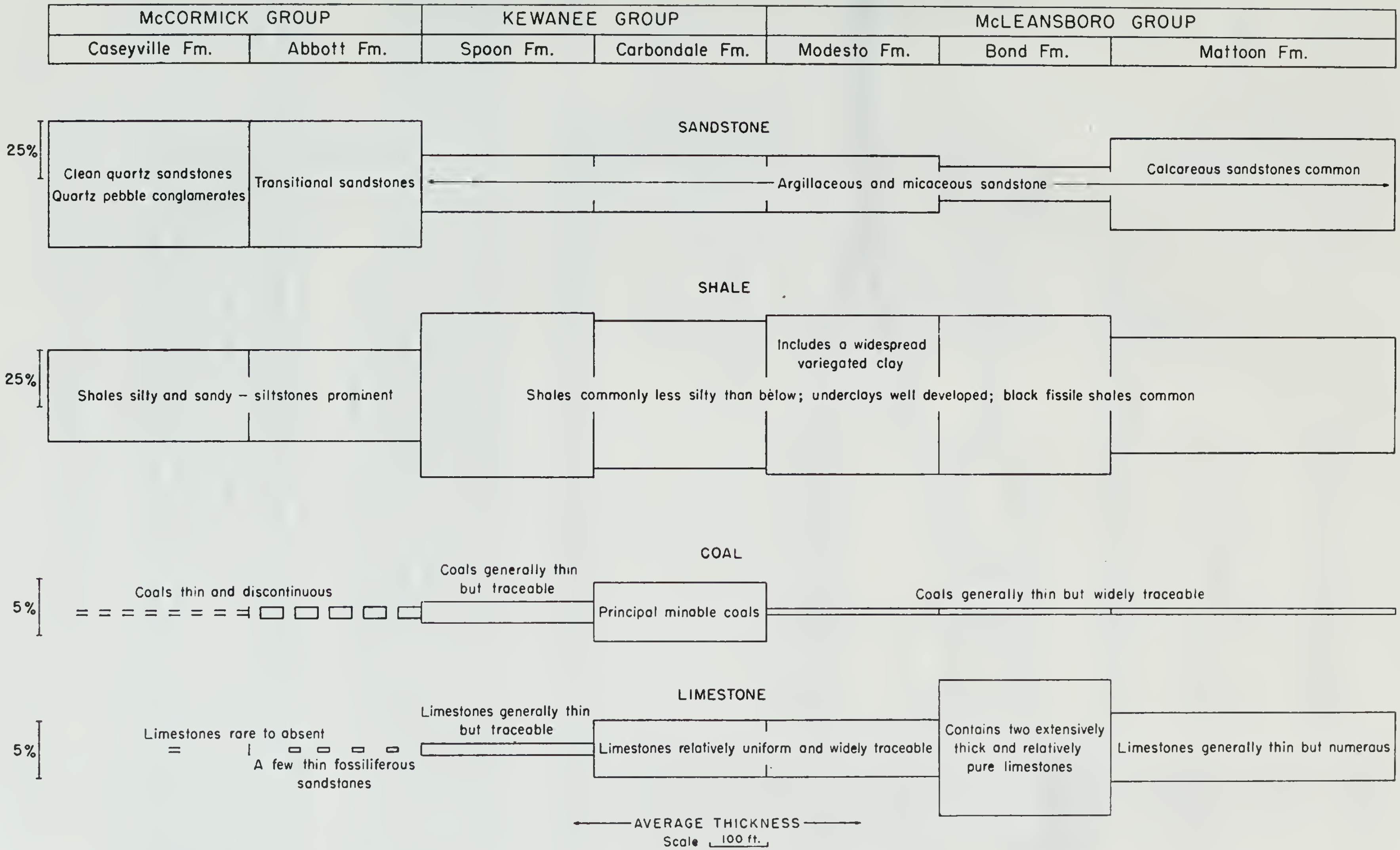
Beneath the quiet water of extensive swamps that prevailed for long intervals on the emergent coastal lowland, peat was formed by accumulation of plant material. Lush forest vegetation covered the region; it thrived in the warm, moist Pennsylvanian-age climate. Although the origin of the underclays beneath 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.



