a guide to the geology of the Golconda area

David L. Reinertsen

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Department of Energy and Natural Resources
STATE GEOLOGICAL SURVEY DIVISION
Champaign, Illinois 61820

the geologic framework

The Golconda area is in the eastern part of the Shawnee Hills, one of the most scenic areas in Illinois. This rugged terrain was produced primarily by differential erosion of upper Mississippian and lower Pennsylvanian sedimentary strata. These strata consist of regular alternations of sandstone, limestone, and shale. Ridges are underlain by the relatively less resistant limestones and shales. Numerous faults cut the strata and interrupt the regularity of the ridges and valleys.

The field trip area is underlain by approximately 10,000 feet of Paleozoic sedimentary rocks ranging in age from Late Cambrian (about 500 million years old) to early Pennsylvanian (about 300 million years old). These rocks, which rest upon a basement complex of Precambrian granitic rocks more than a billion years old, were deposited in the ancient, shallow seas that periodically covered the Midwest during the Paleozoic Era. The field trip area lies near the southern margin of the Illinois Basin, a large elliptical depression—now filled with Paleozoic sediments—that covers most of Illinois, northwestern Kentucky, and southwestern Indiana. About 3000 feet of these sedimentary rocks, ranging in age from early Devonian (about 400 million years old) to early Pennsylvanian is exposed. Exposures of the Devonian rocks are restricted to a small area on Hicks Dome, a relatively localized uplift just outside the field trip area to the northeast.

Regionally, the bedrock strata are tilted gently toward the northeast, although many anomalous local dips occur because of the structural disturbance of the area. The major structural features that influence the Golconda area are Hicks Dome and the Dixon Springs and Rock Creek Grabens. The latter are elongated downfaulted blocks that extend diagonally across the region from northeast to southwest. Locally, areas adjacent to these major structures are complexly faulted.

The Golconda area lies on the western edge of the Illinois-Kentucky Fluorspar District. Fluorspar mining began in 1842 in the Illinois portion of the district, and the area is still rich in minable fluorspar, accounting for nearly 90 percent of the U.S. domestic fluorspar output for 1982. Valuable accessory minerals also mined are galena, sphalerite, and barite, the principal sources of lead, zinc, and barium, respectively. Another mineral resource of considerable importance to the economy of this area is limestone, used as agricultural lime, roadstone, and riprap. In addition, minor amounts of silver, gemstones, and germanium are produced.

guide to the route

Miles to next point	Miles to starting point	
0.0	0.0	Line up heading south at the east entrance to the west parking lot at Pope County Community High School. CAUTION—TURN LEFT (east) on Illinois Route (IR) 146.
0.1	0.1	Mississippian Hardinsburg Sandstone exposed on both sides of highway in roadcut.
0.4	0.5	Mississippian Cypress Sandstone exposed on both sides of highway in roadcut.
0.7	1.2	CAUTION—cross Miller Creek bridge and enter Golconda.
0.15-	1.35-	SLOW—pass through floodgate in levee.
0.1-	1.45-	STOP (4-way)—CONTINUE AHEAD (east) on Main Street and leave IR-146.
0.05+	1.5	CAUTION—enter Golconda business district.
0.15	1.65	Pope County Courthouse to the right.
0.1-	1.75-	BEAR LEFT (northeast) and ascend levee; then TURN SHARP RIGHT (south) on top of levee.
0.3+	2.05	Mississippian Cypress Sandstone bluff to right.
0.3	2.35	CAUTION—enter area of abandoned shops and offices of abandoned Lock and Dam No. 51. CONTINUE AHEAD (south).
0.2-	2.55-	CAUTION—TURN AROUND AND RETRACE ROUTE (north) through the shop area.
0.35+	2.9	PARK along the riverside of the drive as close to the cable as possible.
		STOP 1. DISCUSSION OF ABANDONED LOCK AND DAM NO. 51. OUTCROP OF MISSISSIPPIAN RIDENHOWER SHALE AND OVERLYING CYPRESS SANDSTONE. ROCK FALL OF CYPRESS SANDSTONE AT SOUTH END OF ABANDONED ROCK QUARRY.

Miles to next point	Miles from starting point	
0.0	2.9	Leave Stop 1. CONTINUE AHEAD (north). Retrace itinerary to the intersection of Main Street and IR-146 (Adams Street).
0.4+	3.3+	CAUTION—TURN SHARP LEFT (southwest) and descend levee.
0.05+	3.35+	BEAR RIGHT (westerly) on Main Street and enter business district.
0.3	3.65+	STOP (4-way); intersection with IR 146 West and Adams Street. TURN LEFT (south) on Adams Street (Bay City Road).
0.8+	4.45+	Cypress Sandstone exposed in roadcut.
0.05+	4.5+	Leave Golconda.
1.5	6.0+	PARK along roadside.
		STOP 2. DISCUSSION OF SOIL PROFILE EXPOSED IN EAST SIDE OF ROADCUT.
0.0	6.0+	Leave Stop 2 and CONTINUE AHEAD (south).
2.25	8.25+	Prepare to descend hill into Bay Creek valley.
0.05	8.3+	View at 10-12 o'clock (southerly) of Bay Creek valley.
0.2-	8.5	View at 9-10 o'clock (south-southeast) of the valley.
0.2	8.7	Route is now in the valley of the ancient Ohio River.
0.3	9.0	PARK along road shoulder.
		STOP 3. DISCUSSION OF PLEISTOCENE DRAINAGE CHANGES IN THE PRESENT BAY CREEK-CACHE RIVER VALLEY.
0.0	9.0	Leave Stop 3. CONTINUE AHEAD (west and then south).
0.25	9.25	TURN RIGHT (west-northwest) from 950E to 1610N, the Homberg Road.

