GUIDE LEAFLET
GEOLOGICAL SCIENCE FIELD TRIP

METROPOLIS AREA
Massac, Pope, and Pulaski Counties
Brownfield, Golconda, La Center, Paducah, Smithland, and Vienna 15-Minute Quadrangles

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Host—Metropolis Community High School
Sponsored by the
ILLINOIS STATE GEOLOGICAL SURVEY

April 19, 1975
October 25, 1975

Urbana 61801
TO THE PARTICIPANTS:

The Geological Science Field Trip program is designed to acquaint Illinois residents with the landscape, the rock and mineral resources, and the geological processes that have led to their origin. With this program, we hope to stimulate a general interest in the geology of Illinois and a greater appreciation of the state's vast mineral resources and their importance to the over-all economy.

We encourage you to ask the tour leaders any questions that may occur to you during the trip. Discussion often clarifies points that otherwise would remain confused to many of the participants. We also invite your written comments upon the conduct of the trips so that we might improve them as much as possible.

Additional copies of this guide leaflet, as well as itineraries for field trips that have been held in the past, may be obtained free of charge by writing to the Illinois State Geological Survey. The itinerary maps for each field trip can be purchased for 10 cents each.

Several of the stops along this itinerary are located on private property whose owners have graciously given us permission to visit their lands. Please obey the instructions of your trip leaders and conduct yourselves in a manner that will show respect for the property owners' cooperation. Please do not litter, or climb on fences, and leave all gates as found, so that we may be welcome to return on future field trips. These simple rules of courtesy also apply to public property as well. For the convenience of those persons who may use this itinerary at some future time, the names and addresses of every private property owner are listed for the respective stops on a page at the back of this guide leaflet. Whenever possible, always attempt to obtain permission when visiting private property.

We hope that you enjoy today's field trip and will attend others in the future.

THE STAFF
EDUCATIONAL EXTENSION SECTION
ILLINOIS STATE GEOLOGICAL SURVEY
INTRODUCTION

The Metropolis area is located in extreme southern Illinois, where some of the most interesting geology in the state is found. This region is one of only two in Illinois where Paleozoic, Mesozoic, and Cenozoic aged strata occur together. The boundary between two physiographic provinces—the western end of the Interior Low Plateaus province, a region of rugged, scenic terrain developed on resistant Paleozoic strata, and the northern end of the Coastal Plain province, a region of low, gentle hills formed upon softer Mesozoic and Cenozoic sediments—crosses the area (see attached Physiographic Divisions of Illinois map). Other important topographic features include the Ohio River Valley and the Cache River-Bay Creek Valley, which contrast sharply with adjacent rolling, deeply dissected uplands (note itinerary map).

PALEozoIC ROCKS

The Metropolis area is also geologically interesting because it occurs along the boundary between two major geologic bedrock provinces—the Illinois Basin to the north and the Mississippi Embayment to the south (fig. 1). The Illinois Basin is a large bedrock structure containing a thick sequence of Paleozoic sedimentary rocks which have been warped into a great spoon-shaped depression, 250 to 300 miles in diameter, that covers most of Illinois and adjacent parts of Indiana and Kentucky (figs. 1 and 2 and attached Geologic Map of Illinois). The deepest part of the basin is in western White County, Illinois, about 65 miles north-northeast of the Metropolis area. In that part of the basin, more than 13,000 feet of sandstones, shales, limestones, and coals have been encountered in a deep oil-test hole. These strata were deposited in the ancient shallow seas that periodically covered Illinois and the Midwest during the Paleozoic Era from Cambrian time, about 570 million years ago, until at least the close of the Pennsylvanian Period, about 280 million years ago. It seems quite likely that an undetermined thickness of younger Pennsylvanian and perhaps even strata of the Permian Period, the youngest Paleozoic rocks, were deposited across this region and then subsequently removed by erosion over millions of years. The base of the Cambrian sedimentary rocks rests upon an ancient Precambrian basement of crystalline granitic rocks more than one billion years old (figs. 2 and 3).

The Metropolis field trip area is situated nearly at the extreme southern margin of the Illinois Basin and is underlain by about 13,500 feet of Paleozoic rocks.
Fig. 2 - North-south cross-section through Illinois showing the Paleozoic strata in the Illinois Basin.
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**Fig. 3 - Geologic ages, names, and descriptions of rock units underlying the Metropolis field trip area.**
ranging in age from Cambrian to Chesterian (late Mississippian). Only Paleozoic rocks of Valmeyeran and Chesterian (middle to late Mississippian) age are exposed here. The Valmeyeran (middle Mississippian) formations, although dominantly limestone, contain considerable siltstone and some sandstone; and the Chesterian (upper Mississippian) formations consist largely of sandstone and shale with some limestone (figs. 3 and 4). (See attached MISSISSIPPIAN DEPOSITION). These Mississippian strata, which could have an aggregate thickness of as much as 1600 feet, range from the St. Louis Limestone Formation up to the Menard Limestone Formation and were deposited from about 330 up to about 320 million years ago in shallow seas that covered the midcontinent region. Hundreds of feet of younger Mississippian and Pennsylvanian strata that occur a few miles to the north and east also once covered the Metropolis area, but erosion stripped them away during the 190 million years or so that followed the withdrawal of the Pennsylvanian sea and preceded the advance of the Gulfian (upper Cretaceous) sea.