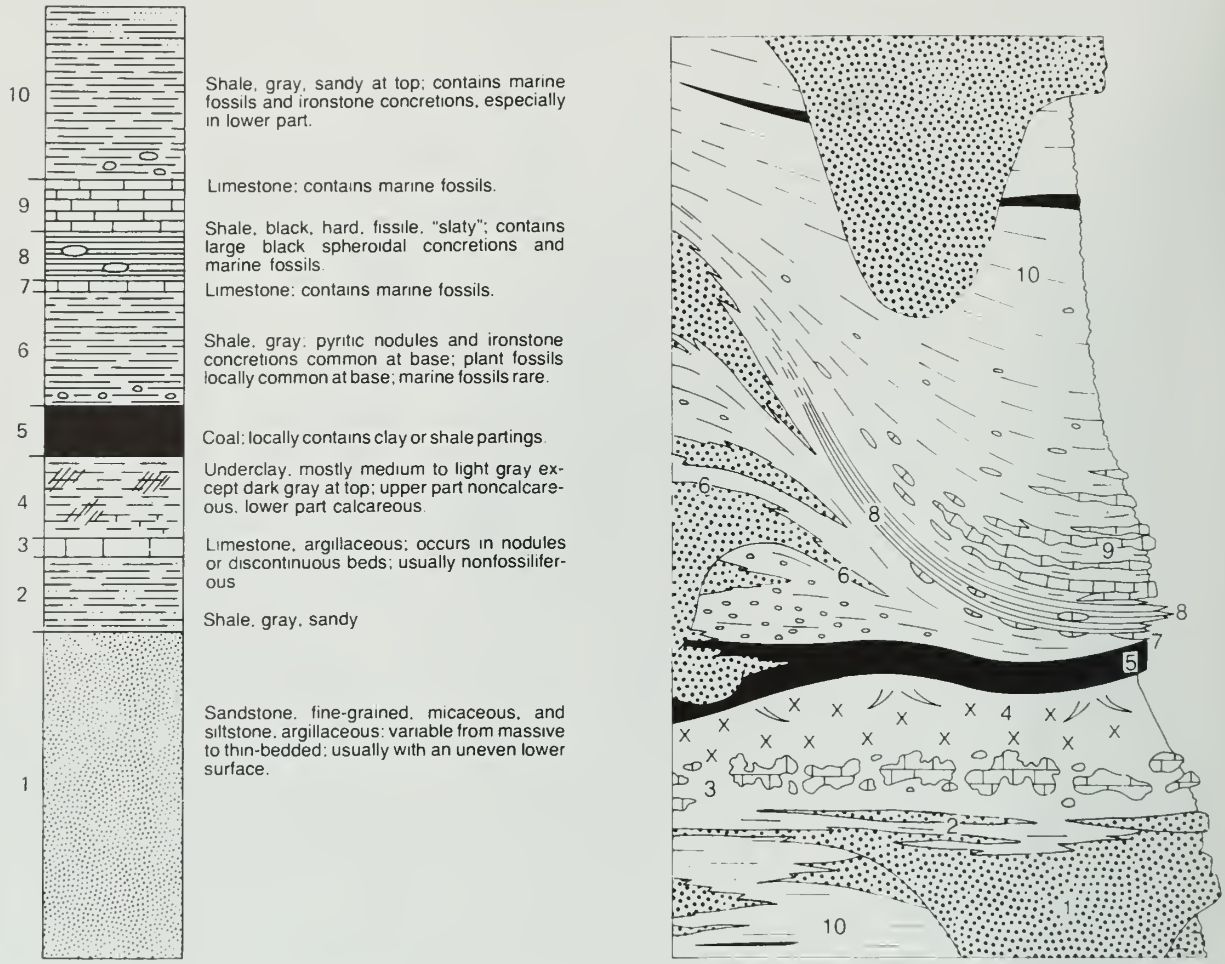
Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows a Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

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.



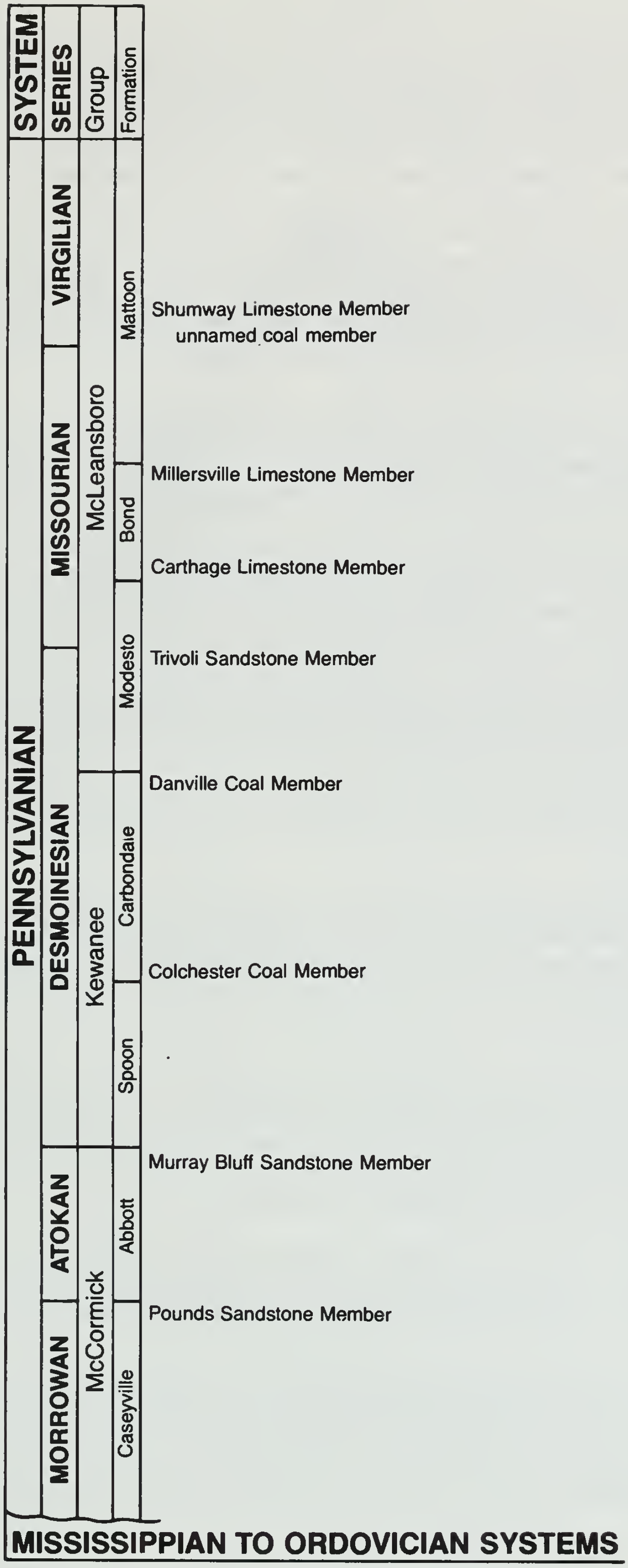
General distribution of the four principal lithologies in Pennsylvanian strata of Illinois.



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.



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

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 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.

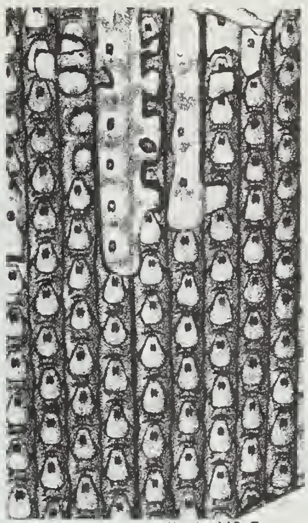
Willman, H. B., et al., 1967, Geologic Map of Illinois: Illinois State Geological Survey map; scale, 1:500,000 (about 8 miles per inch).