Miles to next point	Miles from starting point	
0.3	9.55	Route roughly parallels an elongate sand bar formed when the river was flowing through this old valley.
0.2+	9.75+	TURN RIGHT (north). The road ahead crosses several of the sand ridges deposited in the old river valley bottom.
1.25-	11.0-	Route crosses the crest of one of the highest sand ridges in this vicinity. Note that houses and barns are located along the ridge crests. Drainage is poor over much of the area, and swampy places have developed in the low spots. A look at the topographic map indicates that this ridge may have been developed across an older terrace deposit.
0.1+	11.1	CAUTION—enter hamlet of Homberg. CONTINUE STRAIGHT AHEAD (north).
0.05	11.15	CAUTION—unguarded railroad crossing.
0.15+	11.3+	CURVE RIGHT (east) on blacktop.
0.25	11.55+	CURVE LEFT (northerly) and ascend hill.
0.3-	11.85-	Exposure of Mississippian Golconda Group to right.
0.2	12.05-	Massive Hardinsburg Sandstone in bluff to right. A northeast trending fault is present along the west side of this valley (note route map).
0.35-	12.4-	The fault noted above crosses the route at this approximate location. Surface deposits mask its presence here.
0.75+	13.15	CAUTION—Y-intersection with Hodgeville Road from left. CONTINUE AHEAD (northerly).
0.05	13.2	The water tower to the right is in Golconda; the skyline beyond is Kentucky.
0.4	13.6	BEAR LEFT (northerly) on the blacktop at the "Y."
0.4-	14.0-	PARK along roadside to right.
		<u>STOP 4</u>. DISCUSSION OF CUESTAS IN SOUTHERN ILLINOIS.

Miles to next point	Miles from starting point	
0.0	14.0-	Leave Stop 4. CONTINUE AHEAD (north).
0.3	14.3-	STOP (1-way); T-road intersection. CAUTION—poor visibility from left. TURN RIGHT (east) on IR-146.
0.3+	14.6	Mississippian Tar Springs Sandstone exposed in left roadcut.
1.0-	15.6-	West entrance to Pope County Community High School to left. CONTINUE AHEAD (east).
0.1	15.7-	Hardinsburg Sandstone exposed in roadcut.
0.4	16.1-	Cypress Sandstone exposed in roadcut.
0.7	16.8-	Cross Miller Creek and approach Golconda.
0.2+	17.0+	STOP (4-way). TURN LEFT (north) on Adams Street and IR-146.
0.2-	17.2-	Proceed through floodgate.
0.05+	17.25	Cross Lusk Creek bridge.
0.2	17.45	Base of south-facing cuesta face observed at Stop 4 is to the right.
0.2	17.65	Ascend north valley wall of Lusk Creek.
0.3	17.95	Prepare to turn right (turn is not well marked).
0.1-	18.05-	TURN RIGHT (east) on narrow, blacktop roadway.
0.05+	18.1+	BEAR RIGHT (southerly) on main blacktop roadway and enter Ohio River Recreation Area of the Shawnee National Forest.
0.45	18.55+	BEAR RIGHT (south) and enter parking area. Follow parking instructions.
0.05+	18.6+	STOP 5. LUNCH.
0.0	18.6+	Leave Stop 5 and CONTINUE AHEAD AROUND THE PARKING AREA. Return to IR-146.
0.65-	19.25-	STOP (1-way)—T-road intersection. CAUTION—visibility poor from left. TURN RIGHT (north) on IR-146.

Miles to next point	Miles from starting point	
1.4+	20.65	Prepare to turn left
0.1	20.75	TURN LEFT (west) on Eddyville Road.
0.5	21.25	The high land some 3 miles to the west and to the north is the Pennsylvanian escarpment, a south-facing cuesta. The top of the escarpment stands 200-300 feet above the Mississippian Tar Springs Sandstone which underlies this immediate vicinity. The dip slope of the Pennsylvanian cuesta slopes gently northward.
0.55	21.8	CURVE RIGHT (north) on the blacktop.
0.65	22.45	PARK along roadside; be careful of the ditch. USE EXTREME CAUTION HERE—visibility is limited because of the hills behind and the curve at the top of the hill ahead; traffic is fast.
		STOP 6. DISCUSSION OF FAULTING IN THIS IMMEDIATE VICINITY.
0.0	22.45	Leave Stop 6 and CONTINUE AHEAD (northerly) on the blacktop until instructed differently.
0.6	23.05	Palestine Church on left.
0.2-	23.25-	CAUTION—narrow bridge.
0.45+	23.7	Ascend steep hill ahead—the Pennsylvanian escarpment. The lower half of the slope is underlain by Mississippian Kinkaid Limestone. The upper, steep half of the bluff consists of lower Pennsylvanian sandstones that are quite resistant to erosion. The Pennsylvanian sandstones thus form a protective cap above the less resistant Mississippian limestones and shales.
0.4	24.1	Pennsylvanian sandstone exposed to left in roadcut.
0.95	25.05	Prepare to leave the blacktop at the curve ahead.
0.0	25.15	CAUTION—CONTINUE STRAIGHT AHEAD (north) onto the gravel road to Raum (2575N, 1025E).
0.35	25.5	Pennsylvanian sandstone exposed to left in creek bed.

Miles to next point	Miles from starting point	
0.5+	26.0+	The itinerary crosses a northeast trending fault here which brings the Kinkaid Limestone fairly close to the surface.
0.2-	26.2	Site of the hamlet of Raum. CONTINUE AHEAD (north).
0.35	26.55	T-road from right. TURN RIGHT (east).
1.2	27.75	View to the left (west) across Lusk Creek valley about 2 miles south of the main, scenic canyon. The area to the west toward the creek is underlain by Pennsylvanian sandstones. Faulting has brought Mississippian limestones and sandstones to the surface just on the other side of Lusk Creek. Pennsylvanian sandstones cap the distant hills near Eddyville.
0.5+	28.25+	Pennsylvanian sandstone ledges of the Abbott Formation are exposed across the roadway here.
0.15-	28.4	Abbott Formation sandstone is exposed in the right ditch.
0.1+	28.5+	CAUTION—concrete ford across intermittent stream.
0.2-	28.7	Descend short, steep hill. Road crosses Abbott sandstone exposure in lower part of valley.
0.3-	29.0-	CURVE RIGHT (east). Shallow dips in the road ahead expose Abbott sandstone ledges across the road.
1.0+	30.0+	Here the road is along the top of the Grindstaff Sandstone Member of the Pennsylvanian Abbott Formation.
0.8-	30.8-	T-road from right (east); Dutton Chapel Road (2975N, 1190E). TURN RIGHT (east) and PARK along roadside.
		STOP 7. DISCUSSION OF LAND SURVEYS IN ILLINOIS AT THE U.S.G.S. BENCHMARK LOCATED AT THE SOUTHWEST CORNER OF THE GRAND PIERRE ("GRANDPIER") CEMETERY.
0.0	30.8-	Leave Stop 7 and CONTINUE AHEAD (east).

