

# A GUIDE TO THE GEOLOGY OF THE FORREST AREA, LIVINGSTON COUNTY

## Geological Science Field Trip

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**A GUIDE TO THE GEOLOGY OF THE FORREST AREA  
Livingston County**


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



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## THE GEOLOGIC FRAMEWORK

**Physiography and general geology of the area** - The Forrest area lies south of the Illinois River in north-central Illinois between morainal ridges that are part of the Bloomington Ridged Plain of the Till Plains Section (fig. 1). The field trip highlights some features of the glacial deposits that surround and cover the area as well as bedrock features that occur just beneath the land surface.

Thick, slow-moving continental glaciers covered the Forrest area repeatedly during the "Great Ice Age" (Pleistocene Epoch) that lasted more than 1.5 million years and ended only about 12,000 years ago in Illinois. Glacial ice and the meltwater from it eroded the much older bedrock surface and left behind a wide textural variety of unconsolidated materials. Glacial drift in this area ranges in thickness from just a few feet along the crest of the La Salle Anticlinal Belt (fig. 2) to more than 200 feet along the higher parts of moraines that lie just a few miles beyond the field trip area. Limited exposures occur in some of the larger stream channels. Although early glaciers (Pre-Illinoian) (see PLEISTOCENE GLACIATIONS IN ILLINOIS, appendix) doubtless covered the area, glacial deposits visible at the surface in Livingston County are between about 22,000 and perhaps 13,500 years old and were deposited by glaciers of the Wisconsin Stage.

Glacial lakes occupied large areas in and adjacent to the field trip locality during the latter part of Woodfordian time (about 12,000 years ago) and are responsible for the general flatness of those areas. In the northwestern part of the area, meltwater ponded to form Lake Ancona between the Minonk Moraine (see Woodfordian Moraines map, appendix) and the eastward melting Wisconsin ice front. The elevation of this lake was 650 feet, mean sea-level (msl). Apparently, little meltwater ponding occurred during the advance and melting back of the Wisconsin glacier that formed the Chatsworth Moraine to the east. As noted on previous field trips in northeastern Illinois, large lakes did form across the region as a vast ice mass covering the Lake Michigan Basin and parts of Indiana, Michigan, and northeastern Illinois began to melt rapidly. A tremendous quantity of melt-water ponded between the ice front and encircling morainal ridges. When lake levels rose enough, water poured out across low sags in the morainal ridges to form the Chicago Outlet, Sag Channel, Kankakee River Valley, and the valley of the North Fork of the Vermilion River near Wing, Illinois. This outpouring of meltwater in the Kankakee area, termed the Kankakee Flood, formed glacial Lake Wauponsee in the Morris area and Lake Watseka in Iroquois County. Overflow from Lake Wauponsee crossed the Marseilles Morainic System and caused flooding of the Vermilion River Basin in the Pontiac area to form glacial Lake Pontiac. At the same time overflow from glacial Lake Watseka cut the channel near Wing and contributed large volumes of water to Lake Pontiac. Later, wind-deposited silt (loess) mantled the region, and localized areas of sand dunes formed. During the last interval of geologic time (Holocene Age) rich prairie soils formed in the glacially derived sediments.

In the Forrest field trip area, glacial deposits consist of mixed clay, silt, sand, pebbles, and boulders laid down directly by the ice. This material is called till (see Stop 3). Another common glacial deposit, transported and

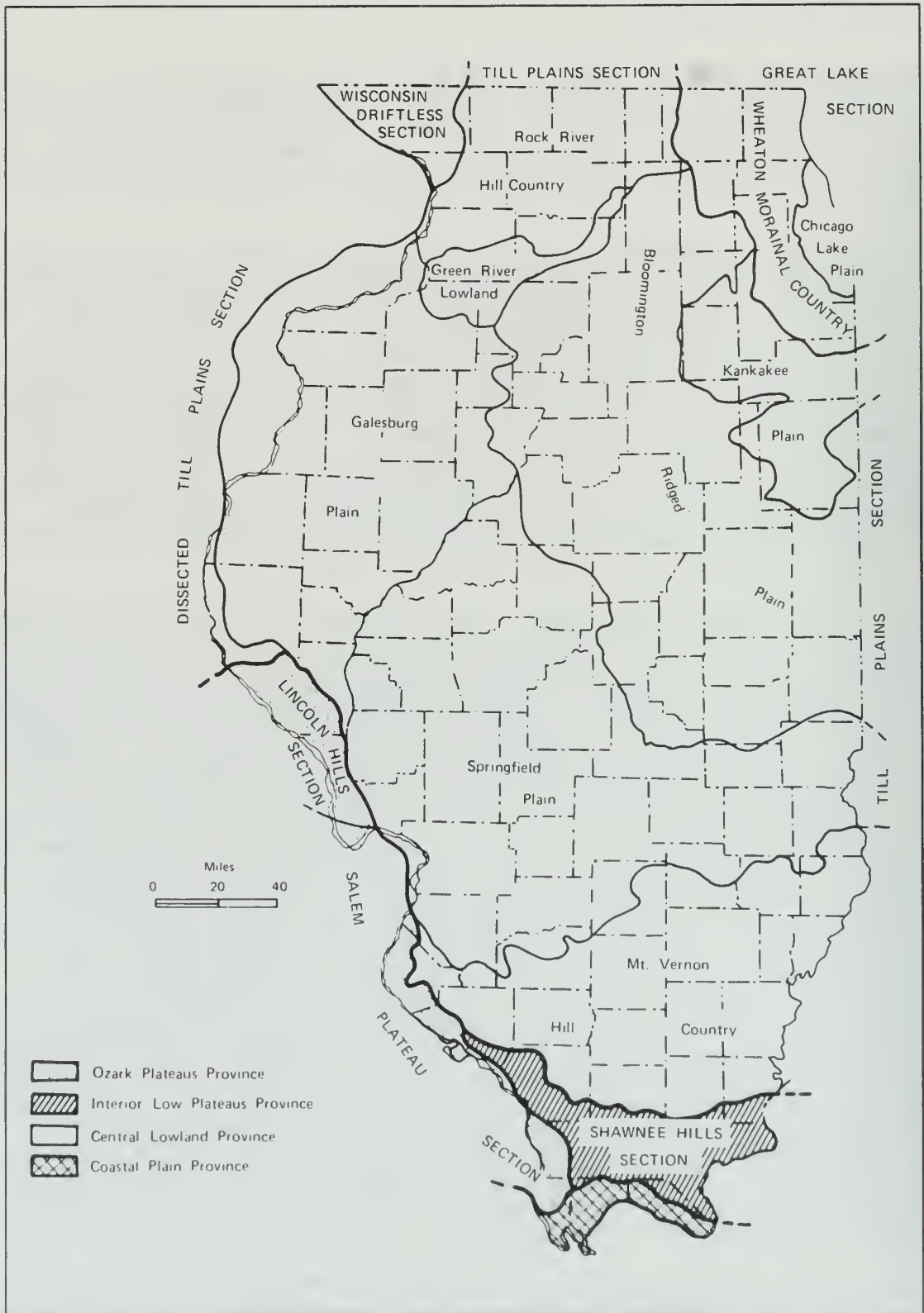
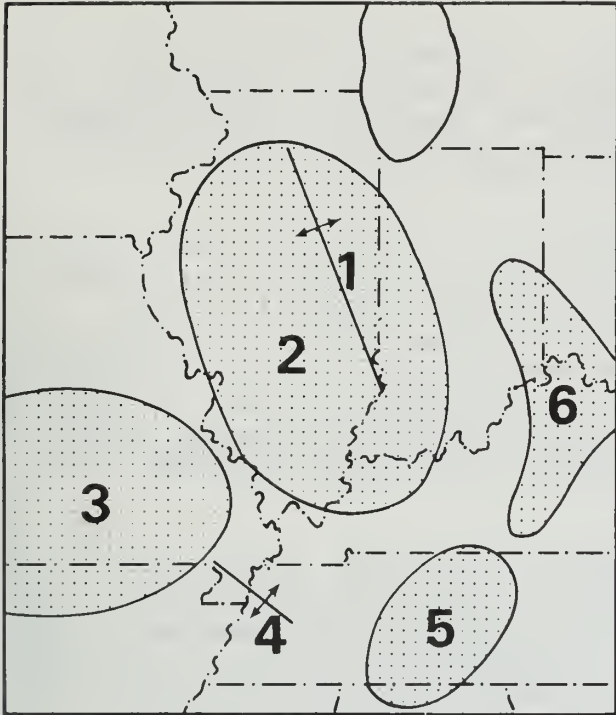
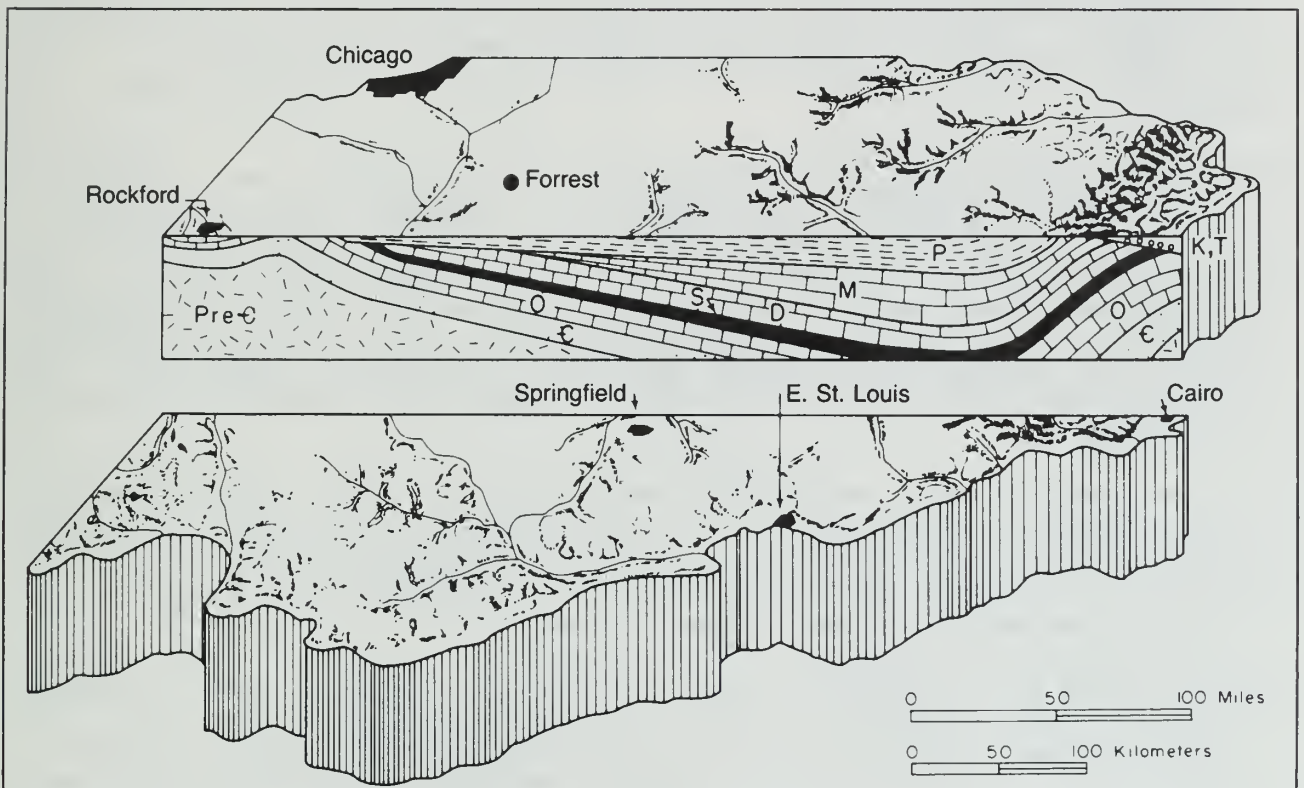


Figure 1 Physiographic divisions of Illinois



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



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

laid down by flowing meltwater, is outwash--sorted sand and gravel (see Stop 7). Outwash is commonly found along glacial valleys as valley trains and in front of moraines where meltwater flowed away from the ice across outwash plains. In this area, a thin cover (less than two feet) of wind-blown silt, called loess (rhymes with bus) mantles the ground surface.

The bedrock that underlies the glacial deposits in the Forrest area consists of 4,200 to 5,100 feet of sedimentary strata (figs. 3 and 4). These strata are mostly shale, limestone, dolomite, and sandstone deposited as loose sediments, layer upon layer, in shallow seas, related shorelines, swamps, bays, and deltas that covered the Midcontinent Region during the Paleozoic Era between 570 and 245 million years ago. The Paleozoic is divided into major subdivisions of rocks known as systems, each of which was deposited during a specific period of geologic time. The systems are further subdivided into many formations.

Bedrock exposed along streams and in quarries in this area belongs to the Pennsylvanian System of rocks (fig. 5). It is underlain by progressively older formations of Silurian, Ordovician, and Cambrian age in the subsurface. The Cambrian strata rest on ancient Precambrian igneous and metamorphic rocks that are more than one billion years old. In northern Illinois there is no record in the rocks of the time between the formation of the youngest bedrock (Pennsylvanian age--more than 290 million years ago here) and the beginning of continental glaciation (Pleistocene age--more than 1.5 million years ago). The region was apparently above sea level and erosion prevailed over deposition. We call such gaps in the rock record "unconformities" (see Stop 8).

The Pennsylvanian rocks (sometimes called the Coal Measures) were formed in shallow seas and bordering deltaic swamps that repeatedly occupied much of Illinois (see DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS, appendix). Lush forest vegetation consisting largely of tree ferns, which thrived in the warm, moist Pennsylvanian climate, covered the area and accumulated beneath the quiet waters of widespread long-lived swamps. Over a period of geologic time, these accumulations of plant debris were converted to coal in the Pennsylvanian rocks. In nearby areas plant fossils are commonly associated with the coal.

A line between Pontiac and Forrest, roughly parallel to the Vermilion River, lies diagonally across the La Salle Anticlinal Belt, the largest structure in the Illinois Basin (figs. 2 and 3). The La Salle Anticlinal Belt is 10 to 50 miles wide and can be traced from north-central Illinois about 200 miles south-southeastward into southwestern Indiana.

The Illinois Basin encompasses most of Illinois and adjacent parts of Indiana and Kentucky and contains more than 14,000 feet of Paleozoic strata in southern Illinois (fig. 3). The basin is the product of vertical tectonics (deformation). Recent structural research indicates that vertical fractures or faults have broken the Earth's crust in the Midcontinent Region into irregular polygons. Usually these fractures are restricted to the basement (Precambrian igneous and metamorphic rocks) but occasionally the faults may extend into the overlying Paleozoic strata.

Most large features of the Illinois Basin are the result of differential



Era	System	Series	Group or Stage	Formation	Material	
CENOZOIC	Quaternary	Pleistocene			Wisconsinan till, gravel, sand, and lake clays and silts	
			Pennsylvanian	McLeansboro	Bond Modesto	Sandstone, shale, clay, limestone, Colchester (No. 2), Herrin (No. 6), and Danville (No. 7) Coals
	Kewanee	Carbondale Spoon				
PALEOZOIC	Silurian	Niagaran		Port Byron Racine Waukesha Joliet	Dolomite and/or some limestone	
				Alexandrian	Kankakee Edgewood	Dolomite and sandstone
	Ordovician	Champlainian	Cincinnatian	Maquoketa		Shale and some dolomite or limestone
			Galena- Platteville			Dolomite and/or limestone, light brown
						Dolomite and/or limestone with streaks of shale
						Dolomite and/or limestone
				Ancell	Glenwood St. Peter Sandstone	Sandstone, shale, and dolomite Sandstone, sometimes conglomeratic at base
	Canadian	Prairie du Chien		Shakopee Dolomite	Dolomite and some thin sandstone beds	
				New Richmond Sandstone	Sandstone and some dolomite	
	Cambrian	St. Croixan		Oneota Dolomite	Dolomite, usually cherty	
				Trampealeuan		Dolomite, sandstone, and shale Dolomite
				Franconian		Sandstone, dolomite, and shale; very glauconitic
			Dresbachian		Sandstone and some dolomite Sandstone, shale, and dolomite Sandstone, arkosic in lower part; some shale and conglomerate	
		Pre-Cambrian			Crystalline rocks	

Figure 4 Generalized geologic column of the Forrest area.