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.

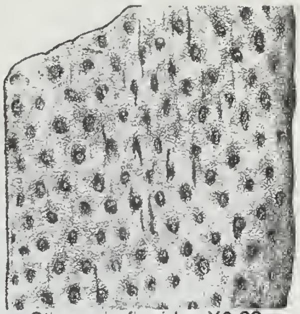
Common Pennsylvanian plants: lycopods, sphenophytes, and ferns

Lepidodendron aculeatum X0.8

Lepidophloios laricinus X0.63

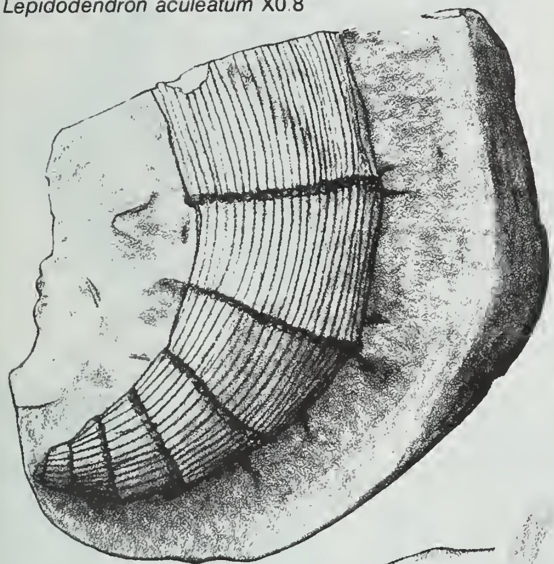


Sigillaria mammilaris X0.5



Stigmaria ficoides X0.32

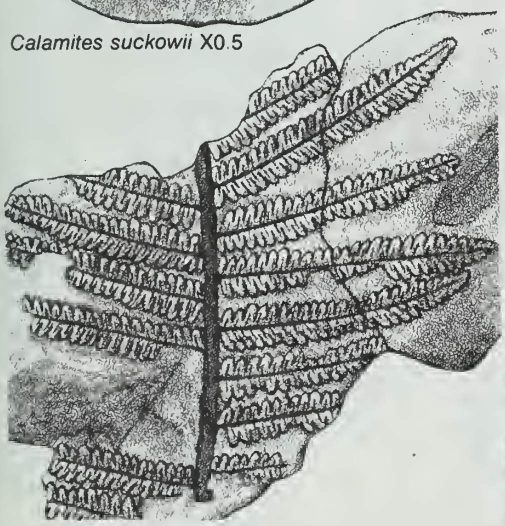
Lepidostrobus ovatifolius X0.8



Calamites suckowii X0.5

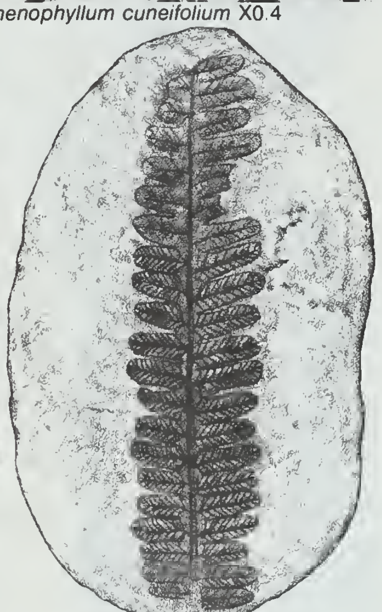
Annularia stellata X0.63

Sphenophyllum cuneifolium X0.4



Pecopteris sp. X0.32

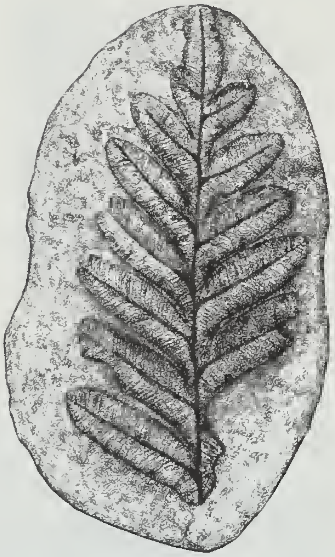
Pecopteris miltonii X2.0



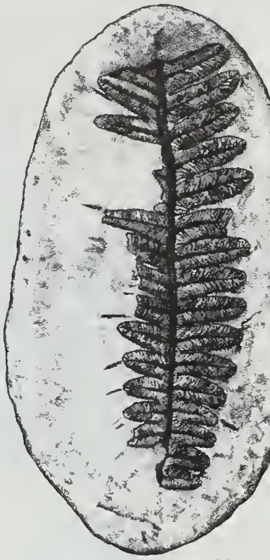
Pecopteris hemitelioides X1.0

J. R. Jennings, ISGS

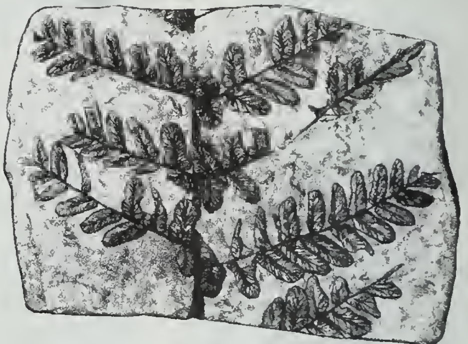
Common Pennsylvanian plants: seed ferns and cordaiteans