Miles to next point	Miles from starting point	
0.45+	31.25+	This is the highest elevation on this field trip: 795± feet mean sea level (msl) estimated from topographic map. The downhill slope for the next 0.3+ miles is underlain by Abbott sandstone and shale, including the Grindstaff Sandstone Member (the lowest massive unit in this formation), which is 20 to 30 feet thick here. The Grindstaff Sandstone is correlated with the Babylon Sandstone Member of western Illinois, where it was the oldest Pennsylvanian sandstone deposited.
0.35-	31.6	The route for the next 0.5- mile is across massive, clean, quartz sandstones of the lower Pennsylvanian Caseyville Formation. The uppermost of these units is the Pounds Sandstone Member (30 to 40 ft thick here), which contains numerous quartz pebbles. The underlying Battery Rock Sandstone Member is the lowest massive strata in the Pennsylvanian of southeastern Illinois. It contains quartz pebbles and is about 50 feet thick here.
0.475	32.075	Itinerary is across upper Mississippian (Chesterian) strata; in descending order—Kinkaid Limestone, Degonia Sandstone, and Clore Formation. None are well-exposed here.
0.4	32.475	Crossroads. TURN RIGHT (southerly) toward Lusk and Golconda.
0.525	33.0	Sandstone and shale of the Clore Formation exposed in ditches.
0.1	33.1	Pleistocene windblown loess frequently slumps in roadcuts in this vicinity--the slumping generally results mostly because the base of the loess is inadequately drained and the cut is sloped, not vertical.
0.15	33.25	CAUTION—hamlet of Lusk.
0.2	33.45	Julien Hill lies to the left (southwest) within 0.5 mile of the route. The two peaks are capped by the Caseyville Formation.
0.425	33.875	CAUTION—bridge.
0.575	34.45	War Bluff, capped by Battery Rock Sandstone, lies to the left (west-southwest) within 1.2 miles of the route.

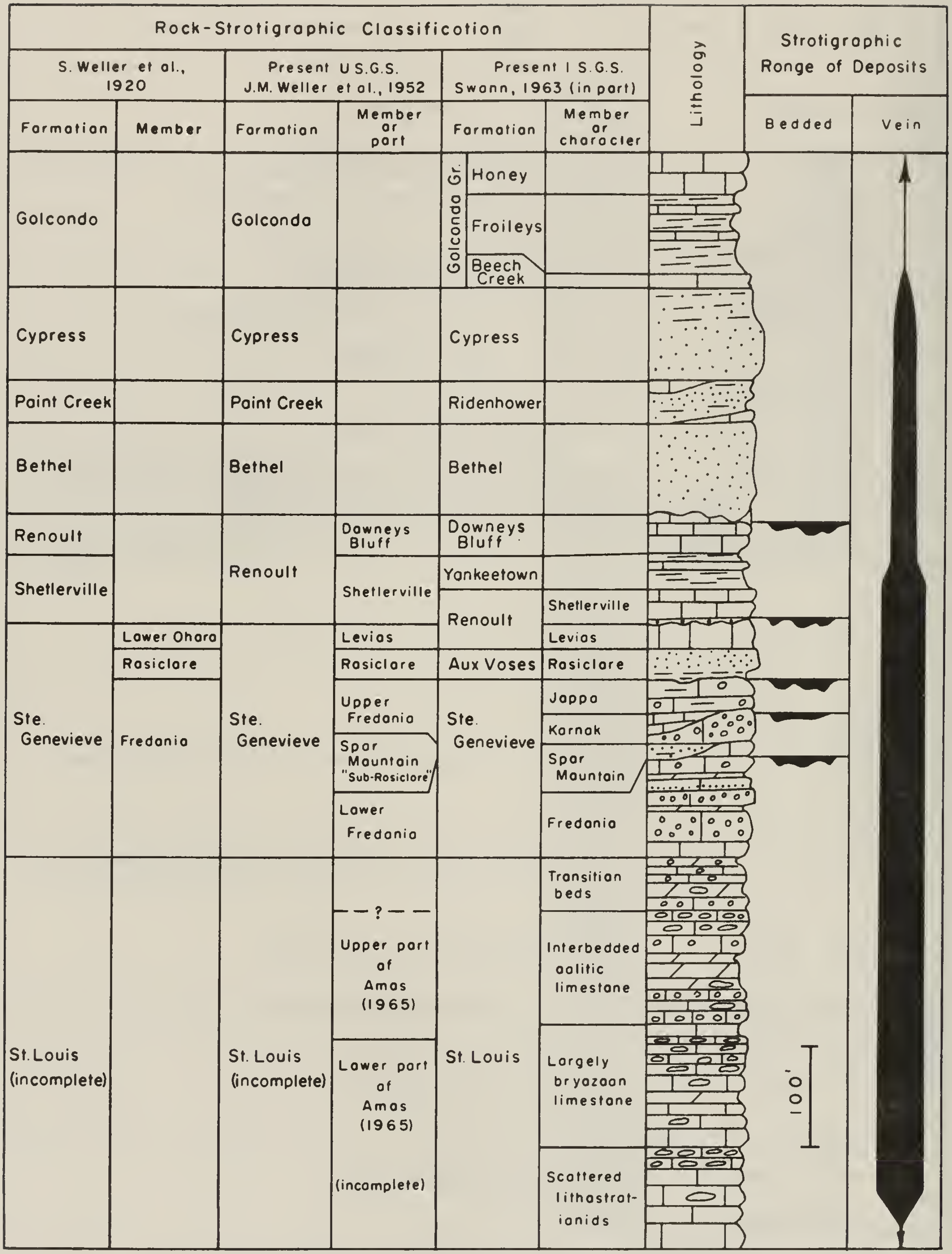
Miles to next point	Miles from starting point	
0.1	34.55	A fluorspar mine, the Henson Shaft, is located to the left. This mine is owned and operated by the Ozark-Mahoning Mining Company in a mineralized fault zone.
0.25	34.8	TURN LEFT (east) at T-road intersection. CAUTION—this road is rough.
0.725	35.525	TURN RIGHT (southerly). The Mississippian Tar Springs Sandstone crops out along the route here.
1.25	36.775	STOP (1-way); T-road intersection at Gowins. CAUTION—TURN LEFT (northeasterly) on IR-146.
0.325	37.1	Tar Springs Sandstone exposed in roadcut.
1.05	38.15	Hardinsburg Sandstone caps this hill. CAUTION—steep hill ahead.
0.3	38.45	The Haney Limestone of the Mississippian Golconda Group crops out to the left along the highway.
0.65	39.1	CAUTION—cross Grand Pierre Creek. PREPARE TO STOP.
0.1	39.2	PARK on highway shoulder—make sure that vehicles are well off the roadway; get out of and into vehicles on the PASSENGER SIDE ONLY. You MUST HAVE PERMISSION to enter this property.
		<u>STOP 8</u>. DISCUSSION OF FLUORSPAR MINING DISTRICT AND COLLECTING ROCK AND MINERAL SPECIMENS AT THE ABANDONED PARKINSON MINE OF OZARK-MAHONING MINING COMPANY SOUTH OF IR-146.
0.0	39.2	Leave Stop 8 and CONTINUE AHEAD (easterly).
0.8	40.0	Itinerary crosses a major mineralized faulted complex trending north-northeast along the western side of the Fluorspar District.
0.4	40.4	CAUTION—approaching Y-intersection with IR-34 at the Humm Wye. CONTINUE STRAIGHT AHEAD and prepare to turn right.
0.1+	40.5+	TURN RIGHT (south) on blacktop part way through the Y-intersection <u>before</u> IR-146 intersects with IR-34.