McLeansboro Group

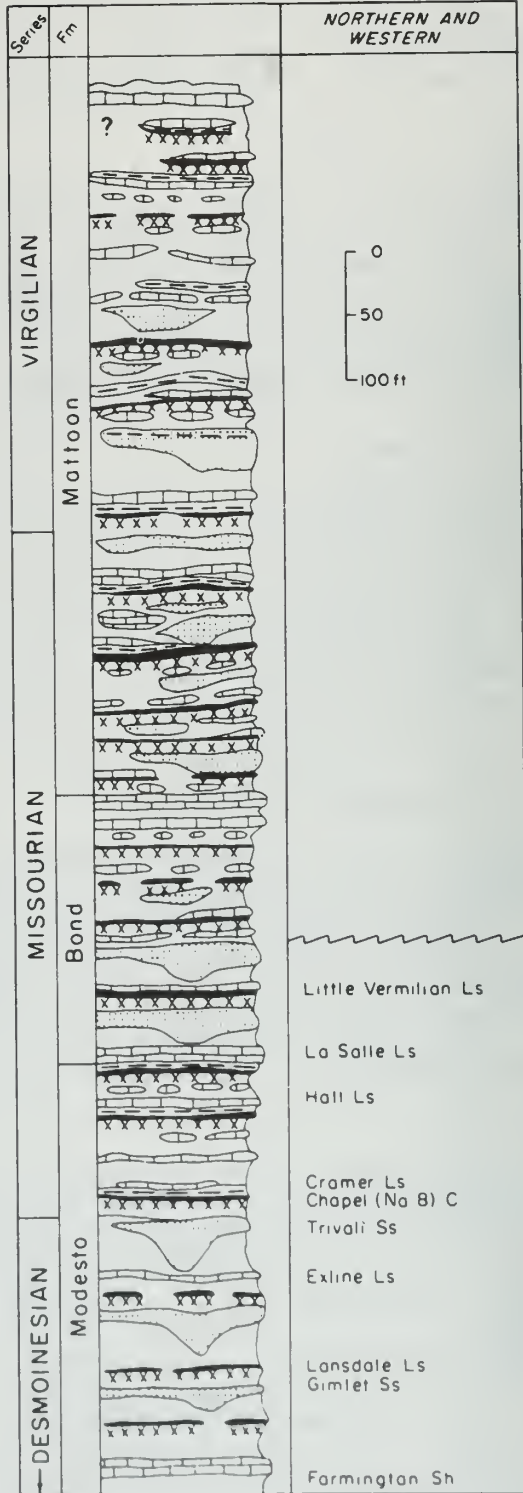
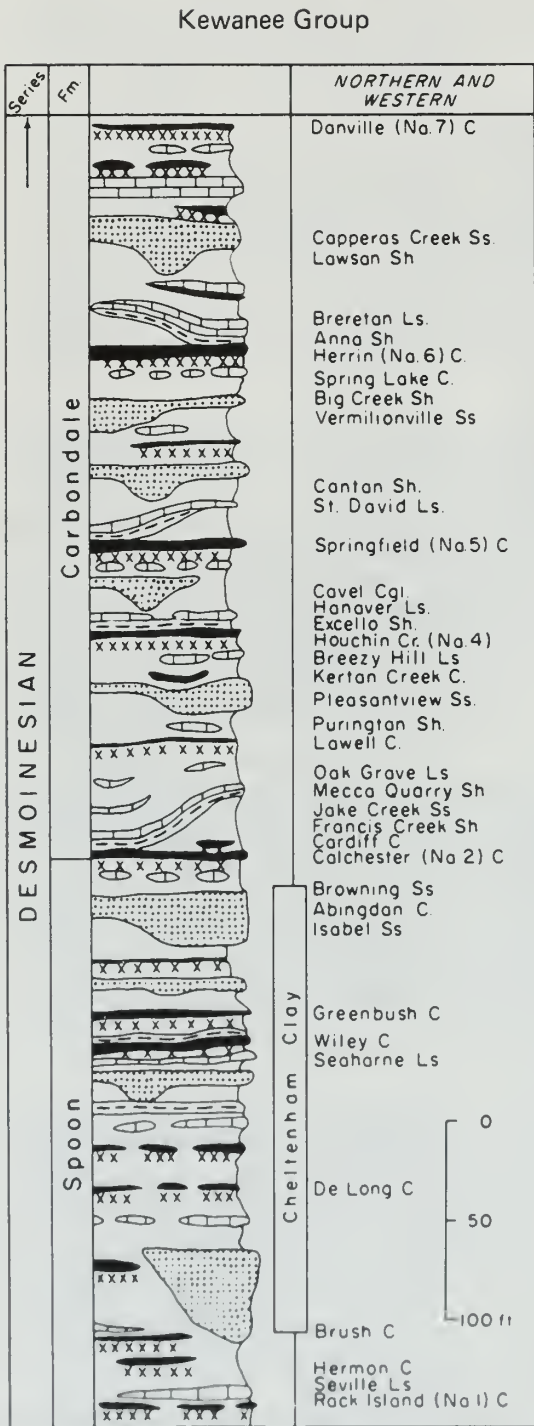


Figure 5 Generalized geologic column of Kewanee and McLeansboro Group strata for northern and western Illinois. (Not all units are present in the field trip area.)

vertical movement of fault-bounded blocks. The La Salle Anticlinal Belt marks a hinge line separating blocks that uplifted differentially. The west block was stable; the east block was uplifted and tilted slightly eastward, forming the asymmetrical La Salle Anticlinal Belt along its western edge. From late Mississippian time (about 325 million years ago) through at least Pennsylvanian time, tilting of the east block continued sporadically. By Pennsylvanian time, enough relief was present along the northern part of the La Salle Anticlinal Belt to influence the transport of sediment and the lateral distribution of many stratigraphic intervals in adjacent areas. Thus, there are sediment-draped structures as well as primary bedrock structures in the anticlinal belt.

**Mineral production** - During 1985, the last year for which production totals are available, Illinois mineral production values amounted to:

1. extracted	\$3,012.1 million
2. processed	\$ 540.4 million
3. manufactured	\$ 205.3 million

\$3,757.8 million

Major mineral commodity ranking was: (1) coal, (2) oil, (3) stone, (4) sand and gravel, and (5) clays.

Mineral resources extracted in Livingston County during 1985, consisted of stone, clay, and sand and gravel, in order of value. Tonnage and dollar values are withheld to avoid disclosing confidential data from individual companies. The county ranked 51st among the 98 Illinois counties reporting mineral production.

With respect to the production of sand and gravel, and clay in the general area of the field trip, we do not know of any pits that are currently processing material.

The crushed limestone industry is very active in the region between Fairbury and Pontiac. As many as eight companies may be producing stone from about 10 quarries. They are producing from the Pennsylvanian-age La Salle Limestone Member (see Stop 8).

Coal of Pennsylvanian age was mined near Fairbury in the field trip area until the early 1940s. The most widespread and persistent is the Colchester (No.2) Coal Member of the Carbondale Formation (fig. 5) which averages about three feet thick across much of Livingston County. It is about 380 feet deep near Fairbury. The Danville (No. 7) Coal Member was the main coal mined near Fairbury where it ranged from four to slightly more than five feet thick.

Various companies operated a mine about 1 1/2 miles west of the west edge of Fairbury and 1/4 mile north of U.S. 24. The Danville Coal was mined underground from a depth of about 220 feet, between 1904 and 1926. The location is marked by the 20 to 30-foot high remains of a reddish-brown gob pile south and east of Stop 8.

Groundwater is a mineral commodity frequently overlooked in assessments of an area's mineral resource potential. Groundwater is obtained from underground reservoirs occurring in beds of saturated glacial sand and gravel or stream alluvium, or in porous or creviced bedrock layers. The source of all potable

water in this part of Livingston County is precipitation that eventually filters down into underground reservoirs that are tapped by wells ranging from 50 to more than 200 feet deep.

Groundwater probabilities from sand and gravel aquifers are variable but generally favorable for domestic and farm supplies where the glacial drift is greater than 50 feet thick east and south of Fairbury. There the drift is composed mostly of till with only thin, discontinuous layers of water-bearing sand and gravel. However, more than 100 feet of sand and gravel are encountered locally in the Chatsworth Bedrock Valley, a north-south trending buried valley between Forrest and Chatsworth.

Groundwater from bedrock sources is available in all parts of southeastern Livingston County. Near Fairbury, and locally in other areas, domestic and farm supplies are obtained from shallow formations of Pennsylvanian age. Water from the Pennsylvanian and older bedrock strata may be of poor quality in some areas. The St. Peter Sandstone of Ordovician age, which is present at 1,400 feet at Fairbury, is considered to be a dependable source of groundwater by local well drillers. However, the town of Chatsworth abandoned a well finished in the St. Peter Sandstone at a depth of 1,285 feet because of poor water quality.

Detailed groundwater investigations have been conducted in the "boot heel" of Livingston County since 1946 when an electrical earth resistivity survey (a geophysical method for characterizing buried sand and gravel deposits) was completed at Chatsworth. This work resulted in the development of four sand and gravel wells of 84 feet (2) and 228 feet (2) in the Chatsworth Bedrock Valley. These wells have a combined yield of 600 gpm (gallons per minute) or 850,000 gallons per day. At Fairbury, two sand and gravel wells in use have an average depth of 50 feet and are reported to yield 350 gpm each or about one million gallons per day. Forrest has three sand and gravel wells with an average depth of 110 feet. The combined yield of these wells, which are situated in the Chatsworth Bedrock Valley, is about one million gallons per day. Strawn has one sand and gravel well 60 feet deep that is pumped at the rate of 50 gpm.

## GUIDE TO THE ROUTE

**NOTE:** The number in parentheses following the topographic map name, (40088G4), is the code assigned to that map as part of the National Mapping Program. The state is divided into 1° blocks of latitude and longitude. The first pair of numbers refers to the latitude of the southeast corner of the block and the next three numbers designates the longitude. The blocks are divided into 64 7.5-minute quadrangles; the letter refers to the east-west row from the bottom and the last digit refers to the north-south row from the right.

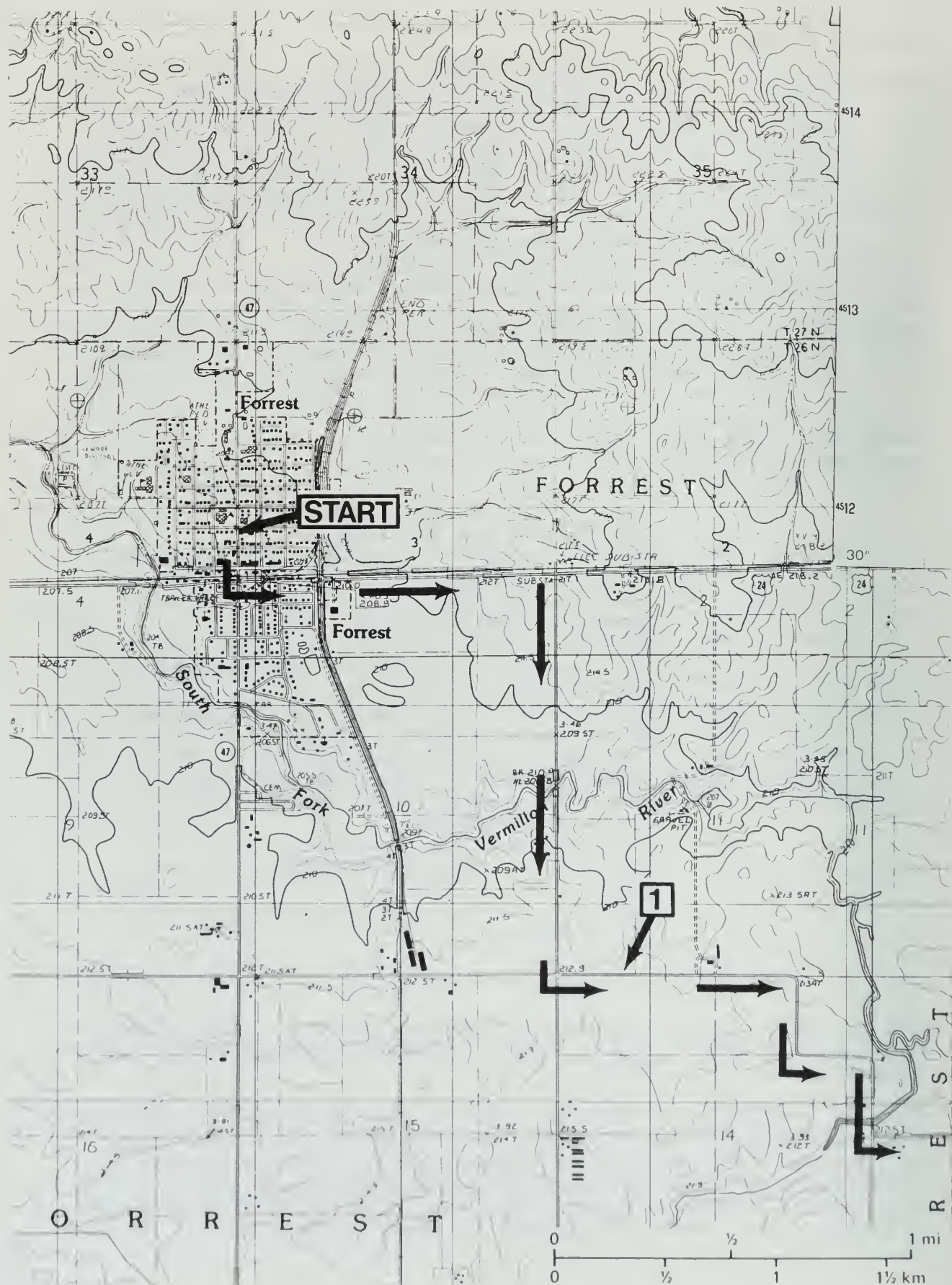
Line up heading **east** on Watson Street on the south side of Prairie Central Junior High School. Mileage figure is at the intersection of Watson Street and Center Street which is also State Route 47 [E edge SE 1/4 NE 1/4 NE 1/4 SE 1/4 Sec. 4, T. 26 N, R. 7 E., 3rd P.M., Livingston County; Forrest North 7.5-minute Quadrangle (40088G4)].

Miles to Next Point	Miles from Start	
0.0	0.0	Enter Route 47 and <b>turn right</b> (south). Use extreme <b>caution, this is a busy highway.</b>
0.15+	0.15+	<b>CAUTION:</b> Cross Sante Fe Railroad (formerly TP&W) and <b>stop</b> (4-way) <b>Do not stop on the tracks</b> There are two sets of tracks--guarded crossing. <b>Turn left</b> (east) on U.S. 24.
0.25	0.4+	<b>CAUTION:</b> Norfolk & Southern (N & S) Railroad crossing--two tracks--guarded. <b>Continue east</b> and leave Forrest.
0.25-	0.65	Ahead and to the left (north) the higher ground is part of the Chatsworth Moraine.
0.25+	0.9+	Starting to ascend the outer portion of the Chatsworth Moraine. Prepare to turn right.
0.25	1.15+	<b>Turn right</b> (south) on the oiled road at the crossroad 2800E/825N.
0.65	1.8+	Cross South Fork Vermilion River.
0.6	2.4+	<b>Stop</b> (2-way); crossroad 2800E/700N <b>Turn left</b> (east).
0.2	2.6+	Park along the right side as far off the road as you can safely.

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**STOP 1.** View of prominent Woodfordian Moraines [N edge NE 1/4 NE 1/4 NW 1/4 NW 1/4 Sec. 14, T.26 N.,R. 7 E., 3rd P.M., Livingston County; Forrest South 7.5-minute Quadrangle (40088F4)].