Alethopteris serlii X0.63



Alethopteris ambigua X0.63



Neuropteris rarinervis X0.5

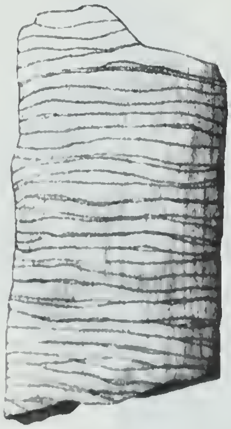
Mariopteris nervosa X0.8

Neuropteris scheuchzeri X0.63

Sphenopteris rotundiloba X0.8

Trigonocarpus parkinsonii X1.25

Cordaicladus sp X1 0

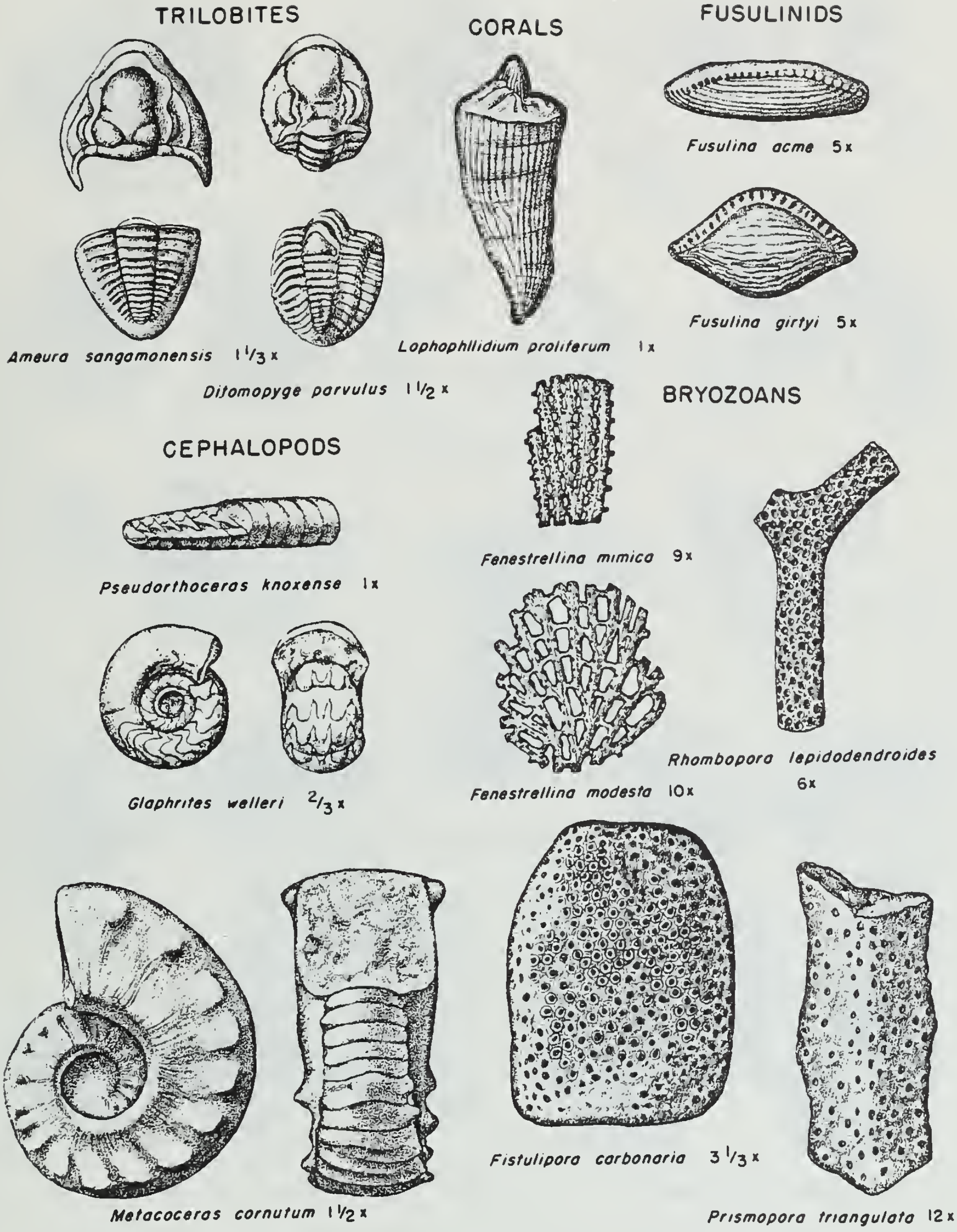


Artisia transversa X0 63

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
Rhombopora lepidodendroides 6x
Glaphrites welleri 2/3 x
Fenestrellina modesta 10x
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 1½x

Cardiomorpha missouriensis
"Type A" 1x

Cardiomorpha missouriensis
"Type B" 1½x

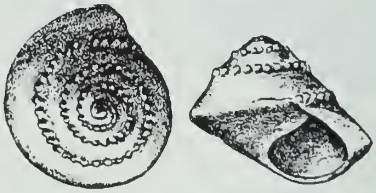
GASTROPODS

Euphemites carbonarius 1½x

Trepospira illinoisensis 1½x

Donaldina robusta 8x

Naticopsis (Jedria) ventricosa 1½x



Trepospira sphaerulata 1x

Knightites montfortianus 2x

Glabrocingulum (Glabrocingulum) grayvillense 3x

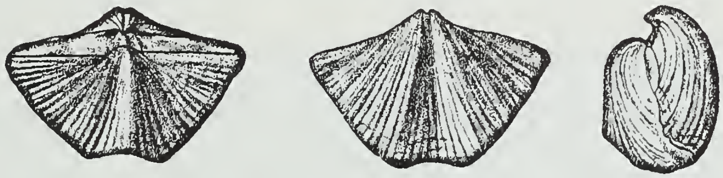
BRACHIOPODS

Wellerella tetrahedra 1 1/2 x

Juresania nebrascensis 2/3 x

Derbyo crosso 1x

Composita argentia 1x



Neospirifer cameratus 1x

Chonetes granulifer 1 1/2 x

Mesalobus mesalobus var. *evampygus* 2x

Marginifera splendens 1x

Crurithyris planoconvexa 2x

Linoproductus "cora" 1x

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 Mississippi, 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.