STRUCTURE OF THE PALEOZOIC ROCKS

The Metropolis area is located in that portion of southern Illinois where faulting of Paleozoic strata has been extensive and, as a consequence, stratigraphic relationships of the various rock units are complicated. Regionally the Paleozoic strata are tilted downward about 2 degrees to the north and east into the Illinois Basin (fig. 2). Although a few faults trend northwest, most of the faults in this region trend northeast-southwest and are, for the most part, extensions of the structural features of the Illinois-Kentucky fluorspar district, which lies just to the northeast of the field trip area. The major faults are so aligned as to form a series of nearly parallel grabens in which the beds have a general, irregular northward dip. Currently available data indicate that this system of faults developed sometime after Pennsylvanian time.

THE MISSISSIPPI EMBAYMENT

The Mississippi Embayment, floored by Paleozoic strata, is a broad, gentle syncline, or trough, that deepens southward toward the Gulf of Mexico; the northern part
of the axis of the syncline trends northeastward paralleling the major structural trend in extreme southern Illinois. This trough, also called the Embayment Syncline, is bordered on the west by the Ozark Dome, on the east by another large bedrock arch in western Tennessee known as the Nashville Dome, and on the north by the southern margin of the Illinois Basin (fig. 1). The Embayment Syncline was formed by movements of the earth's crust which began during Gulfian (late Cretaceous) time, about 90 million years ago, and continued until the end of the Eocene Epoch in Tertiary time, about 38 million years ago. As the trough subsided, an arm of the sea advanced northward into the Embayment from the present site of the Gulf of Mexico, inundating the southern tip of Illinois at least twice during Cretaceous time and twice during Tertiary time. The Tertiary inundations, during the Eocene Epoch, marked the last time that the sea reached into Illinois. The Cretaceous and Tertiary strata deposited during these invasions fill the Embayment Syncline and form a wedge-shaped body of unconsolidated marine and non-marine clays, silts, sands, and gravels that gradually thickens southward from a thin erosional edge in extreme southern Illinois to more than 3000 feet near Memphis, Tennessee. In the Metropolis area these relatively young sedimentary strata overlap, and rest unconformably upon, the much older Paleozoic sedimentary rocks (figs. 2 and 3).

After the sea withdrew at the end of Eocene time, the region was uplifted, and erosion has continued to the present. At some time during the Pliocene Epoch, which lasted from about 12 million years ago up to some 2 to 3 million years ago, a great river system flowed across the region. Streams from this system deposited an extensive sheet of sand and coarse gravel over a large area of the Ohio River region. These materials, called the Mounds ("Lafayette") Gravel, thinly mantle the Paleozoic, Mesozoic, and earlier Cenozoic strata and cap most of the hills in the Metropolis area (fig. 3).

PLEISTOCENE HISTORY

The extensive continental glaciers that covered northern North America and large portions of Illinois and the Midwest during the Pleistocene Epoch, commonly referred to as "The Great Ice Age," did not extend as far south as the Metropolis area. (See attached PLEISTOCENE GLACIATIONS IN ILLINOIS). The Illinoian glacier, the third of four major glacial advances, was the most extensive in the state and advanced to an irregular margin extending westward from north of Harrisburg (Saline County) to south of Carbondale (Jackson County). The southernmost point of continental glaciation is about 1.5 miles south of the north boundary of Johnson County, nearly 30 miles northwest of Metropolis. Although till, deposited directly by the glaciers, is not found here, other materials, called outwash, composed of silt, sand, and gravel, were deposited by sediment-laden meltwater streams pouring away from the ice fronts, during both advance and waning of the glaciers. Major river valleys, such as the Mississippi and Ohio Valleys, were the main channels for the escaping meltwaters, and thus these valleys were greatly deepened and widened during times of greatest flood. During times of decreased meltwater flow, however, the valleys became filled and choked with outwash called valley trains far beyond the ice margins. Near Cairo, outwash deposits in the Mississippi River are as much as 250 feet thick. About 13,000 years ago, near the end of the last glacial stage (the Wisconsinan) in Illinois, a great flood of meltwater poured down these valleys and caused major changes in the channels of the Mississippi and Ohio Rivers. The changes affecting the Ohio River will be discussed in detail at later stops along the itinerary.