This stop provides one of the best views of a glacial end moraine in the field trip area. Actually, two moraines have been identified in the area ahead of us. Straight ahead (east) is the northern terminus of the Paxton Moraine which extends for about 57 miles in an arcuate lobe from the Indiana State Line (see the Woodfordian Moraines map in PLEISTOCENE GLACIATIONS IN ILLINOIS in the appendix). The highest surface elevations on the field trip are along



the Paxton Moraine which rises nearly 100 feet above us; it is even some 30 feet higher a couple of miles east of our route.

The younger Chatsworth glacier to the north and northeast, overrode and buried the northern part of the Paxton Moraine. The Chatsworth extends for some 75 miles from the Indiana State Line, roughly paralleling the Paxton Moraine, to a point northeast of Pontiac where it has been buried by a younger moraine. The main part of the Chatsworth Moraine is about four miles wide. The backslope, facing the ice, is more gentle than is the slope facing us. The moraines represent a time during which melting of the ice front essentially kept pace with the arrival of new ice from the north--the glacier was functioning much like a gigantic conveyor belt in bringing a continuous supply of glacial debris from areas far to the north and northeast of us. As the ice front melted, the entrained debris melted out with the coarser materials being dumped close to the ice front to form the moraines. The glacier that formed the Paxton Moraine melted north and east an unknown distance and then re-advanced to form the Ellis Moraine to the southeast of here. Another melting back of the glacier occurred before the Chatsworth ice invaded the area.

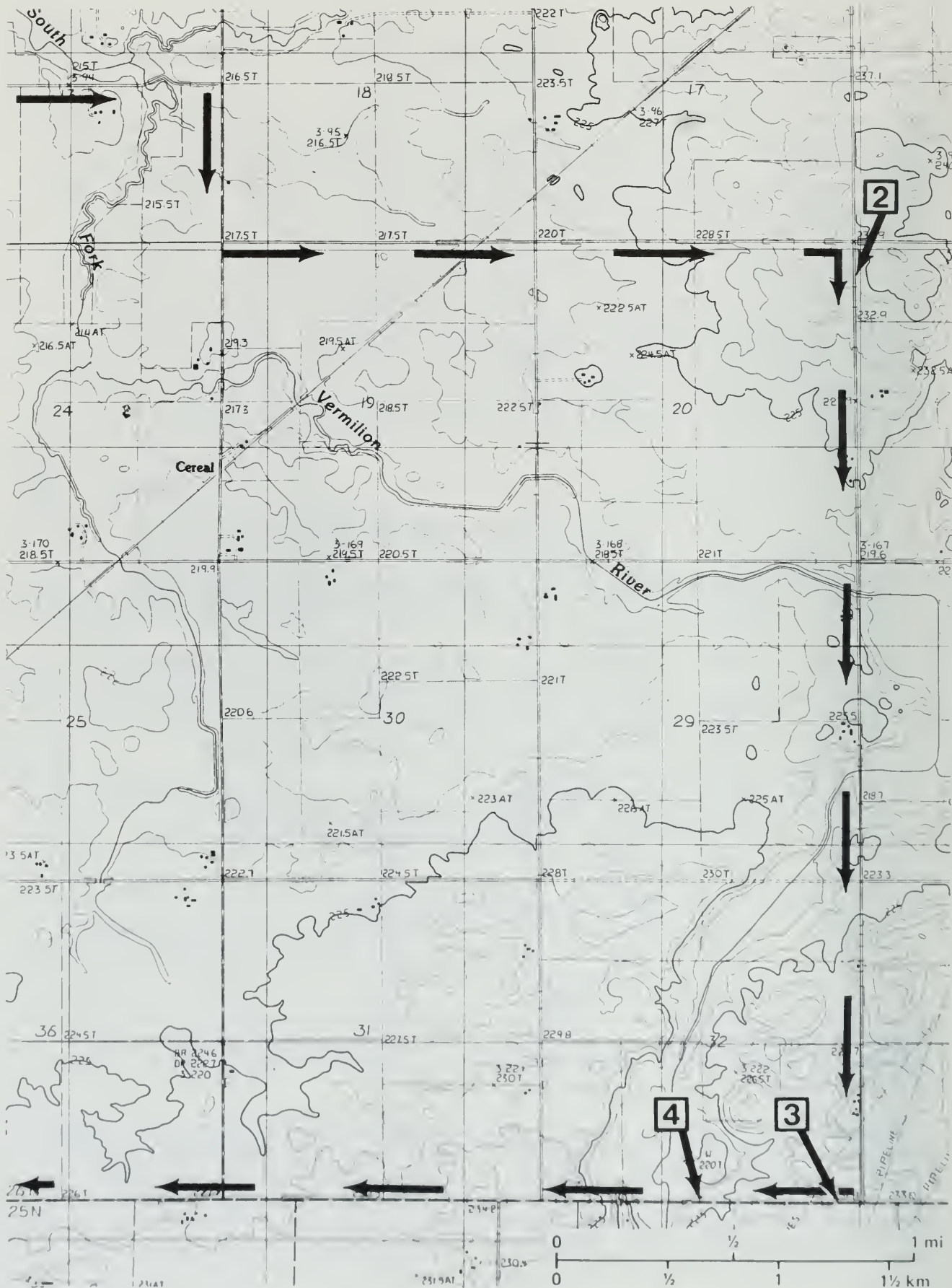
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0.0	2.6+	<b>Leave Stop #1 and continue ahead east.</b> Notice how relatively flat the till plane is south and west from the Chatsworth and Paxton Moraines.
1.25-	3.85-	Cross drainage ditch and prepare to turn left.
0.05	3.9-	T-road intersection from left 2900E/650N. <b>Turn left (east).</b>
0.75+	4.65	<b>CAUTION:</b> One lane bridge over South Fork Vermilion River <b>continue ahead easterly.</b>
0.25	4.9	T-road intersection 3000E/650N. <b>Turn right (south).</b>
0.15	5.15	Cross box culvert-- <b>continue ahead.</b>
0.35	5.4	T-road intersection from left 3000E/600N. <b>Turn left (east)</b>
0.8+	6.2+	<b>CAUTION:</b> Bloomer Line Railroad crossing. Single track--unguarded. <b>Continue ahead (east).</b>
0.15+	6.35+	<b>CAUTION:</b> crossroad 3100E/600N <b>Continue ahead (east).</b>
0.7	7.05+	Starting to ascend to some of the higher portions of the Chatsworth Moraine again.
0.3	7.35+	<b>CAUTION:</b> crossroad 3200E/600N <b>Turn right (south).</b>
0.1-	7.45	Park along the right road shoulder as far off the road as you can safely.

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**STOP 2.** View of outwash and till plains from high point on Paxton Moraine. [E edge SE 1/4 NE 1/4 NE 1/4 NE 1/4 Sec. 20, T. 26 N., R. 8 E., 3rd P.M.; Chatsworth South 7.5-minute Quadrangle (40088F3)].

To the northeast the land rises to the crest of the Chatsworth Moraine. These landforms were built by the Woodfordian glacier during an interval of several hundred years about 17,000 years ago. The land is high and complex here because of the coincidence of three ice margins that stagnated here in sequence. The high land about three miles directly south is the moraine built by the oldest of the three. After this glacier stagnated the Paxton glacier





overrode the former ice margin producing part of the complex topography to the southeast. Within a short time the Chatsworth glacier approached this area and caused much erosional evolution of the landscape. About a half mile to the southeast is the beginning of a large erosional channel that we will see as we drive south. The size and character of this channel is evidence of catastrophic flooding similar to, but smaller than the Channeled Scablands in the state of Washington. This event appears to be related to the advance of the Chatsworth glacier, which caused a one-time outburst of water that created a peculiar channel about three miles long, 50 feet deep, and up to about 2,000 feet in width. In this channel are scoured landforms, and on the upland west and south are sand deposits that indicate overflowing of the channel at least once. The biggest flood event probably lasted only a few days but carried a torrential flow of water about the size of a cross-section through the present Illinois River. The main flow was to the south but some water was directed to the northwest to establish the present course of the South Fork of the Vermilion. After all the ice melted a lake formed in the channel and through time it has filled in with marl, peat and muck that we will see at Stop 4.

- 
- 0.0            7.45        Leave Stop #2 and **continue ahead south.**
  - 0.7            8.15        To the left is a part of the valley that was mentioned at Stop 2.
  - 0.2+          8.35+      **CAUTION:** crossroad 3200E/500N--**yield. Continue ahead (south).** To the left in the ditch on the northeast corner of the intersection, you will see that a pole and timber bulkhead had been erected to hold road material in place. Because the poles were set in peat and muck they did not provide good support. Eventually pressure on the roadway from traffic and the fill material caused the bulkhead to fail and lean over into part of the ditch.
  - 0.1            8.45+      Cross South Fork Vermilion River. This stream has water in it even though nearby streams are dry this year. This is because of water seeping out of the nearby peat-muck materials. **Continue ahead (south).**
  - 0.55          9.0+        We are crossing a tributary to South Fork Vermilion River.
  - 0.35-         9.35+      **CAUTION:** Crossroad 3200E/400N **continue ahead (south).**
  - 0.35+         9.7         The moraine surface in this area is quite hummocky. A very good example of morainic topography in this area. There are occasional small kames across the area. You will also find some shallow kettles which represent areas where detached pieces of ice melted .
  - 0.5+          10.4+      **CAUTION:** Park along road. DO NOT block road. Deep ditch along N side of road.
-

**STOP 3.** Examination of glacial till exposure along north side of road [Near Ctr. S edge SE 1/4 SE 1/4 SE 1/4 Sec. 32, T. 26 N., R. 8 E., 3rd P.M.; Chatsworth South 7.5-minute Quadrangle (40088F3)].

The glacial till exposed here consists of part of the Snider-Yorkville Till Members (undifferentiated) of the Wedron Formation that was deposited approximately 15,000 years ago. Till is defined as: "Dominantly unsorted and unstratified drift, generally unconsolidated, deposited directly by and underneath a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, and boulders ranging widely in size and shape" (Bates and Jackson, 1980).

In the midwest, the abundance of the various ranges of particle-size material in tills is generally in the order listed in the preceding definition. The till we see here is a good example to illustrate the definition. The matrix is a blend of clay, silt, and sand with floating gravel-size rock fragments (clasts). Sheet-wash erosion of the clayey matrix has left the gravel standing out in relief on the surface. The till is light brownish-gray, calcareous, dense, and blocky.

Geomorphically, this stop is in an area of hummocky topography where two sets of moraines that gently curve concave to the southwest meet to form a re-entrant pointing to the northeast. These moraines consist of Wedron Formation material that was deposited during the Woodfordian Substage of the Wisconsin Stage of the Pleistocene Series. This was a time of major continental glaciation when massive ice lobes slowly flowed southward through the Lake Michigan Basin and spread out over northeastern Illinois and northwestern Indiana. This re-entrant area is the dividing line between the Decatur Sublobe (east) and the Peoria Sublobe (west) of the Lake Michigan Lobe.

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0.0	10.4+	<b>Leave Stop 3. Continue ahead (west).</b>
0.2	10.6+	The distinct, broadly-rounded hill about 0.3 of a mile to the north-northwest is an ice-contact feature known as a "kame."
0.25	10.85+	Park along the road shoulder. <b>CAUTION:</b> deep ditch. DO NOT block the drive and field entrance. You MUST have permission to enter this property--first house N of T-road intersection at mileage 10.35+; farmhouse at mileage 10.1-.

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**STOP 4.** Examine Chatsworth Bog and some of its deposits [entrance near SE cor. SE 1/4 SE 1/4 SW 1/4 Sec. 32, T. 26 N., R. 8 E., 3rd P.M.; Chatsworth 7.5-minute Quadrangle (40088F3)].

The Illinois State Geological Survey, under the direction of Dr. Follmer, has been studying Chatsworth Bog for several years in order to learn more about soil formation and about the movement of glaciers across this region. Bogs, such as this one, occur infrequently this far south in Illinois, so it is a special outdoor laboratory. King (1986) reported that this marl bog occupies a roughly circular 10-acre depression that is dissected by an outwash channel that had its origin in the Woodfordian Chatsworth Moraine about 2.5 miles to

the north. A small permanent stream flows northward through the bog. In the 1930s the organic-rich marl was commercially mined from the east part of the bog for agricultural lime. This operation produced a pit that is now occupied by this small lake. Although the bog was probably surrounded by forest in the 19th century, the primary vegetation on the rolling morainic upland was tall-grass prairie (Anderson, 1970).

During 1984, a 2-inch diameter continuous core about 42 feet long was collected from the southwestern unmined side of Chatsworth Bog. A generalized description of the core follows (from the top downward):

Peat.....	3 feet
Organic marl.....	11 feet
Organic silty clay.....	12 feet
Organic marl.....	3 feet
Gyttja (a dark, pulpy, high-organic mud).....	9 feet
Clay.....	4 feet

The sediment record found in this rare bog provides significant information about the floral history from about 14,000 years ago to the present.

Fossil pollen from the bog was first studied more than 50 years ago during the time of active mining (Voss, 1937). Studies of the pollen record show that it is dominated by spruce (Picea) in the lower Pleistocene levels and oak (Quercus) in the upper Holocene sections. The pollen record is divided into four assemblage zones.

**ZONE I.** Zone I is dominated by up to 76% spruce with lesser amounts of fir, larch, alder birch, and oak. Also present are grass and sage. Pollen influx values range from 1,000 to 2,100 grains/sq cm/yr. Zone I dates from the base of the core, about 14,700 BP to 13,800 BP. Although oak comprises up to 17% of the total pollen in Zone I, its influx ranges only from 80 to 400 grains/sq cm/yr. This is considerably less than the 2,000-12,000 grains/sq cm/yr in areas where oak trees presently occur (Davis et al., 1973) and indicates that the late Pleistocene oak component was from long distance wind transport not the presence of significant quantities of local oak trees. Zone I is interpreted as reflecting a mosaic of open spruce woodland and tundra, perhaps similar to the modern forest-tundra transition.

**ZONE II.** This zone contains much lower spruce percentages and increases in ironwood, elm, oak, and ash, particularly black ash. There is little pine pollen present, less than 2%. Pine is never prominent at Chatsworth Bog, suggesting that pine did not occupy an important place in the late-glacial vegetation of central Illinois as it did in areas to the north. Total pollen influx increases slightly to maximums of 2,400 grains/sq cm/yr. Most of this increase is due to ash pollen; oak remains about 500 grains/sq cm yr. Zone II dates between 13,800 and 11,600 BP. This zone is interpreted as a rapid expansion of black ash in the wet lowlands in the vicinity of the bog while the surrounding uplands remained open and treeless. Spruce had been displaced by the ash with climatic warming.

**ZONE III.** This double zone is dominated by tree taxa. Zone IIIa, dominated by cool temperate species, contains a sharp decline in ash and increases in alder, elm, and oak. IIIa also contains the last major occurrence of spruce



and fir; it is dated between 11,600 and 10,600 BP. In Zone IIIb the cool-temperate taxa are replaced by warm-temperate trees. s Ash, fir, spruce, larch, alder decline further or disappear from the pollen record while elm, ironwood, hickory, and oak increase to maximums. Zone IIIb dates from 10,600 to 8,300 BP and is interpreted as the culmination of the transition from tundra and boreal woodland to oak dominated deciduous forest. By the top of Zone IIIb, the dominant vegetation in the area was oak-hickory forest. The climate in central Illinois at this time was wetter than at present.