Miles to next point	Miles from starting point	
1.3	41.8+	Ascend hill and prepare to stop.
0.1+	41.9+	PARK along roadside off the blacktop. CAUTION—fast, heavy truck traffic here.
		STOP 9. FOSSIL COLLECTING FROM THE MISSISSIPPIAN DOWNEYS BLUFF LIMESTONE, YANKEETOWN SHALE, AND SHETLERVILLE LIMESTONE MEMBER OF THE RENAULT LIMESTONE.
0.0	41.9+	Leave Stop 9. TURN AROUND where convenient and return northward to IRs-146 and 34.

End of Trip*

SYSTEM	SERIES	FORMATION	MEMBER	LITHOLOGY	THICKNESS (FT.)	LITHOLOGIC DESCRIPTION
PENNSYLVANIAN					600-900	Sandstone, shale, thin coals
MISSISSIPPIAN	CHESTERIAN	KINKAID			0 - 80	Gray, cherty limestone; shale
		DEGONIA			0 - 30	Shale and thin-bedded sandstone
		CLORE			100-120	Shale; limestone; thin-bedded sandstone
		PALESTINE			50 - 60	Sandstone, silty shale
		MENARD			100-130	Fine-grained limestone; shale
		WALTERSBURG			15 - 50	Shale; shaly sandstone
		VIENNA			10 - 20	Limestone; shaly limestone
		TAR SPRINGS			90 - 110	Sandstone; shale; thin coal
		GLEN DEAN			40 - 70	Fossiliferous, partly oolitic limestone; shale
		HARDINSBURG			90 - 115	Sandstone; shale
		HANEY			105-140	Fossiliferous limestone
		FRAILEYS				Shale; thin limestone
		BEECH CREEK				Silty limestone
		CYPRESS			80-110	Sandstone; shale
		RIDENHOWER			25 - 65	Shale; shaly sandstone
		BETHEL			80-100	Sandstone
		DOWNEYS BLUFF			25 - 40	Crinoidal, locally oolitic limestone
		YANKEETOWN			30 - 45	Shale; siltstone (Yankeetown); limestone; shale (Shetlerville)
	VALMEYERAN	RENAULT	Shetlerville		15 - 35	Light-colored oolitic limestone (Levias)
		AUX VASES	Levias Rosiclare		15 - 35	Calcareous sandstone, shale at base
		STE. GENEVIEVE	Spar Mtn.		120-160	Light-colored, largely oolitic limestone; sandstone lenses
		ST. LOUIS			350-400	Fine-grained, cherty limestone
		SALEM			500±	Dark-colored, fine-grained limestone; foraminiferal calcarenite
		ULLIN			125-360	Crinoidal, bryozoan limestone; dark-gray, fine-grained limestone
		FORT PAYNE			225-640	Siltstone; silty, cherty limestone
DEVONIAN-MISSISSIPPIAN		SPRINGVILLE				Gray and greenish gray shale
		NEW ALBANY GROUP			395±	Gray to black shale
DEVONIAN		LINGLE				
		GRAND TOWER			250±	Limestone and chert
		CLEAR CREEK				