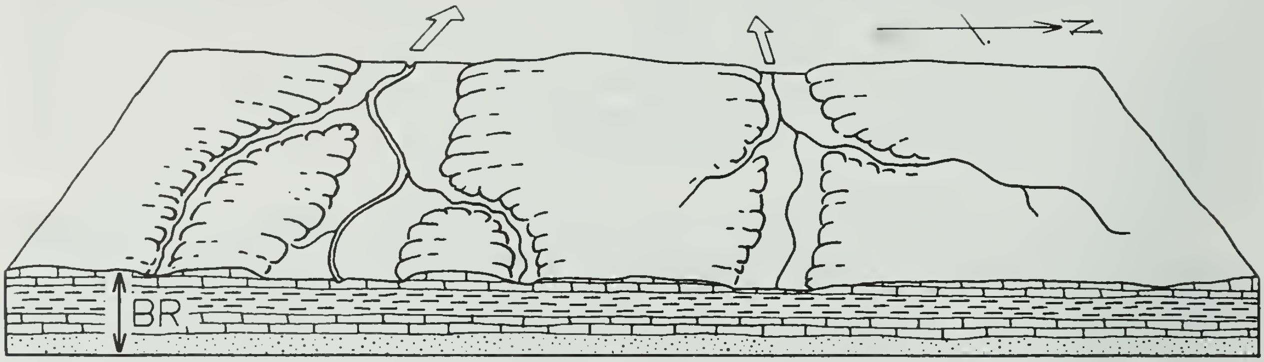
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and 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.

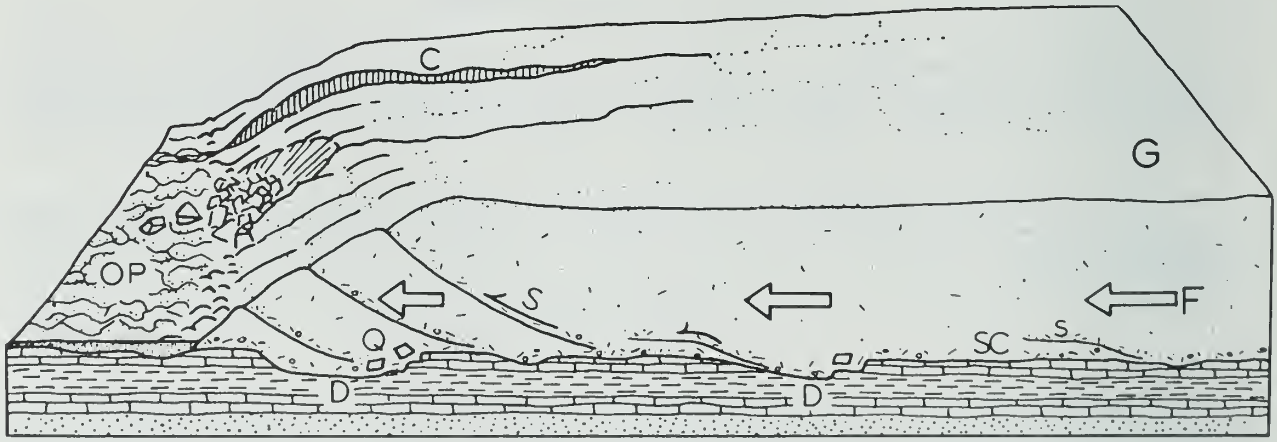
Glaciation in a Small Illinois Region

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.

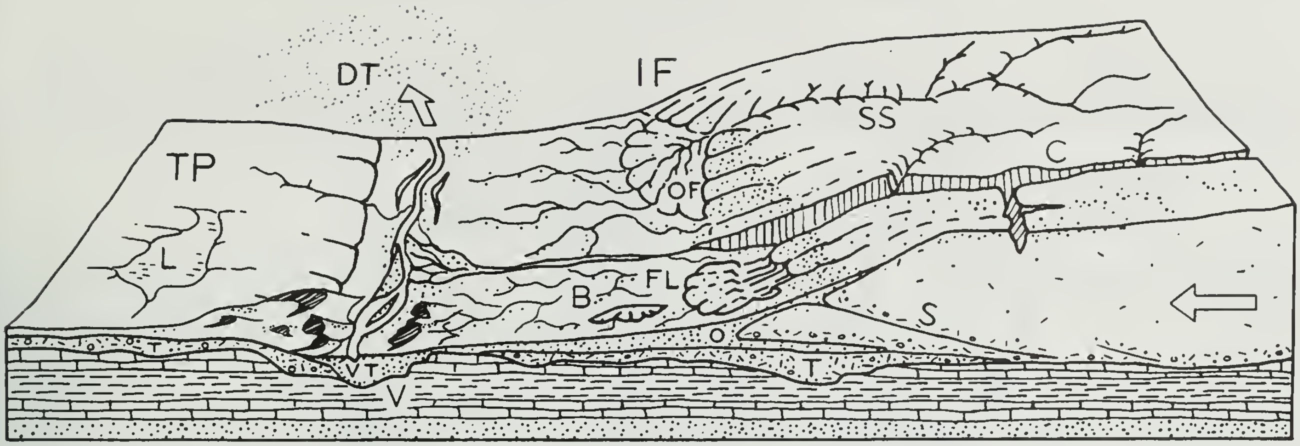
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



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.