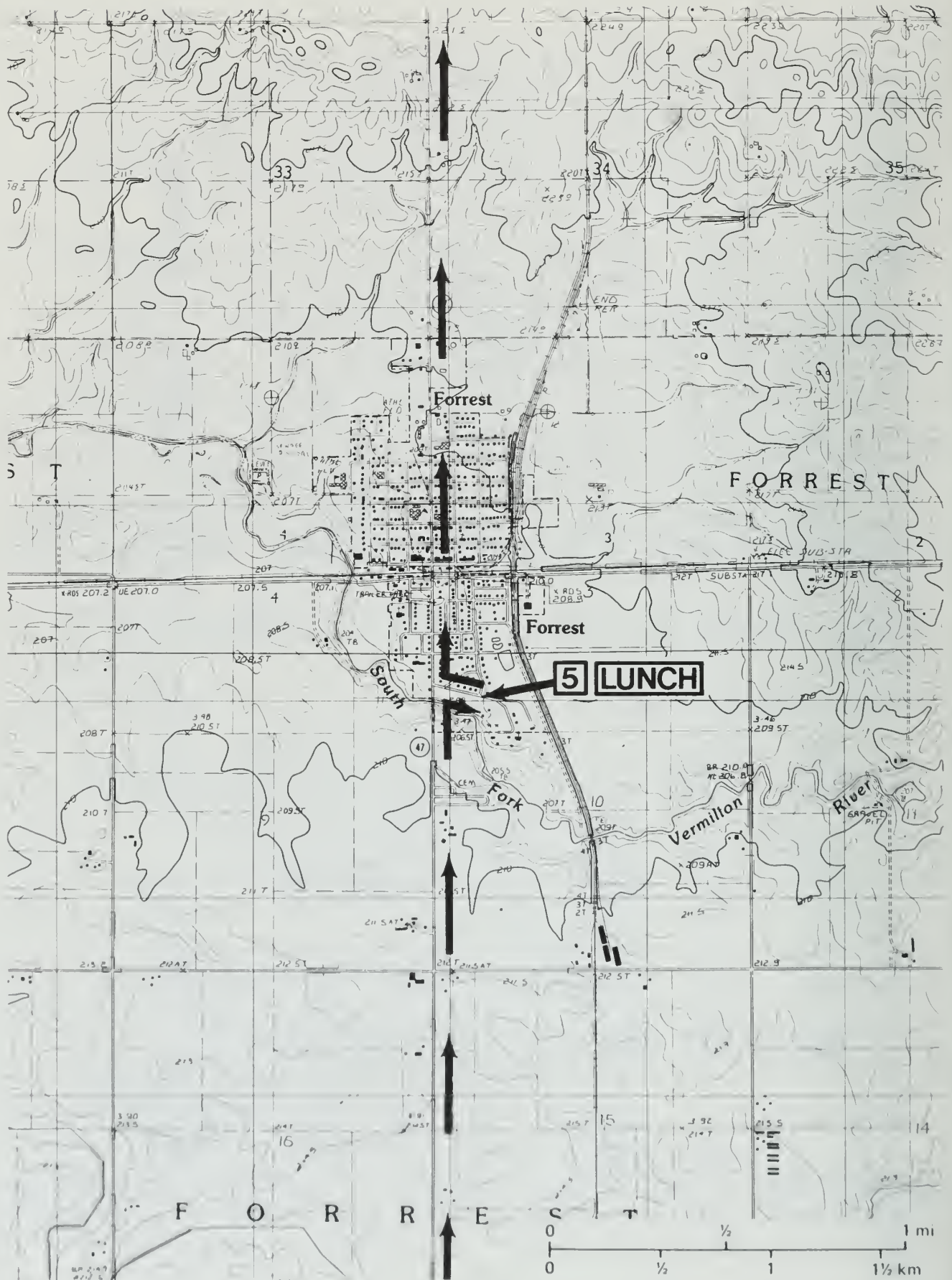
**ZONE IV.** At 8,300 BP there was an abrupt increase in ragweed (*Ambrosia*) and shortly, after grass, Chenopods, and the sunflower group (*Tubulifloae*) increased. The pollen of the deciduous trees declined at the same time. Between 970 and 860 cm depth the percentage of NAP (non-arboreal pollen) increases from 3% to 37%. The percentage increase in NAP is also apparent in the influx values. This increase in herb and grass pollen is interpreted as the first appearance of prairie in the Holocene on the broad upland of central Illinois. Oak pollen continues to dominate the pollen record, however, as small remnants of forest persisted along rivers and streams. The prairie produces small amounts of pollen because most of its constituent species, with the exception of grass and ragweed, are insect pollinated. Because of the disproportionately large production of pollen by trees, small NAP increases are more significant than overriding percentages of trees. The shift from forest to grasslands in central Illinois 8,300 years ago suggests that climatic conditions were becoming increasingly drier.

There is little vegetation change in the Chatsworth Bog pollen record after 8,300 BP. Once the area became prairie it has remained that way to the present.

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0.0	10.85+	Leave Stop #4 and <b>continue ahead west.</b>
0.1	10.95+	Cross creek that flows northward through the bog.
0.35+	11.35+	Ascend back onto the till plane. Notice how very, very gently rolling it is. You will <b>continue ahead west to State Route 47.</b>
3.5+	14.9	<b>CAUTION:</b> Railroad crossing--two tracks--unguarded (N&S). <b>Continue ahead.</b>
0.1	15.0	<b>CAUTION:</b> Railroad crossing--one track. (BL) <b>Continue ahead west.</b>
0.4	15.4+	Stop (2-way) crossroad 2700E/300N--SR 47. <b>Turn right</b> (north) and continue to Forrest.
4.8-	20.2	<b>CAUTION:</b> Enter Forrest. Cross South Fork of Vermilion River and prepare to turn right.
0.1	20.3	<b>Turn right</b> (easterly) toward Forrest Park.
0.15	20.45	Stop (4-way) crossroad--entrance to Forrest Park to the right. <b>NOTE:</b> Mileage figures resume from this point after lunch. There is some parking in that area. You can park along the road. <b>Don't block driveways.</b> Parking ahead near the tennis court.

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**STOP 5.** Lunch in Forrest Park [entrance - NW 1/4 SE 1/4 NW 1/4 NW 1/4 Sec. 10, T. 26 N., R. 7E., 3rd P.M.; Forrest South 7.5-minute Quadrangle (40088f4)].

The park is situation on a a low terrace along the south fork of the Vermilion River.

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0.0	20.45	<b>Leave stop #5 and head west.</b>
0.15	20.6	<b>Stop (1-way) Turn right (north) on SR 47.</b>
0.3+	20.09+	<b>Stop (4-way) U.S. 24 Continue ahead north</b> across the SF Railroad crossing--guarded crossing--two tracks.
0.6	21.5	Leave Forrest and ascend the Chatsworth Moraine.
1.6	23.1	We are crossing the crest of the Chatsworth Moraine. The topography is not as sharply rolling as it was southeast of Forrest.
1.0	24.1	View to northeast is down the back slope of the moraine. This is a much more gentle slope than the south-southwest facing front of the moraine. continuing north, we are descending from the moraine, toward the glacial Lake Watseka drainage way.
1.4	25.5	Prepare to turn left.
0.15	25.85	<b>Turn left (west) with extreme caution--Traffic is</b> fast and fairly heavy. Wing road/crossroad 2700E/1300N.
0.05	25.7	Pull off on the right road shoulder as far as you can. <b>DO NOT BLOCK ROADWAY OR DRIVEWAY.</b>

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**STOP 6.** View to north and northeast of glacial Lake Watseka drainageway [S edge SE 1/4 SE 1/4 SE 1/4 SE 1/4 Sec. 9, T. 27 N., R. 7 E., 3rd P.M.; Forrest North 7.5-minute Quadrangle (40088G4)].

Meltwater from a large region covered by the Valparaiso glacier during late Woodfordian time escaped down the Illinois Valley. Meltwater from that portion of the glacier that covered northern Indiana flowed westward down the Kankakee Valley. Unusually large volumes of meltwater issued from this glacier because melting appears to have been much more rapid than usual. Because these vast volumes of meltwater were unable to escape down the Illinois Valley through the Marseilles Moraine, a large lake (Wauponsee) partially filled the Morris Basin to a temporary depth of 650 feet.

At its maximum elevation, some of the Kankakee floodwater flowed southward through the Iroquois River Gap in the Marseilles Moraine and flooded the Iroquois Basin to form Lake Watseka. This lake, in turn, rose and overflowed the Chatsworth Moraine to the west and emptied into the west-flowing North Fork Vermilion River. This overflow via the North Fork plus backwater from the north from the Illinois River formed glacial Lake Pontiac to the west of this stop.



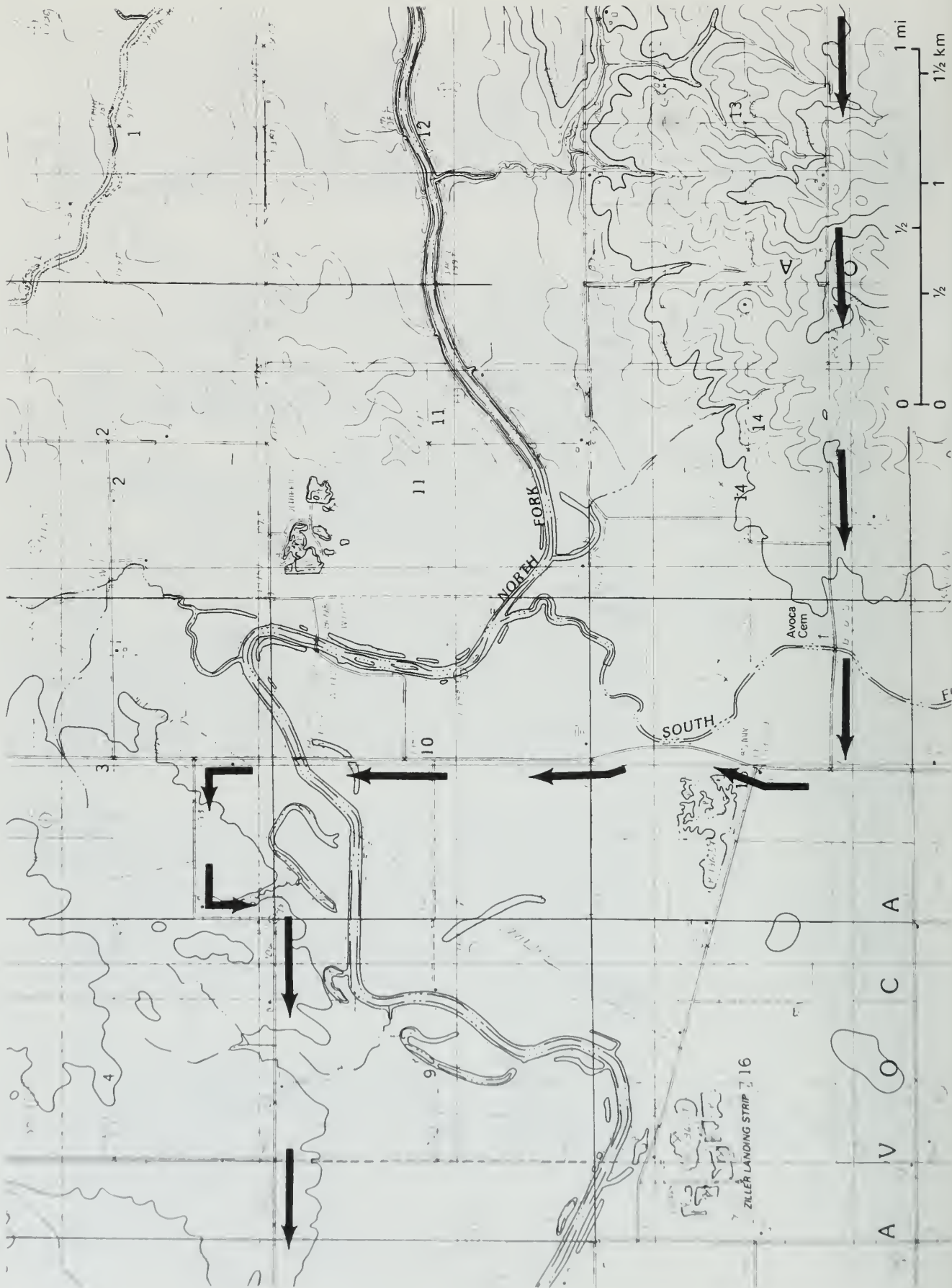


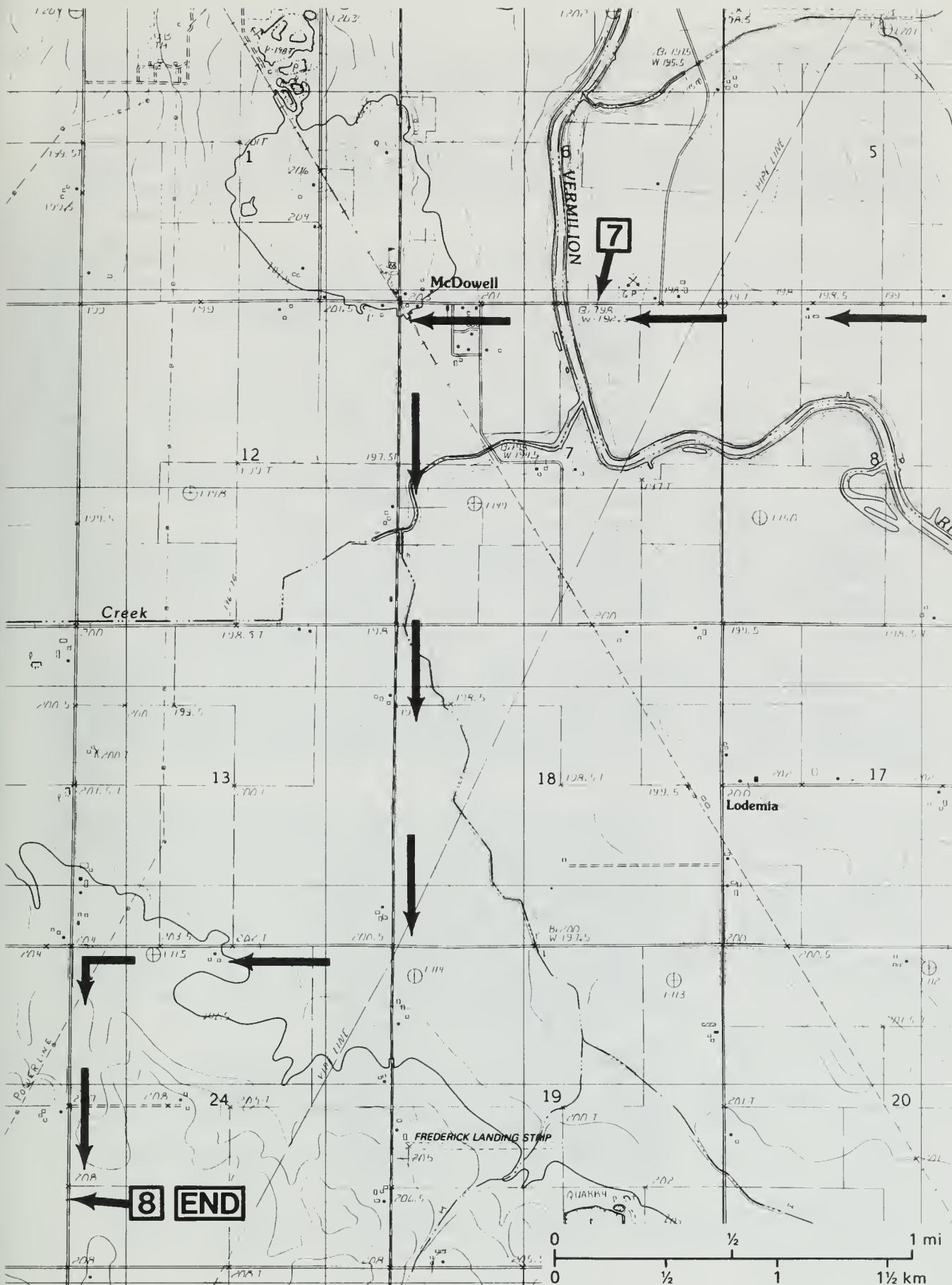
The overflow valley is the narrowest here, being about two miles wide. For extended periods of time the valley may have been filled with floodwater to slightly below where we are standing, perhaps up to nearly 650 feet. The underlying Pennsylvanian bedrock may have been exposed over large areas in the bottom of this overflow valley. Sheetwash along the valley walls has supplied a thin covering across the valley bottom masking bedrock except for some areas along the present channel. The topography here was later subdued when loess was deposited across the region.