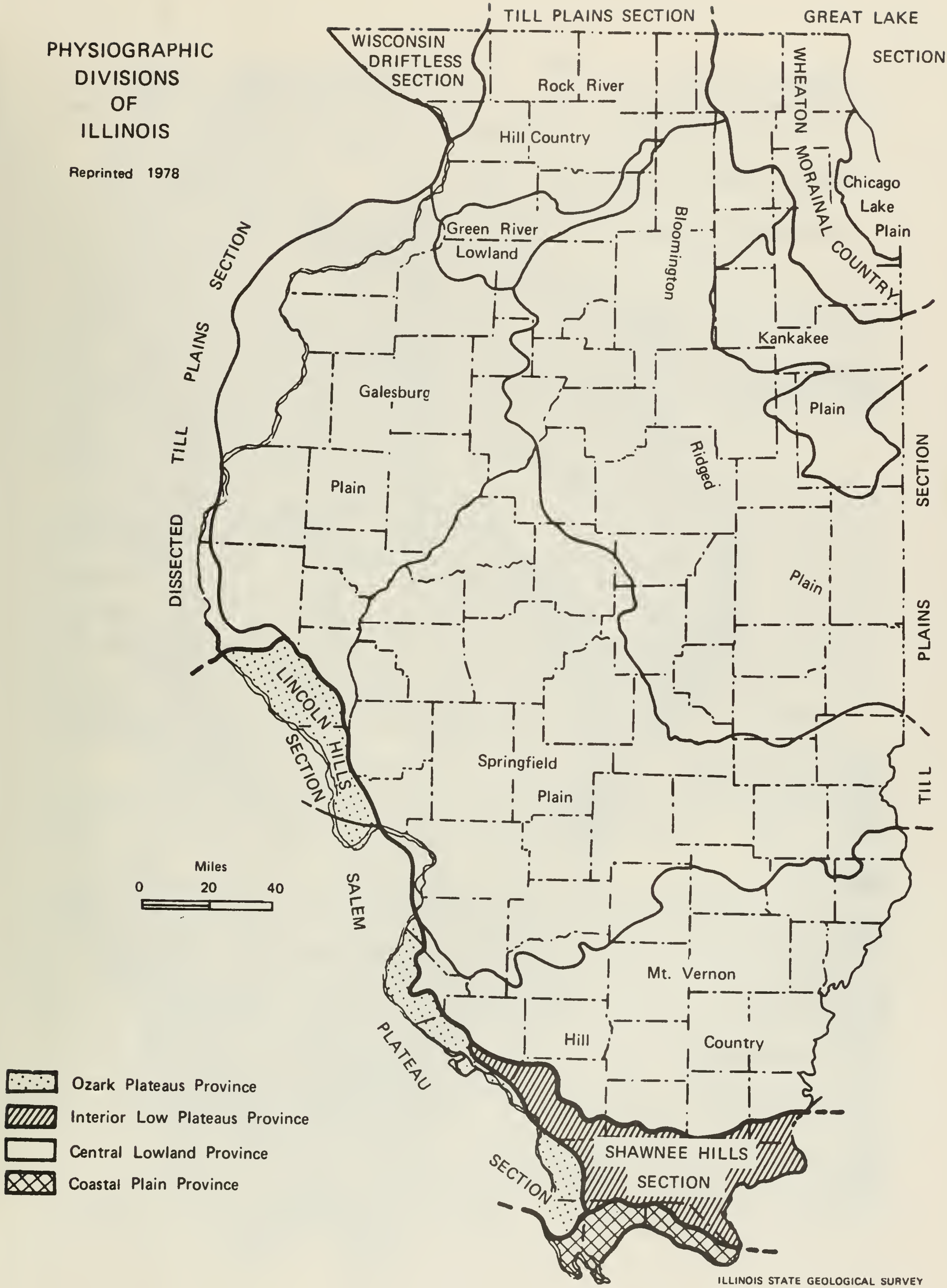
Stratigraphic column of exposed Paleozoic formations, Illinois-Kentucky fluorspar district (from ISGS Guidebook Series 11, 1973).



Lower Chesterian and upper Valmeyeran strata of the Illinois-Kentucky fluorspar district showing range of deposits (from ISGS Guidebook Series 11, 1973).

PHYSIOGRAPHIC DIVISIONS OF ILLINOIS

Reprinted 1978



ILLINOIS STATE GEOLOGICAL SURVEY

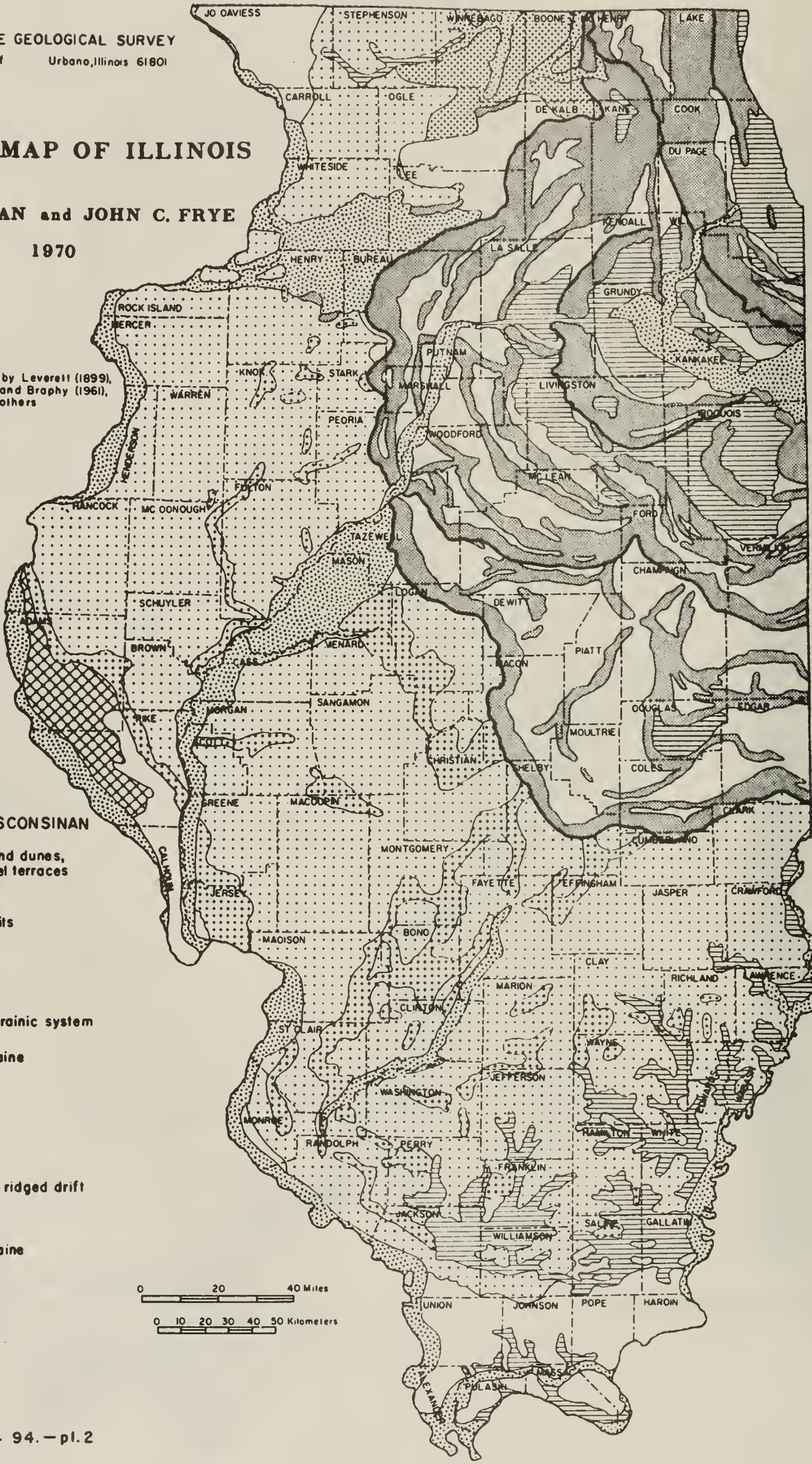
ILLINOIS STATE GEOLOGICAL SURVEY
John C. Frye, Chief   Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