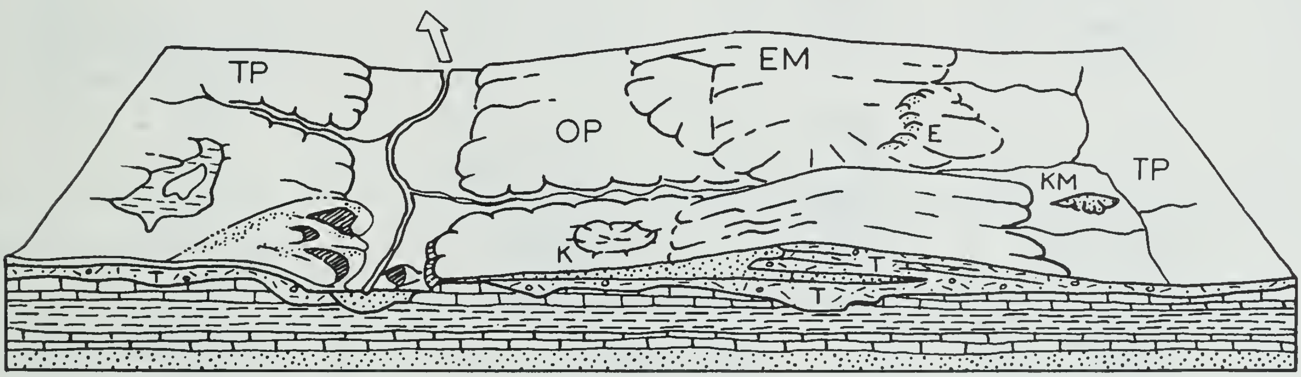
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses 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.

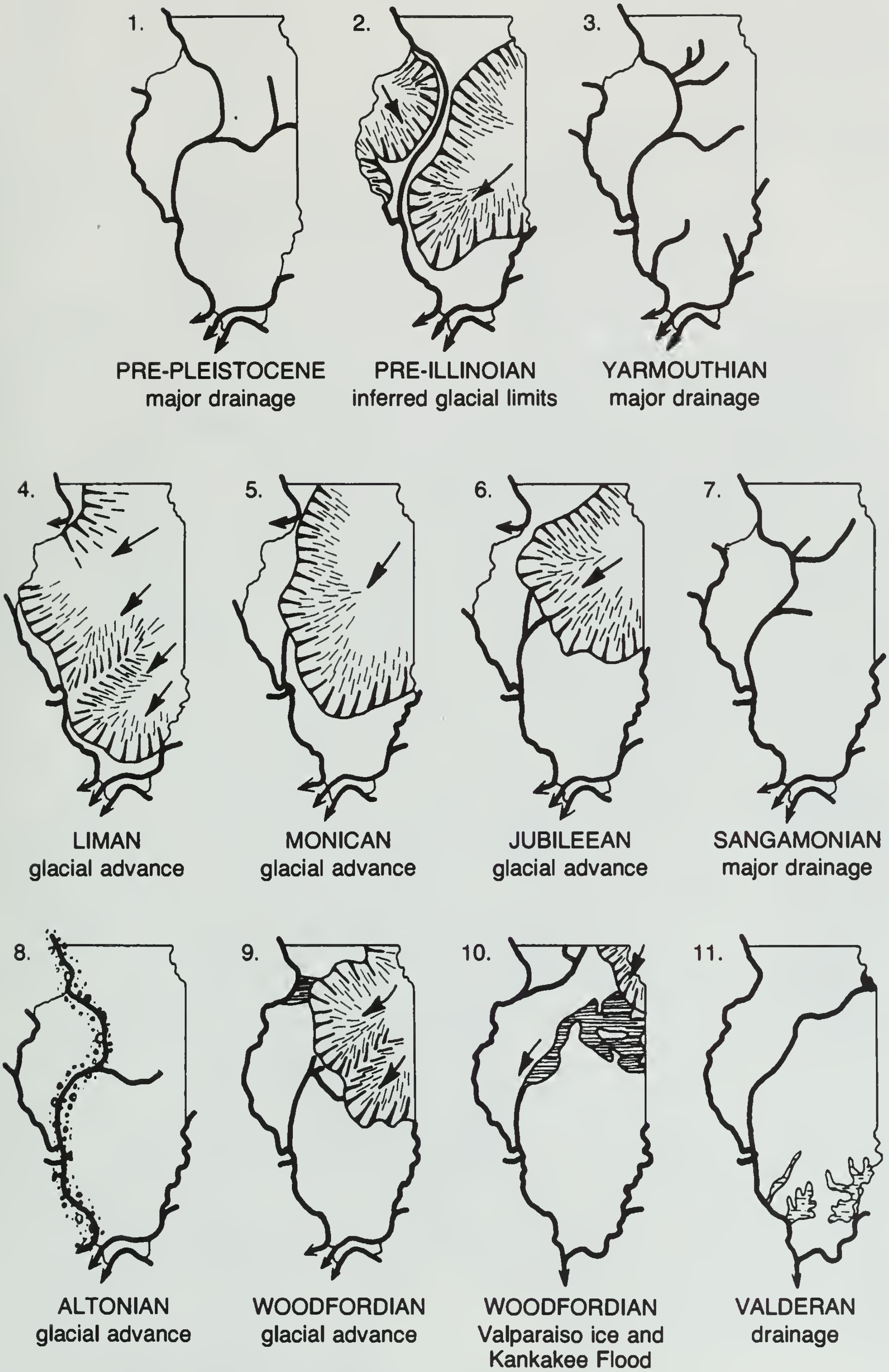
TIME TABLE OF PLEISTOCENE GLACIATION

			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)			Drift (little known)	Glaciers from northwest invaded western Illinois
					1,600,000 or more		