---

0.0	25.7	<b>Leave Stop #6 and continue ahead (west).</b>
2.95	28.65	<b>CAUTION:</b> T-road intersection 2400E/1300N. <b>Turn left (south).</b>
0.05+	28.7+	<b>CAUTION:</b> Cross narrow one-lane bridge. <b>Continue south</b> and ascend the Chatsworth Moraine.
0.6+	29.35+	<b>Stop (2-way):</b> T-road intersection 2400E/1225N. <b>Turn right (west).</b>
2.15	31.5+	Cross South Fork Vermilion.
0.35+	31.85	<b>Stop (1-way):</b> T-road intersection. 2150E/1225N. <b>Turn right (north).</b> <b>CAUTION:</b> Fast traffic.
0.6	32.45+	Broad terrace of the Vermilion River here. Abandoned gravel pit on the right
1.05+	33.5	Cross Vermilion River and ascend the Chatsworth Moraine.
0.3	33.85+	<b>Turn left</b> at T-road 2150E/1425N.
0.25	34.1+	To the right at about 2:00 are buildings and a radio tower that are part of the Pontiac Project of Northern Illinois Gas Company. This is an underground gas storage project with gas coming from the trunkline of Natural Gas Pipeline Company of America through a 12-inch pipeline to the storage area. The gas is used in suburban Chicago.
		Exploratory drilling began in 1963 with gas injection beginning in 1966. The trap is a north-south trending anticline, three miles wide and five miles long. The storage reservoir is in the Cambrian Mt. Simon Sandstone, an aquifer with 10 percent porosity. The Mt. Simon is estimated to be more than 2,000 feet thick here. The structure has a closure of 100 feet on top of the Mt. Simon. The reservoir is 3,000 feet deep and covers about 3,500 acres within the last closing contour.
		Ultimate capacity of the Pontiac Project is estimated to be about 50 billion cubic feet of gas.
2.7	36.8+	<b>Stop (2-way):</b> T-road intersection 1800E/1400N. <b>Continue ahead west.</b>
0.2	37.0+	Pull off along the right side as far as you can safely.

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The overflow valley is the narrowest here, being about two miles wide. For extended periods of time the valley may have been filled with floodwater to slightly below where we are standing, perhaps up to nearly 650 feet. The underlying Pennsylvanian bedrock may have been exposed over large areas in the bottom of this overflow valley. Sheetwash along the valley walls has supplied a thin covering across the valley bottom masking bedrock except for some areas along the present channel. The topography here was later subdued when loess was deposited across the region.

---

0.0	25.7	<b>Leave Stop #6 and continue ahead (west).</b>
2.95	28.65	<b>CAUTION:</b> T-road intersection 2400E/1300N. <b>Turn left (south).</b>
0.05+	28.7+	<b>CAUTION:</b> Cross narrow one-lane bridge. <b>Continue south</b> and ascend the Chatsworth Moraine.
0.6+	29.35+	<b>Stop (2-way):</b> T-road intersection 2400E/1225N. <b>Turn right (west).</b>
2.15	31.5+	Cross South Fork Vermilion.
0.35+	31.85	<b>Stop (1-way):</b> T-road intersection. 2150E/1225N. <b>Turn right (north).</b> <b>CAUTION:</b> Fast traffic.
0.6	32.45+	Broad terrace of the Vermilion River here. Abandoned gravel pit on the right
1.05+	33.5	Cross Vermilion River and ascend the Chatsworth Moraine.
0.3	33.85+	<b>Turn left</b> at T-road 2150E/1425N.
0.25	34.1+	To the right at about 2:00 are buildings and a radio tower that are part of the Pontiac Project of Northern Illinois Gas Company. This is an underground gas storage project with gas coming from the trunkline of Natural Gas Pipeline Company of America through a 12-inch pipeline to the storage area. The gas is used in suburban Chicago.
		Exploratory drilling began in 1963 with gas injection beginning in 1966. The trap is a north-south trending anticline, three miles wide and five miles long. The storage reservoir is in the Cambrian Mt. Simon Sandstone, an aquifer with 10 percent porosity. The Mt. Simon is estimated to be more than 2,000 feet thick here. The structure has a closure of 100 feet on top of the Mt. Simon. The reservoir is 3,000 feet deep and covers about 3,500 acres within the last closing contour.
		Ultimate capacity of the Pontiac Project is estimated to be about 50 billion cubic feet of gas.
2.7	36.8+	<b>Stop (2-way):</b> T-road intersection 1800E/1400N. <b>Continue ahead west.</b>
0.2	37.0+	Pull off along the right side as far as you can safely.

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**STOP 7.** Collecting rock specimens at abandoned Hanley Gravel Pit [entrance - N edge NE 1/4 Nw 1/4 NW 1/4 NE 1/4 Sec. 7, T. 27 N., R. 6 E., 3rd P.M.; Southeast Pontiac 7.5-minute Quadrangle (40088G5)].

Enter through the gate only on the south side of the road and on foot.

**CAUTION:** beware of unstable undercut banks near the water. They may appear sound, but can easily drop you into deep water. Collect from the gravel piles away from the water.

This gravel pit on the east side of the Vermilion River was worked for about three years. The sand and gravel deposit here is about 10 to 20 feet thick with about two to four feet of fine-grained overburden. Portions of the deposit are relatively poorly sorted with excessive amounts of clay and silt, including till balls that increase processing needed for construction aggregates.

Mainly "D Quality" base and surface road rock was produced here. Concrete sand was also produced from the cleaner portions of the deposit. After the cleanest sand and gravel had been mined out, processing the materials was discontinued. Some fill dirt is still sold from the property.

The gravel contains abundant fragments of the local Pennsylvanian-age bedrock, including limestone, sandstone, siltstone, and shale. Other prominent rocks include dolomite from northern Illinois and various igneous and metamorphic rock types from the Precambrian Canadian Shield. Some fossils and glacially striated pebbles may be found.

This deposit is part of a widespread outwash terrace system in the Vermilion River Valley. It generally follows the front of the Marseilles Morainic System and was part of the ice-marginal drainage system that existed when the Lake Michigan glacial lobe was depositing the Marseilles. Westward flowing drainage from Lake Watseka also contributed to the development of this terrace system.

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0.0	37.0+	<b>Leave Stop #7 and continue ahead west.</b>
0.1	37.4	Crossing the Vermilion River again, continue ahead west. Glacial Lake Pontiac was just to the north of the bridge. Notice to the left (south), if the water level is down you can see ledges of limestone across the river. This is the Pennsylvanian Shoal Creek Limestone Member.
0.2	37.3+	<b>CAUTION:</b> Enter hamlet of McDowell. <b>Continue ahead west.</b>
0.3	37.9	<b>CAUTION:</b> Crossroad 1800E/1400N. (3-way stop) You don't have one. <b>Turn left</b> (south).
1.2	38.8+	We are crossing glacial Lake Ancona bottomland.
0.8	39.6+	<b>Stop</b> (2-way): crossroad. 1200N/1800E <b>Turn right</b> (west).
1.0	40.6+	<b>CAUTION:</b> crossroad 1700E/1200N <b>Turn left</b> (south).
0.05+	40.7	Cross approximate shoreline of glacial Lake Ancona.
0.7+	41.4+	<b>Turn left</b> at entrance to Hanley Quarry. You must have permission too enter this property.

In addition to the permission, please use extreme caution. Do not climb on rock faces or stock piles. If you get close to the face, make sure that the face is not loose and crumbly. Stay off of all equipment. No rock throwing. Thank you in advance for your cooperation.

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**STOP 8.** Examine the Pennsylvanian La Salle Limestone Member and collect limestone samples and fossils [entrance - W edge NE 1/4 NW 1/4 SW 1/4 SW 1/4 Sec. 24, T. 17, N., R. 5 E., 3rd P.M.; Southeast Pontiac 7.5-minute Quadrangle (40088G5)].

The area between Fairbury and Pontiac has been a source of limestone for a long time. The Hanley Quarry is the newest addition to the industry; it opened in 1986. The local name of the stone is the Pontiac (Lamar, 1929) or Livingston limestone; its formal geologic name is the La Salle Limestone Member. The most recent stratigraphic study of this and other Pennsylvanian-age limestones in the Illinois Basin concluded that this limestone occurs at the top of the Bond Formation in the McLeansboro Group (Jacobson, 1983). The La Salle was deposited in a shallow marine environment, approximately 300 million years ago.

The occurrence of limestone close beneath the surface in this area is related to the arching of strata across the northwest-southeast trending La Salle Anticline. However, the limestone is not continuous throughout the area due to both erosion and non-deposition. Thus it is necessary to test-drill individual properties to determine the stone's presence or absence. It is also necessary to analyze samples taken during drilling to determine if the stone is of sufficient quality for quarrying. Factors such as weathering, occurrence of chert or shale beds, thickness and purity of the stone must be evaluated.

Crushing, washing, and screening of the stone can significantly improve its in-place characteristics, but cannot make good rock out of bad rock. Quarries in the area supply many crushed-stone products including: coarse and fine-grain construction aggregate for use in portland cement, bituminous cement, seal and cover rock, base and shoulder rock, riprap, agricultural limestone, and other finely-ground limestone products for uses such as rock dust, poultry grit, and mineral fillers in flow tile.

In the quarry, limestone occurs at the bedrock surface and is about 14 feet thick. The limestone is generally fine-grained, mottled bluish-gray to light gray and thick bedded (one to three feet) when fresh. However, when weathered or blasted it readily splits into thin slabs one to two inches thick. It contains numerous small cavities or vugs (mostly less than 1/2 inch in diameter) that are usually lined with calcite crystals, although a few contain pyrite crystals. The stone also contains a few zones of shale partings and stylolites. The top layer is usually weathered to a very light gray and is sometimes separated from the rest of the section by a thin, very soft, bluish-gray shale. The bottom layer is often a bluish-gray, clayey, fossiliferous limestone. Black or brown shale occurs below the limestone.

The drift is mainly till, similar to that observed at Stop 3. The lower part is bluish-gray and unweathered. The upper part is oxidized to a light brownish-gray. The surface layer is an organic-rich, brownish-black top soil consisting of weathered till material, with additions of silt and clay deposited from wind and water action.

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This is the last stop of the field trip. To leave the area, go to the entrance. **Turn right** (north) for 3/4 mile, then **turn left** (west) for one mile to the Pontiac blacktop. **Turn right** (north) toward Pontiac.

You can also **turn left** (south) at the entrance for about three miles to the intersection with U.S. 24. Then you can go to the right towards Peoria or to the left towards Fairbury and Forrest/Champaign.

**Join us at Wolf Lake in Southern Illinois.**





# 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.

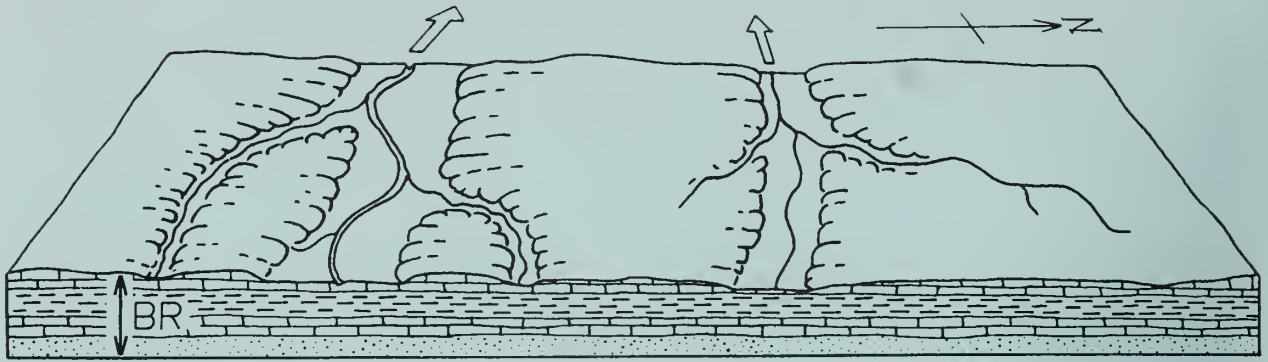
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and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

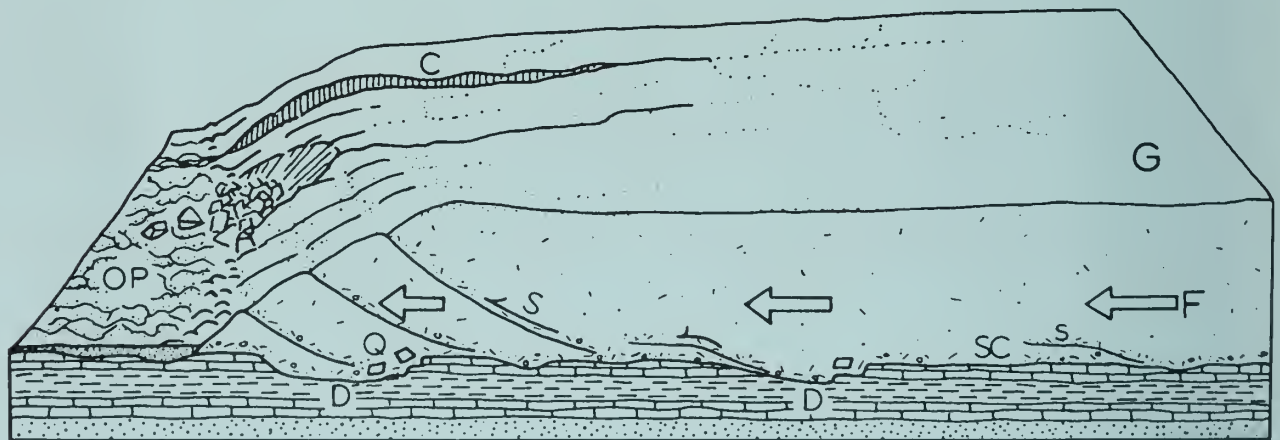
## Glaciation in a Small Illinois Region

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.

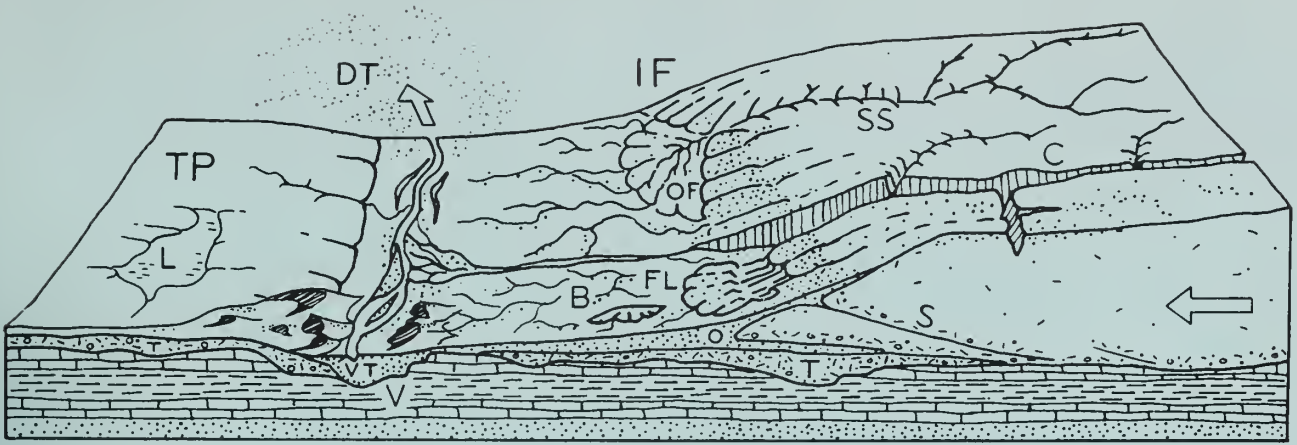
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



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 (stippled), limestone (horizontal lines), and shale (vertical lines). 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.