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



EXPLANATION

HOLOCENE AND WISCONSINAN

- Alluvium, sand dunes, and gravel terraces

WISCONSINAN

- Lake deposits

WOODFORDIAN

- Moraine
- Front of morainic system
- Groundmoraine

ALTONIAN

- Till plain

ILLINOIAN

- Moraine and ridged drift
- Groundmoraine

KANSAN

- Till plain

DRIFTLESS

Modified from Bull. 94.—pl. 2

ILLINOIS STATE GEOLOGICAL SURVEY
Urbana, Illinois 61801

GEOGRAM 5
October 1975

ANCIENT DUST STORMS IN ILLINOIS

Myrna M. Killey

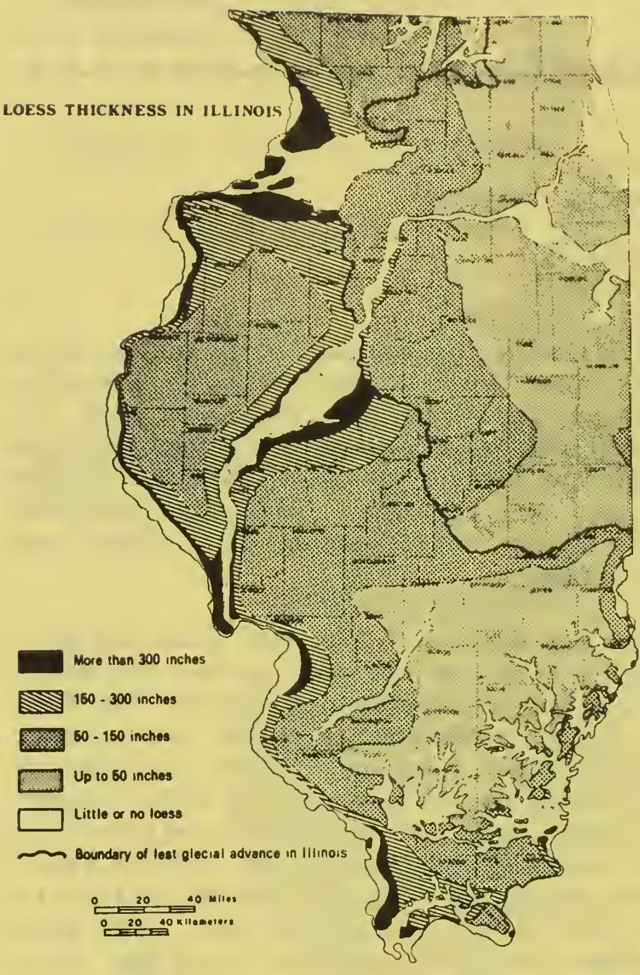
Fierce dust storms whirled across Illinois long before human beings were here to record them. Where did all the dust come from? Geologists have carefully put together clues from the earth itself to get the story. As the glaciers of the Great Ice Age scraped and scoured their way southward across the landscape from Canada, they moved colossal amounts of rock and earth. Much of the rock ground from the surface was kneaded into the ice and carried along, often for hundreds of miles. The glaciers acted as giant grist mills, grinding much of the rock and earth to "flour"—very fine dust-sized particles.

During the warm seasons, water from the melting ice poured from the glacier front, laden with this rock flour, called silt. In the cold months the meltwater stopped flowing and the silt was left along the channels the water had followed, where it dried out and became dust. Strong winds picked up the dust, swept it from the floodplains, and carried it to adjacent uplands. There the forests along the river valleys trapped the dust, which became part of the moist forest soil. With each storm more material accumulated until the high bluffs adjacent to major rivers were formed. The dust deposits are thicker along the eastern sides of the valleys than they are on the western sides, a fact from which geologists deduce that the prevailing winds of that time blew from west to east, the same direction as those of today. From such clues geologists conclude that the geologic processes of the past were much like those of today.

The deposits of windblown silt are called loess (rhymes with "bus"). Loess is found not only in the areas once covered by the glaciers but has been blown into the nonglaciated areas. The glaciers, therefore, influenced the present land surface well beyond the line of their farthest advance.

Loess has several interesting characteristics. Its texture is so fine and uniform that it can easily be identified in roadcuts—and because it blankets such a vast area many roads are cut through it. Even more noticeable is its tendency to stand in vertical walls. These steep walls develop as the loess drains and becomes tough, compact, and massive, much like a rock. Sometimes cracks develop in the loess, just as they do in massive limestones and sandstones. Loess makes good highway banks if it is cut vertically. A vertical cut permits maximum drainage because little surface is exposed to rain, and rainwater tends to drain straight down through it to the rock underneath. If the bank is cut at an angle more water soaks in, which causes the loess to slump down. Along Illinois roads the difference between a loess roadcut and one in ordinary glacial till is obvious. The loess has a very uniform texture, while the till is composed of a random mixture of rock debris, from clay and silt through cobbles and boulders.

Many loess deposits are worth a close look. Through a 10-power hand lens separate grains can be seen, among them many clear, glassy, quartz grains. Some loess deposits contain numerous rounded, lumpy stones called concretions. Their formation began when water percolating through the loess dissolved tiny



limestone grains. Some of the dissolved minerals later became solid again, gathering around a tiny nucleus or along roots to form the lumpy masses. A few such concretions are shaped roughly like small dolls and, from this resemblance, are called "loess kindchen," a German term meaning "loess children." They may be partly hollow and contain smaller lumps that make them rattle when shaken.

Fossil snails can be found in some loess deposits. The snails lived on the river bluffs while the loess was being deposited and were buried by the dust. When they are abundant, they are used to determine how old the loess is. The age is found by measuring the amount of radioactive carbon in the calcium carbonate of their shells.

Some of the early loess deposits were covered by new layers of loess following later glacial invasions. Many thousands of years passed between the major glacial periods, during which time the climate was as warm as that of today. During the warm intervals, the surface of the loess and other glacial deposits was exposed to weather. Soils developed on most of the terrain, altering the composition, color, and texture of the glacial material. During later advances of the ice, some of these soils were destroyed, but in many places they are preserved under the younger sediments. Such ancient buried soils can be used to determine when the materials above and below them were laid down by the ice and what changes in climate took place.