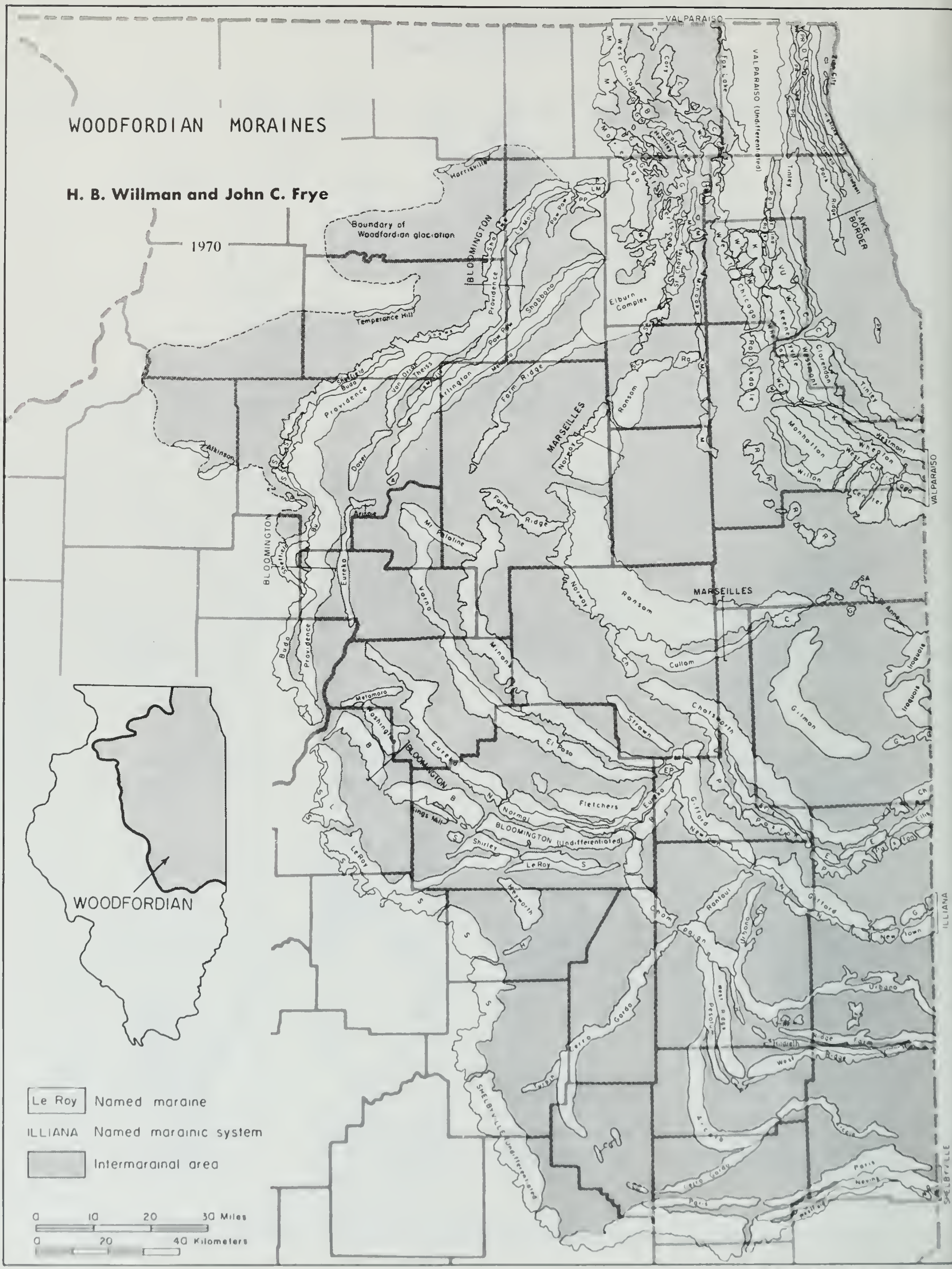
*Old oversimplified concepts, now known to represent a series of glacial cycles.

(Illinois State Geological Survey, 197

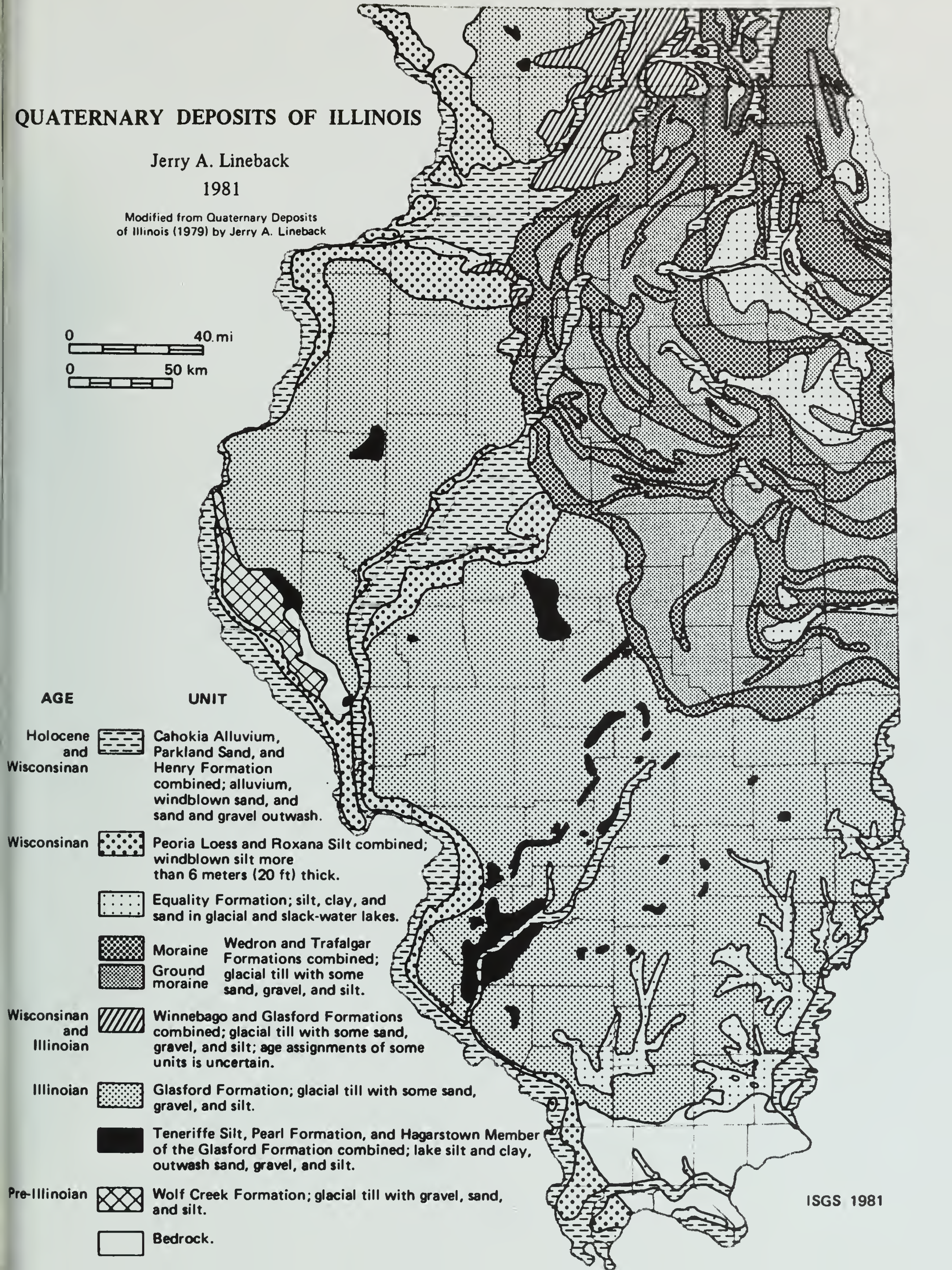
SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS