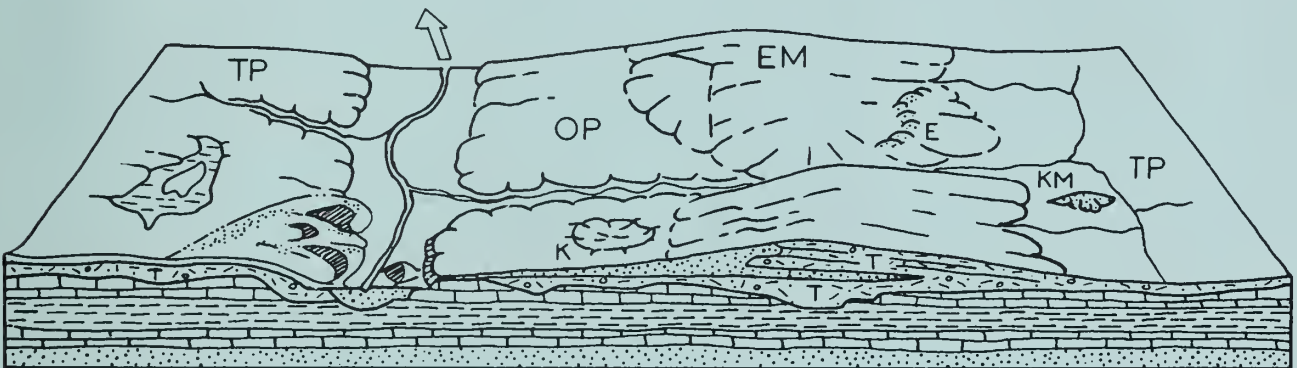
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses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

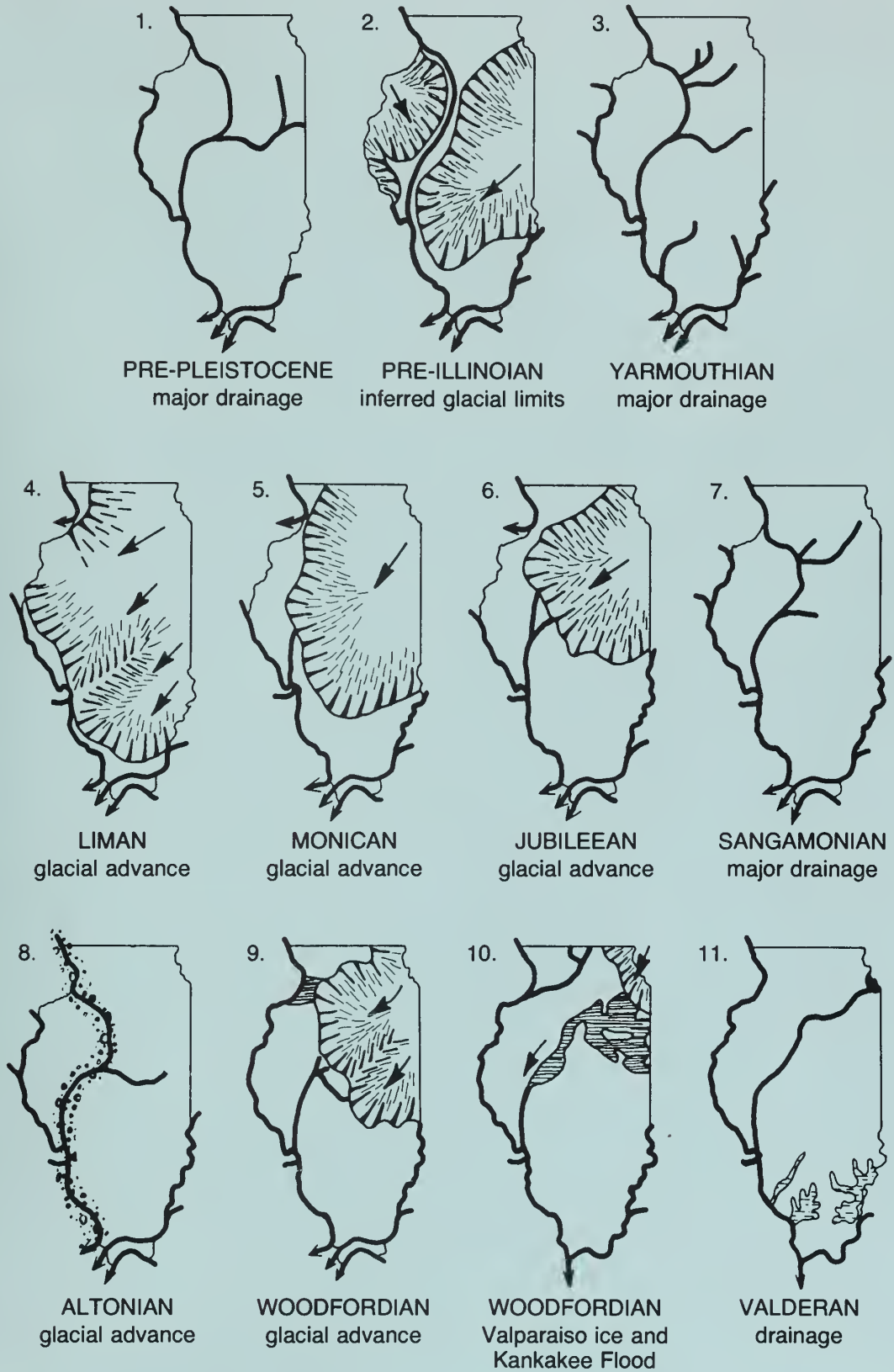
Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel 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	
Q U A T E R N A R Y	Pleistocene	HOLOCENE (interglacial)	Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat		
		WISCONSINAN (glacial)	late	10,000	Outwash, lake deposits	Outwash along Mississippi Valley
				Valderan		
				11,000		
			mid	Twocreekan	Peat and alluvium	Ice withdrawal, erosion
				12,500	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
				Woodfordian		
				25,000		
		28,000				
		early	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion	
			Altonian	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers	
		SANGAMONIAN (interglacial)	75,000	Soil, mature profile of weathering	Important stratigraphic marker	
		ILLINOIAN (glacial)	125,000	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois	
			Jubileean			
Monican						
YARMOUTHIAN (interglacial)	Liman	Drift, loess, outwash				
	300,000?	Soil, mature profile of weathering	Important stratigraphic marker			
Pre-Illinoian	KANSAN* (glacial)	500,000?	Drift, loess	Glaciers from northeast and northwest covered much of state		
	AFTONIAN* (interglacial)	700,000?	Soil, mature profile of weathering	(hypothetical)		
	NEBRASKAN* (glacial)	900,000?	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.

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

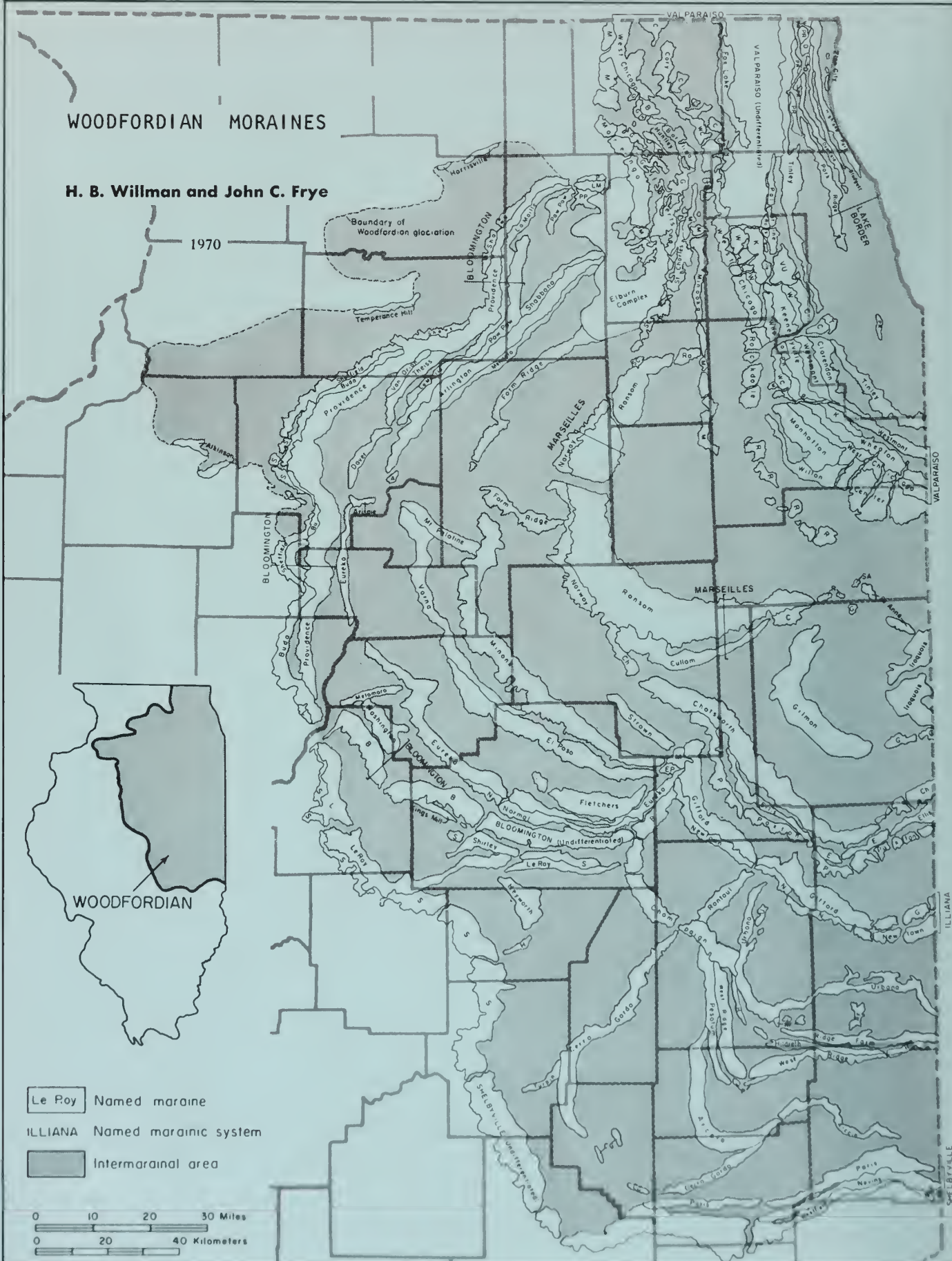
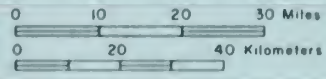
1970