The blanket of loess deposited by the ancient dust storms forms the parent material of the rich, deep soils that today are basic to the state's agriculture. A soil made of loess crumbles easily and has great moisture-holding capacity. It also is free from rocks that might complicate cultivation. Those great dust storms that swirled over the land many thousands of years ago thus endowed Illinois with one of its greatest resources, its highly productive soil.

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS

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

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

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

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

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

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

Pennsylvanian Cyclothems

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

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

Origin of Coal

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

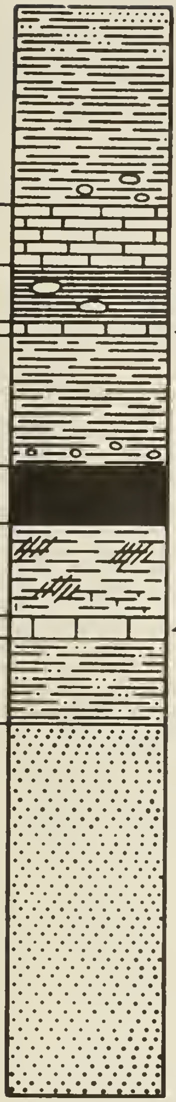
Plant debris from the rapidly growing swamp forests—leaves, twigs, branches, and logs—accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably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

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

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

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

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



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

9 Limestone; contains marine fossils.

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

7 Limestone; contains marine fossils.

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

5 Coal; locally contains clay or shale partings.

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

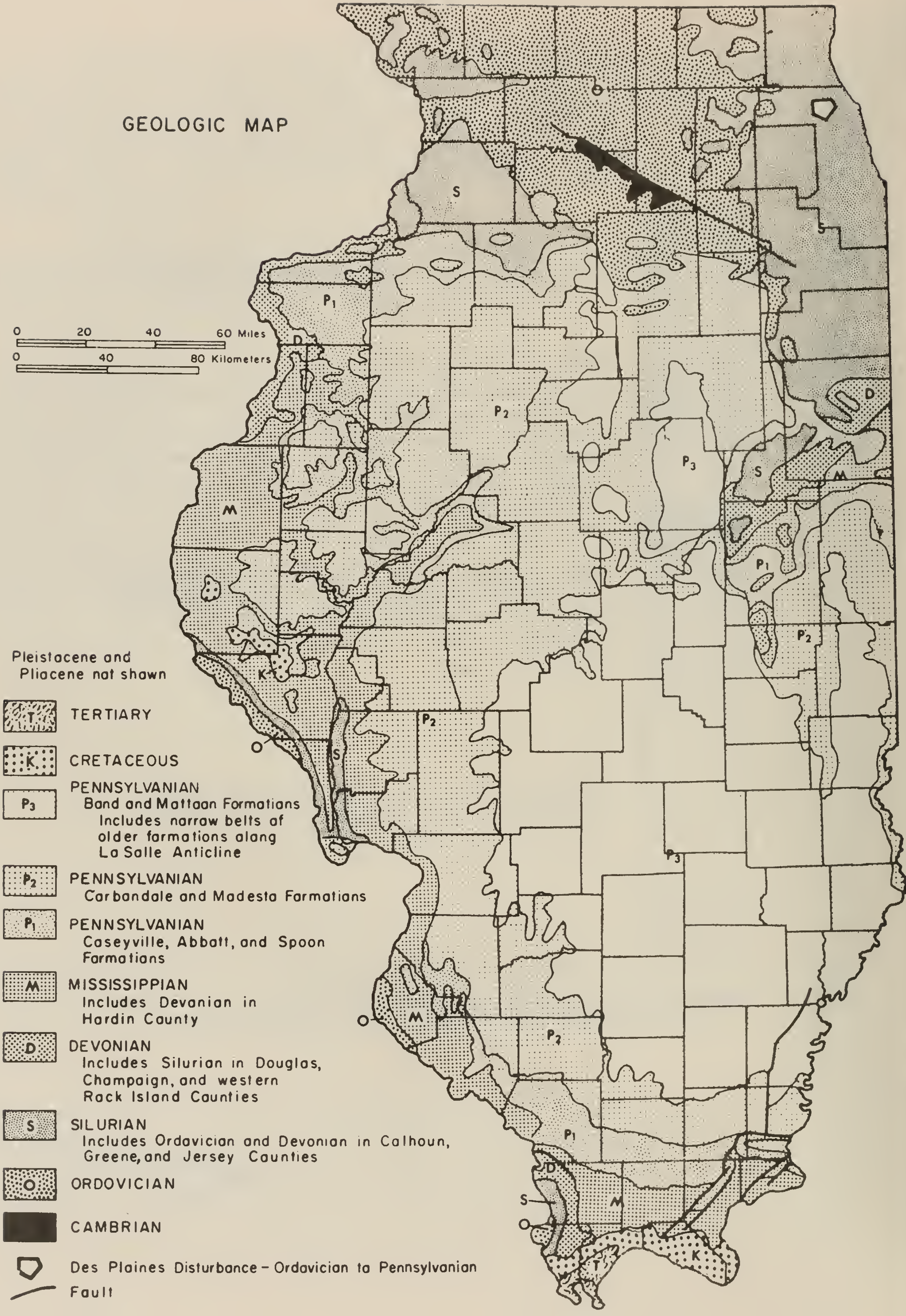
3 Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.

2 Shale, gray, sandy.

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

AN IDEALLY COMPLETE CYCLOTHEM

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


GEOLOGIC MAP
0 20 40 60 Miles
0 40 80 Kilometers
Pleistocene and Pliocene not shown
T TERTIARY
K CRETACEOUS
P3 PENNSYLVANIAN
Bond and Mattoon Formations
Includes narrow belts of older formations along La Salle Anticline
P2 PENNSYLVANIAN
Carbondale and Modesto Formations
P1 PENNSYLVANIAN
Caseyville, Abbott, and Spoon Formations
M MISSISSIPPIAN
Includes Devonian in Hardin County
D DEVONIAN
Includes Silurian in Douglas, Champaign, and western Rock Island Counties
S SILURIAN
Includes Ordovician and Devonian in Calhoun, Greene, and Jersey Counties
O ORDOVICIAN
CAMBRIAN
Des Plaines Disturbance - Ordovician to Pennsylvanian
Fault

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.