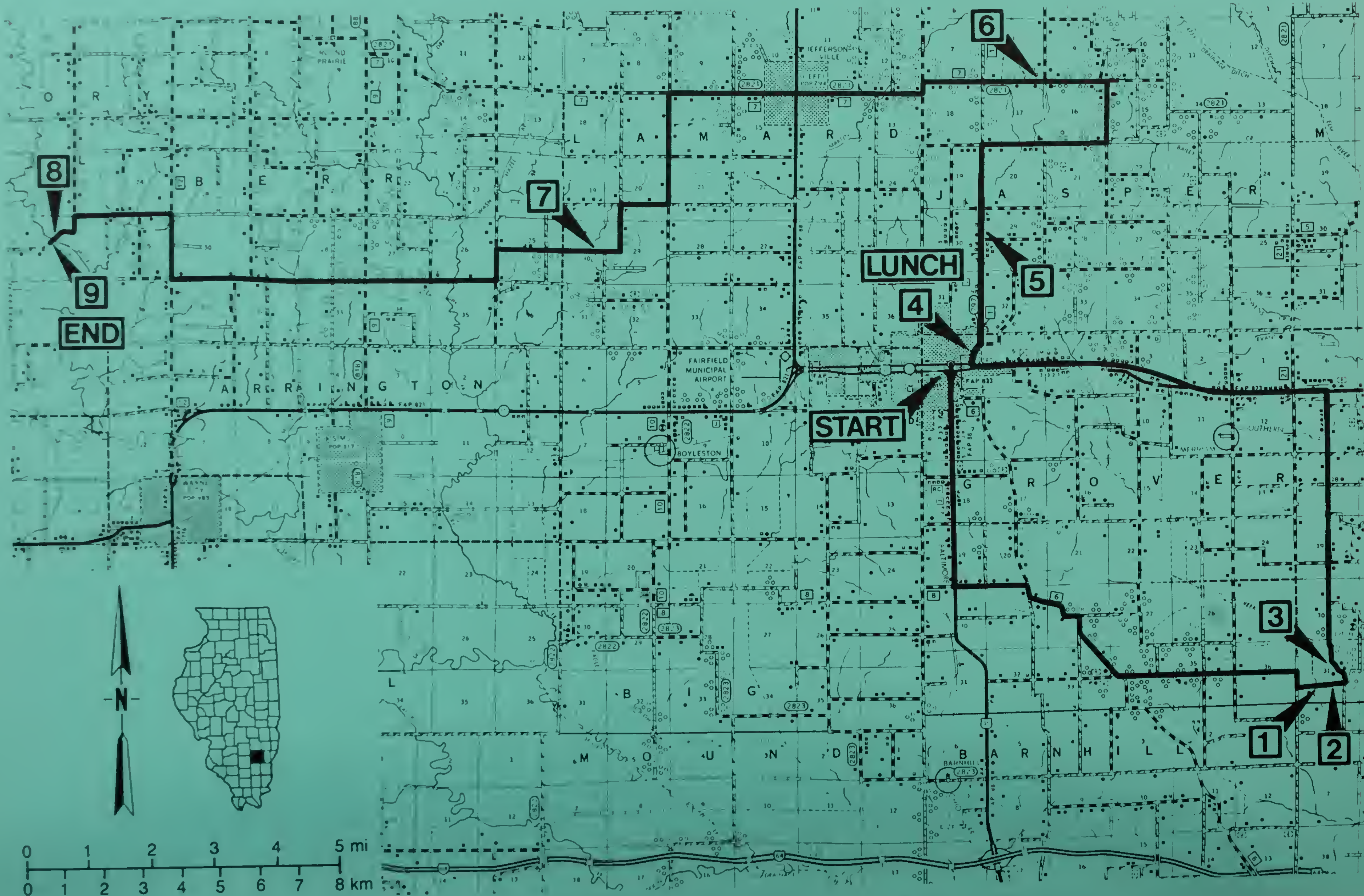


(Modified from Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)



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


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



START
LUNCH
END
1
2
3
4
5
6
7
8
9
FAIRFIELD MUNICIPAL AIRPORT
BOYLESTON
JEFFERSONVILLE
BARNHILL
N
0 1 2 3 4 5 mi
0 1 2 3 4 5 6 7 8 km