Boundary of Woodfordian glaciation

Temperance Hill



- Le Roy Named maraine
- ILLIANA Named marainic system
- Intermarainal area



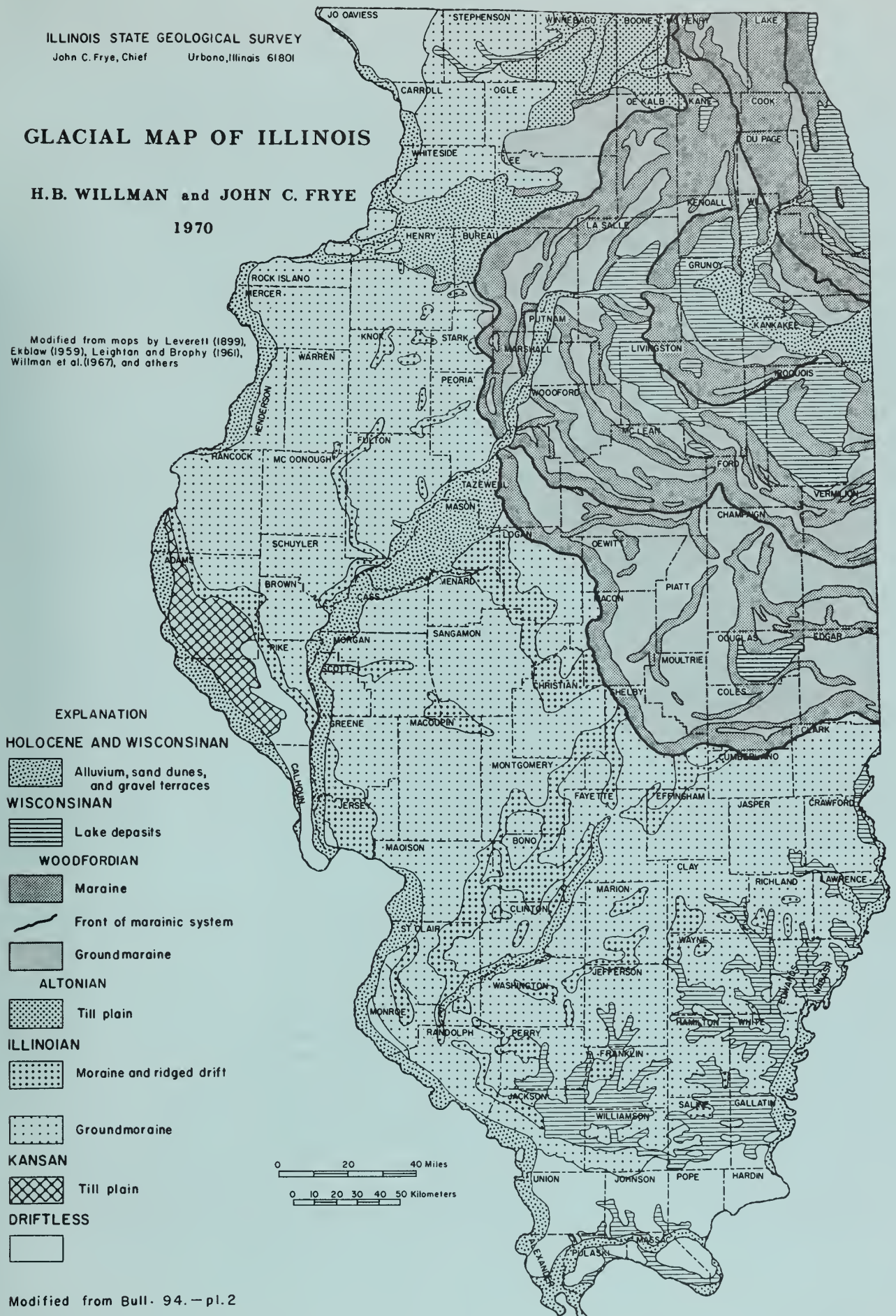


# GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

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



**EXPLANATION**

**HOLOCENE AND WISCONSINAN**

Alluvium, sand dunes, and gravel terraces

**WISCONSINAN**

Lake deposits

**WOODFORDIAN**

Maraine

Front of marainic system

Groundmaraine

**ALTONIAN**

Till plain

**ILLINOIAN**

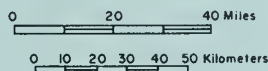
Moraine and ridged drift

Groundmoraine

**KANSAN**

Till plain

**DRIFTLESS**





## DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS

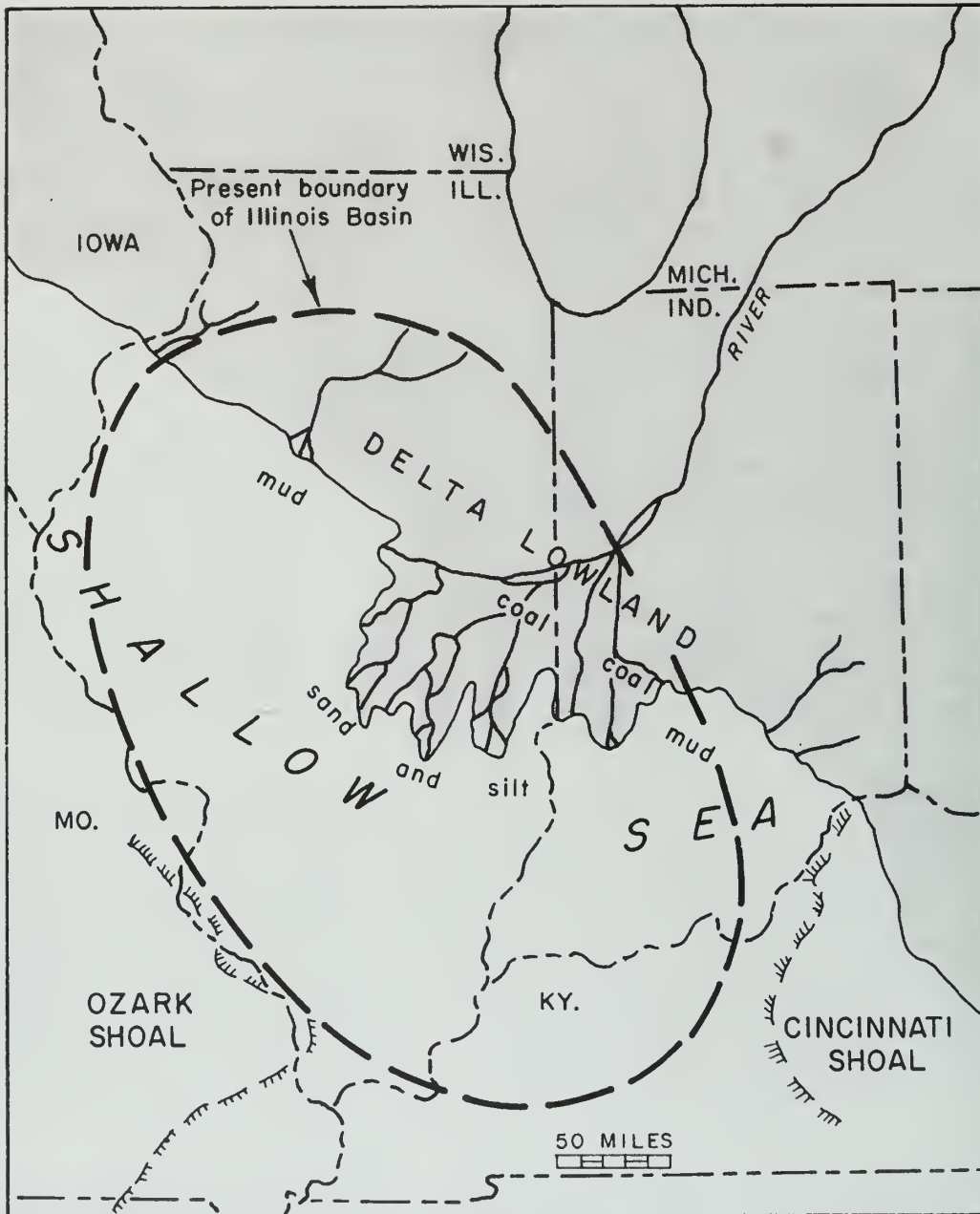
At the close of the Mississippian Period, about 310 million years ago, the Mississippian sea withdrew from the Midcontinent region. A long interval of erosion took place early in Pennsylvanian time and removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting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

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

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

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

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



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

### Pennsylvanian Cyclothems

Because of the extremely varied environmental conditions under which they formed, the Pennsylvanian strata exhibit extraordinary variations in thickness and composition, both laterally and vertically. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and

limestones, however, display remarkable lateral continuity for such thin units (usually only a few feet thick). Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.

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

#### Origin of Coal

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

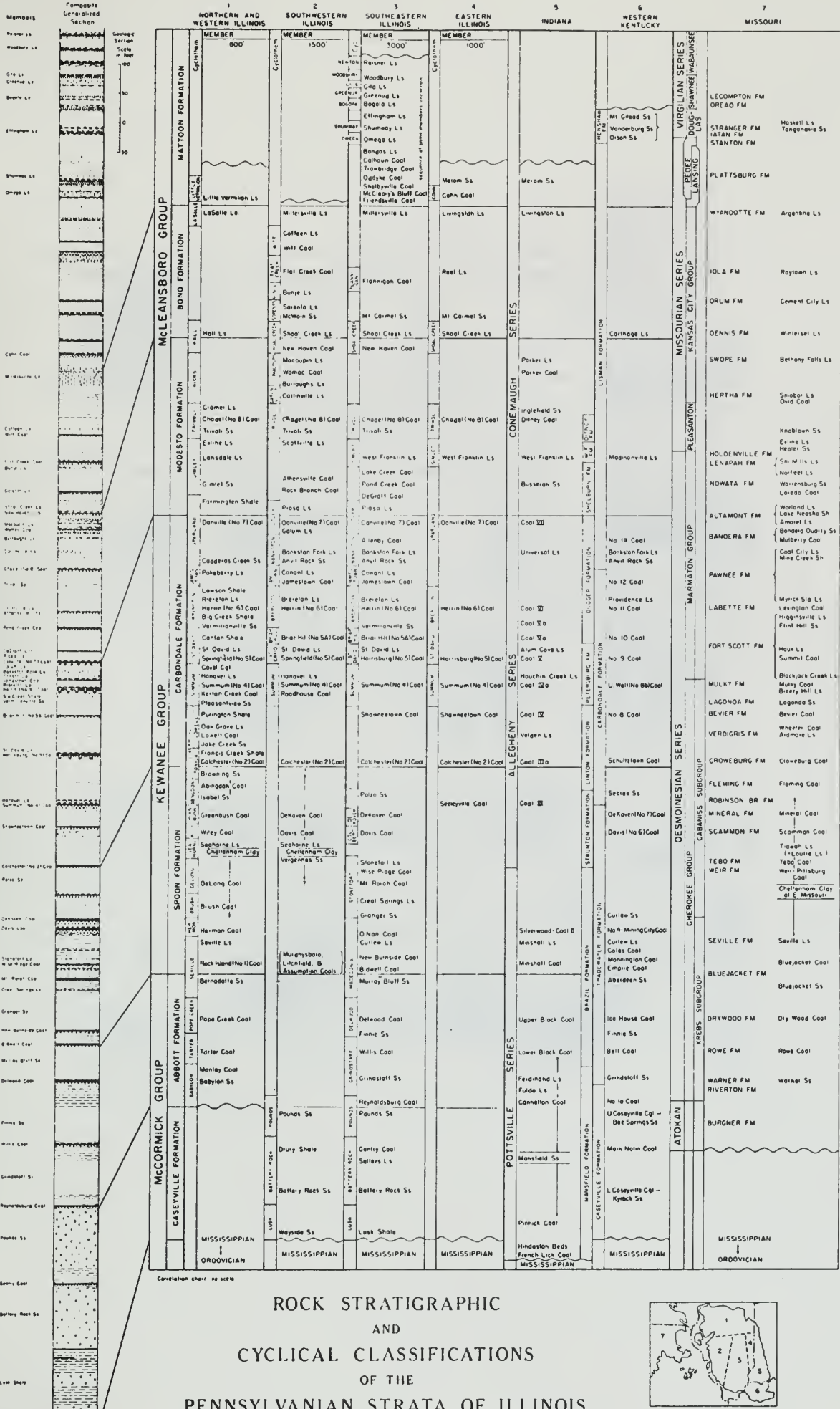
Plant debris from the rapidly growing swamp forests—leaves, twigs, branches, and logs—accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably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

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

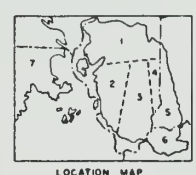
Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized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

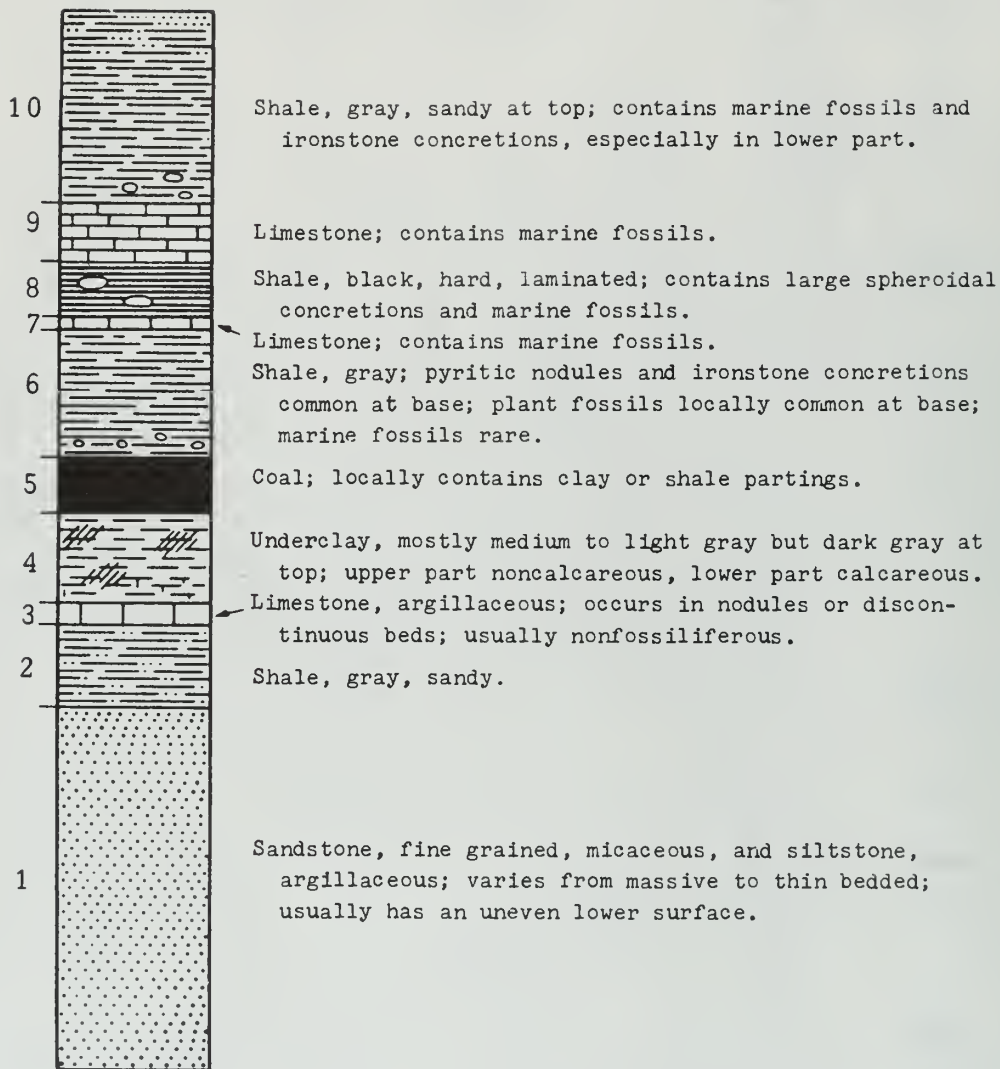
Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

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



ROCK STRATIGRAPHIC  
AND  
CYCLICAL CLASSIFICATIONS  
OF THE  
PENNSYLVANIAN STRATA OF ILLINOIS



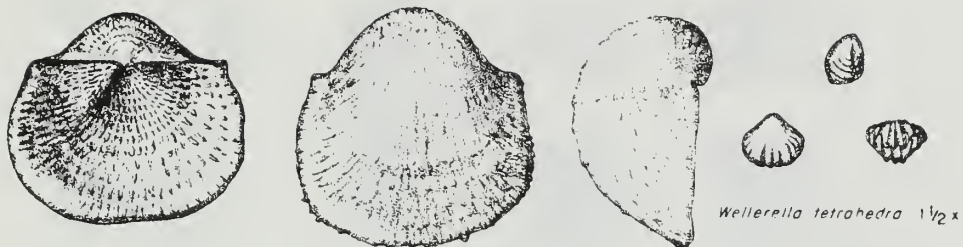


AN IDEALLY COMPLETE CYCLOTHEM

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

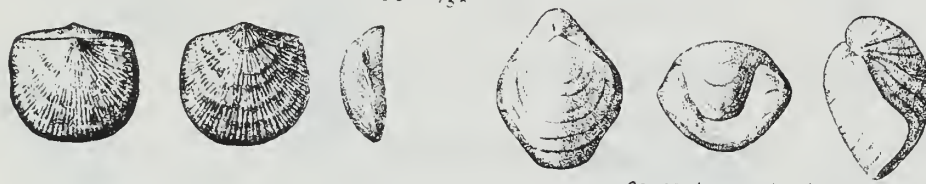


BRACHIOPODS



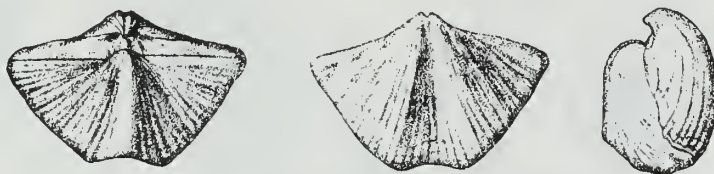
*Wellerella tetrahedra* 1/2 x

*Juresania nebrascensis* 2/3 x



*Derbya crossa* 1x

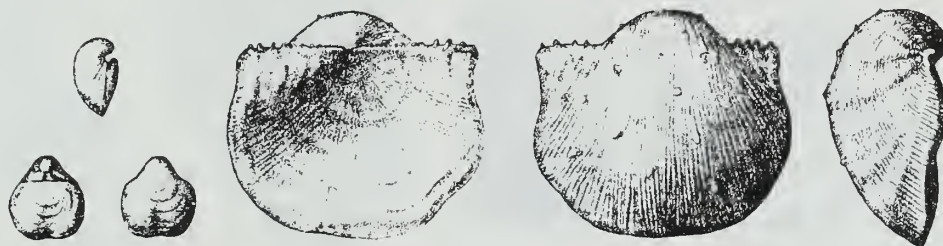
*Camposita argenta* 1x



*Neospirifer cameratus* 1x



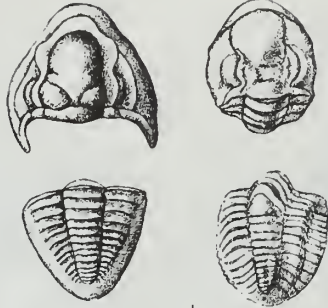
*Chanetes granulifer* 1/2 x *Mesalabus mesalabus* var. *evampyus* 2x *Marginifera splendens* 1x