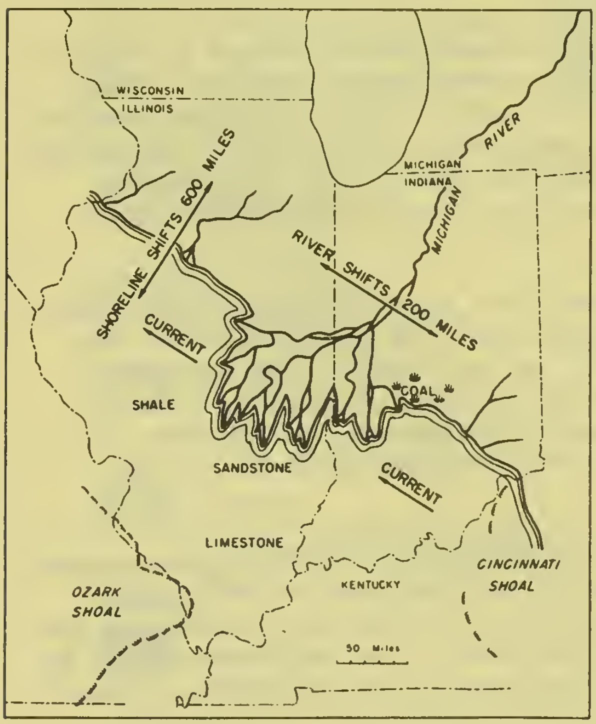
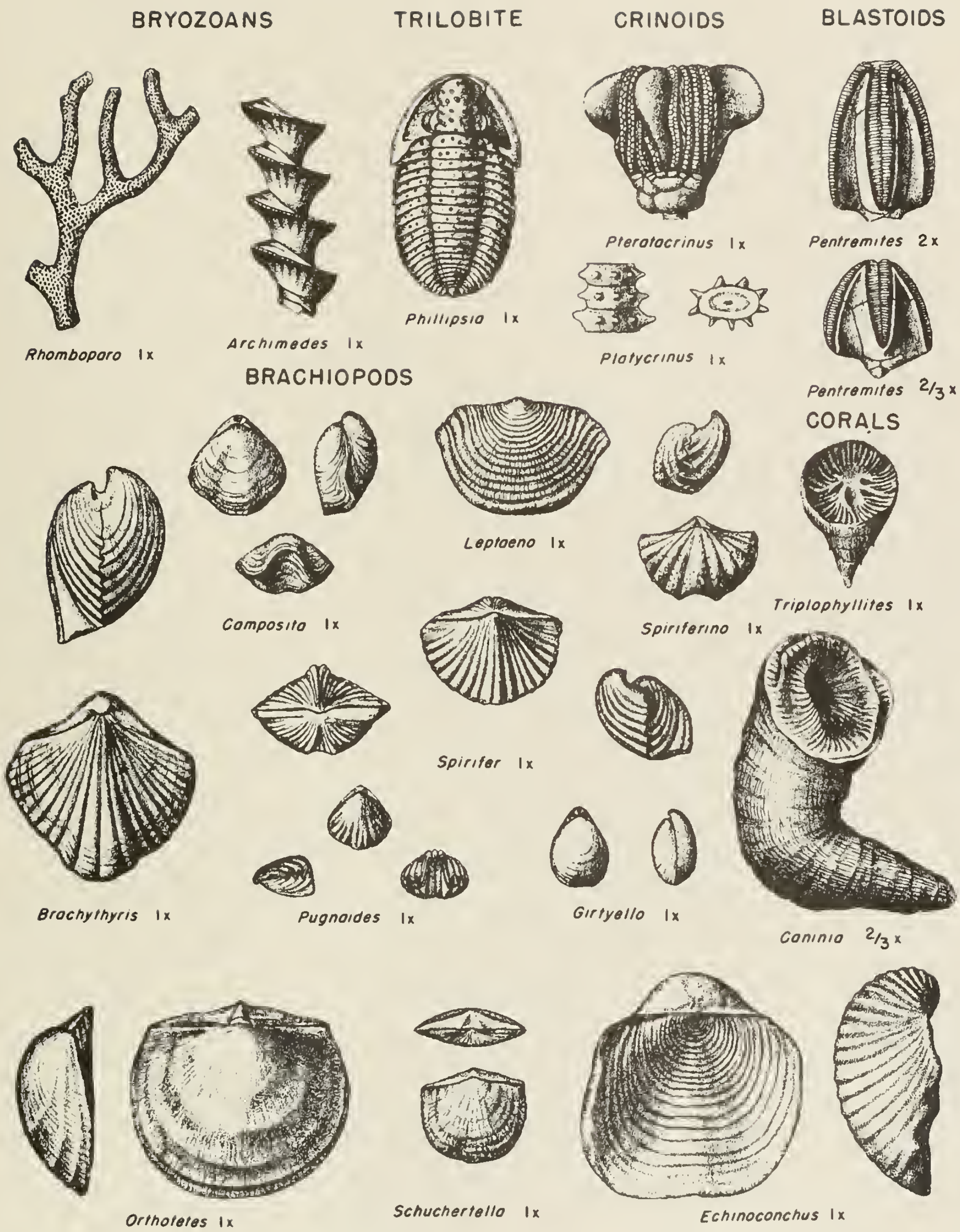


Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.


BRYOZOANS
TRILOBITE
CRINOIDS
BLASTOIDS
Rhombopora 1x
Archimedes 1x
Phillipsia 1x
Pterotocrinus 1x
Platycrinus 1x
Pentremites 2x
Pentremites 2/3x
BRACHIOPODS
CORALS
Leptaena 1x
Composita 1x
Spiriferina 1x
Triplophyllites 1x
Spirifer 1x
Brachythyris 1x
Pugnoides 1x
Girtyella 1x
Caninia 2/3x
Orthotetes 1x
Schuchertella 1x
Echinoconchus 1x


START
LUNCH
END
1
2
3
4
5
6
7
8
9
EDDYVILLE
POP 127
RAUM
GOWINS
SIMMONS
RISING SUN
WALTERSBURG
OHIO RIVER
RECREATION
AREA
HOMBERG
TANSILL
ROSEBUD
HORN
LUSK
OHIO RIVER
COUNTY
LIVINGSTON COUNTY
R 7 E
T 13 S
T 14 S
RONDEAU ISLAND
PRYOR ISLAND
ILLINOIS CENTRAL GULF
SCALE
5 MILES
25 000 FEET
8 KILOMETERS