*Crurithyris planoconvexa* 2x

*Linoproductus "cara"* 1x

TRILOBITES



*Ameura songomonensis* 1 1/3 x

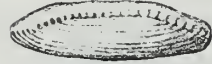
*Ditomapyge parvulus* 1 1/2 x

CORALS



*Lophophlidium proliferum* 1 x

FUSULINIDS



*Fusulina acme* 5 x



*Fusulina girlyi* 5 x

CEPHALOPODS

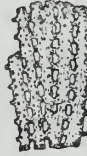


*Pseudorthoceros knoxense* 1 x



*Glaphrites welleri* 2/3 x

BRYOZOANS



*Fenestrellina mimica* 9 x



*Fenestrellina modesta* 10 x

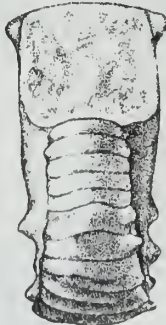


*Rhombopora lepidendroides*

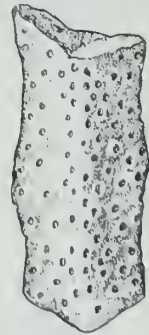
6 x



*Metacoceros cornutum* 1 1/2 x



*Fistulipora carbonaria* 3 1/3 x



*Prismapora triangulata* 12 x



*Nuculo (Nuculopsis) girtyi* 1x

PELECYPODS



*Edmonio ovata* 2x



*Astortello concentrica* 1x



*Dunborella knighti* 1/2 x



*Cardiomorpha missouriensis*  
"Type A" 1x



*Cardiomorpha missouriensis*  
"Type B" 1/2 x

GASTROPODS



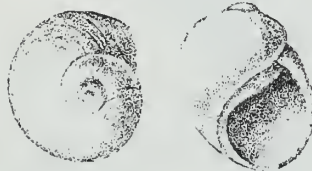
*Euphemites carbonarius* 1/2 x



*Trepospira illinoisensis* 1/2 x



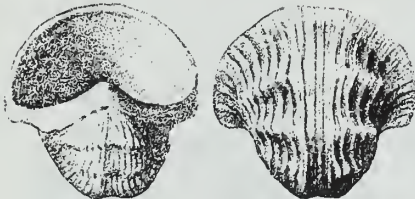
*Donoldina robusto* 8x



*Noticopsis (Jedrio) ventricosus* 1/2 x



*Trepospira sphaerulata* 1x

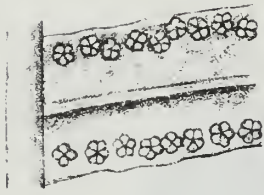


*Kniatites montfortianus* 2x



*Glabrocingulum (Globrocingulum) grayvillense* 3x

# FOSSIL PLANTS, FRANCIS CREEK SHALE



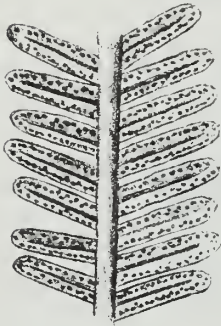
*Astrotheca* 5:1



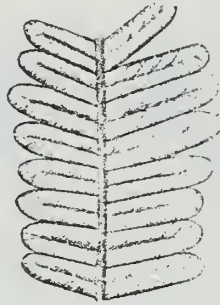
*Pecopteris* 5:1



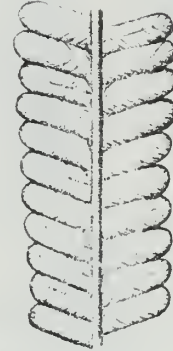
*Pecopteris* sp. 1:1



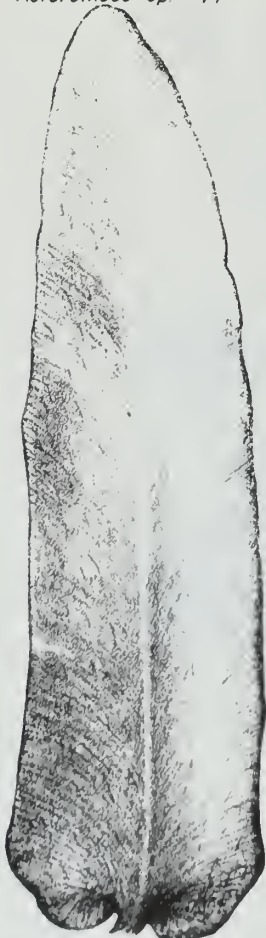
*Astrotheca* sp. 1:1



*Pecopteris* sp. 1:1



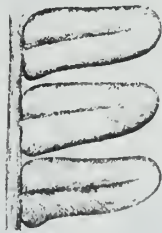
*Pecopteris unita* 1:1



*Neuropteris scheuchzeri* 1:1



*Neuropteris rarinervis* 1:1



*Neuropteris ovata* 1:1



*Sphenophyllum* sp. 1:1



*Alethopteris serlii* 1:1



*Sphenopteris* sp. 1:1

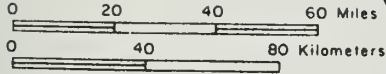


*Sphenopteris* sp. 1:1















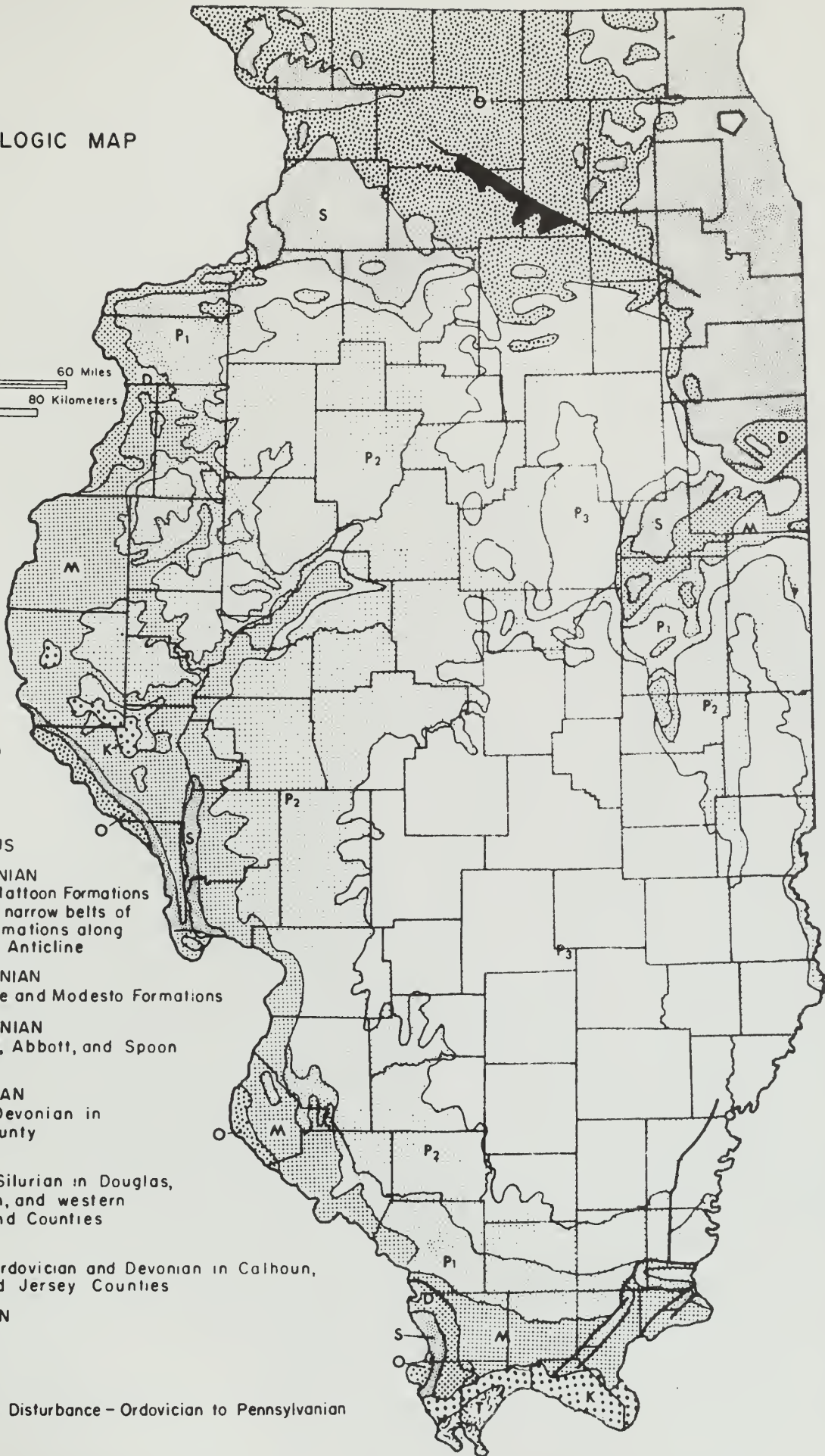
*Mariopteris* sp. 1:1

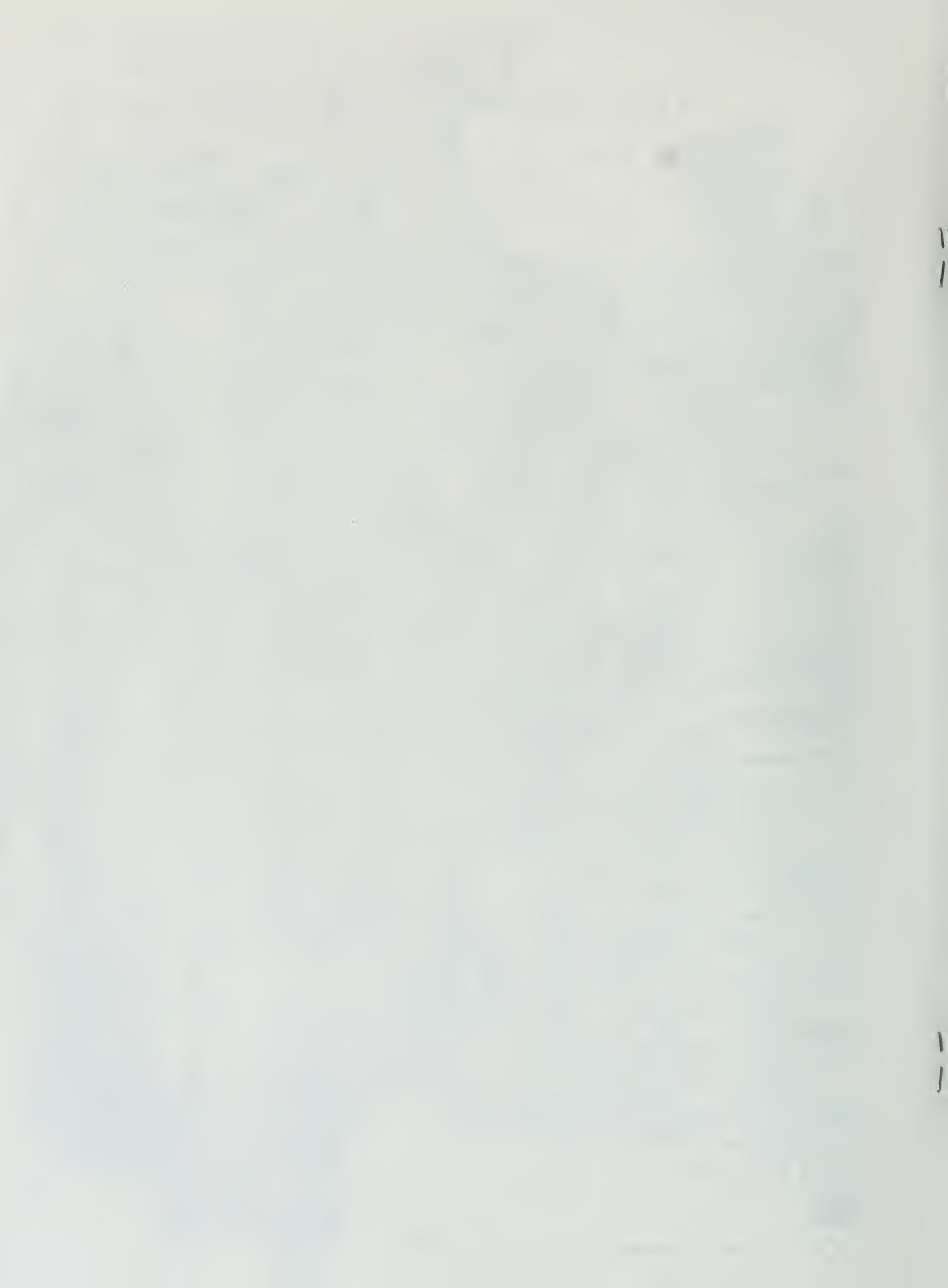
# GEOLOGIC MAP



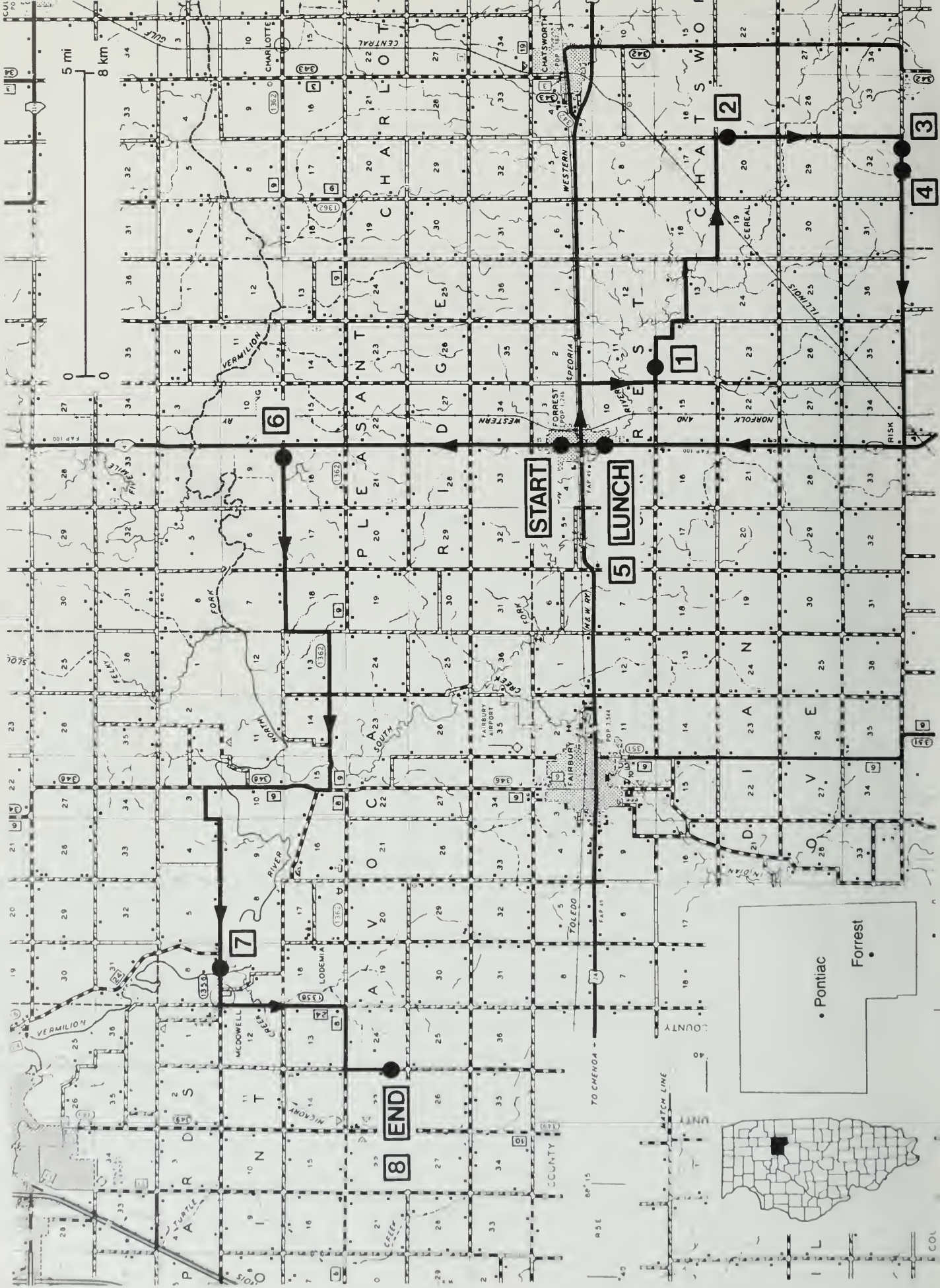
Pleistocene and Pliocene not shown

-  TERTIARY
-  CRETACEOUS
-  PENNSYLVANIAN  
Bond and Mattoon Formations  
Includes narrow belts of older formations along La Salle Anticline
-  PENNSYLVANIAN  
Carbondale and Modesto Formations
-  PENNSYLVANIAN  
Caseyville, Abbott, and Spoon Formations
-  MISSISSIPPIAN  
Includes Devonian in Hardin County
-  DEVONIAN  
Includes Silurian in Douglas, Champaign, and western Rock Island Counties
-  SILURIAN  
Includes Ordovician and Devonian in Calhoun, Greene, and Jersey Counties
-  ORDOVICIAN
-  CAMBRIAN
-  Des Plaines Disturbance - Ordovician to Pennsylvanian
-  Fault









5 mi  
8 km

6

START

5 LUNCH

1

2

4

3

8 END



Pontiac

Forrest

MATCH LINE

TO CMENOA

COUNTY

UNITY

IL

COL

C H A R L O T T E

P L E A S A N T

R I V E R

V E R M I L I O N

P A R D I S

C H A R L O T T E

A N T

F A I R B U R Y

A

I N

C H A R L O T T E

G E O R G E

F A I R B U R Y

A

U N I T

C H A R L O T T E

S T

F A I R B U R Y

A

T

C H A R L O T T E

R E S T

F A I R B U R Y

A

T

C H A R L O T T E

C E R A L

F A I R B U R Y

A

T

C H A R L O T T E

N O R F O L K

F A I R B U R Y

A

T

C H A R L O T T E

R I S K

F A I R B U R Y

A

T

C H A R L O T T E

R I S K

F A I R B U R Y

A

T