Deposits of wind-blown silt, called loess (pronounced "luss"), are also the result of glaciation in Illinois; they blanket the uplands of the Metropolis area. The silt was blown from the floodplain of the Mississippi River and from the
floodplain of the Ohio River when it occupied the Cache River-Bay Creek Valley. Although thicknesses as great as 50 feet are known along the Mississippi Valley, the loess thins eastward to a maximum of about 15 feet in the field trip area. The loess is generally less than 3 feet thick on the lower terrace. Loess deposits of Illinoian and Wisconsinan ages are present.

ECONOMIC GEOLOGY

Massac County - The total value of mineral materials mined and processed in Massac County in 1973 was $16,512,000. $402,810 of this amount was the value of crushed and broken stone produced by the one quarry operating. Sand and gravel and cement are produced in the county, but production statistics for these commodities have been withheld. Massac County ranked second among Illinois counties in cement production.

Pope County - The total value of mineral materials mined and processed in 1973 was $5,953,000. Pope and Hardin County produce fluorspar—in 1974 they produced 75% of the total U.S. output. Barite, lead, zinc, and silver are produced as by-products of fluorspar milling. Four thousand tons of sand were also produced in Pope County in 1973.

Pulaski County - Pulaski County produces clay, stone, and sand and gravel. The amounts and values of the clay and stone produced have been withheld. Four stone quarries and one clay pit were operating in 1973. Five thousand tons of sand and gravel were produced. The total value of mineral materials mined and processed in Pulaski County in 1973 was $1,327,000.

Oil, Gas, and Coal - No production of oil and gas has been reported for Massac, Pope, and Pulaski Counties. No coal production has been reported for Massac and Pulaski Counties, which are beyond the limits of the coal-bearing Pennsylvanian strata. Pope County has produced a total of 23,747 tons of coal in 14 years of mining reported up to 1972, the last active year.

ITINERARY

0.0 0.0 Assemble with cars facing south along west side of Catherine Street across from Metropolis Community High School. Set odometer to zero. Please read TO THE PARTICIPANTS at the front of the guide leaflet.

0.0 0.0 Leave registration point and head south.

0.05 0.05 STOP--4-way (Tenth Street). TURN RIGHT (west).

0.15 0.2 STOP--2-way (Metropolis Street). CONTINUE AHEAD (west).

0.1 0.3 STOP--4-way (Ferry Street and Tenth Street [U.S. Route 45 North]). CONTINUE AHEAD (west) on Tenth Street and Route 45.

0.05 0.35 CAUTION: stoplight. CONTINUE AHEAD (west).

0.5 0.85 Illinois Central Gulf Railroad (ICG) underpass.

1.35 2.2 Metropolis Works of Allied Chemical Corporation to the left. This is the world's largest privately-owned fluorine gas plant. Hydrofluoric acid (HF) produced in Louisiana is converted to fluorine gas for use
in treating uranium ore and converting it into a very pure nuclear fuel (uranium hexafluoride, \( \text{UF}_6 \)). \( \text{UF}_6 \) is shipped to nuclear-power sites, where it is used to enrich the fuel pile, that is, it is used to reprocess spent fuel from the reactors. The \( \text{UF}_6 \) must be ultra-pure so that peak efficiency of the nuclear-fuel cycle can be maintained. The Metropolis Works, which began production early in 1959, converts millions of pounds of uranium concentrates into fuel annually. The major consumer of this fuel has been the Atomic Energy Commission fuel reprocessing plant near Paducah, Kentucky.

Allied Chemical Corporation has recently purchased the fluorspar mines in southern Illinois formerly owned and operated by the Minerva Company, Division of Minerva Oil Company, Eldorado, Illinois.

1.3 3.5 A coal terminal and barge-loading facility is being constructed to the left. Sub-bituminous coal from Wyoming will be shipped via the Burlington Northern Railroad (BN) to this point to be loaded on barges for shipment on the Ohio River to industrial and power generating facilities.

1.35 4.85 Prepare to turn left at Joppa Road.

0.1 4.95 TURN LEFT (west) onto the Joppa Road.

0.05 5.0 CAUTION: Railroad crossing (BN).

0.9 5.9 The itinerary crosses sandy Cretaceous materials here. The hilltop ahead is capped by Pliocene (Tertiary) Mounds ("Lafayette") Gravel.

0.5 6.4 The gentle slopes to the left are developed in the Quaternary terrace deposits.

0.9 7.3 Prepare to turn right.

0.1 7.4 TURN RIGHT (north) on Massac County Road 550E. There is a power substation to the right on the northeast corner of the intersection. To the north the road is quite rolling as it crosses the heads of the many small streams and gullies that are cutting back into the terrace deposits. The hilltops to the right and ahead are capped by "Lafayette" Gravel.

0.95 8.35 T-road from right. CONTINUE AHEAD (north).

0.05 8.4 T-road intersection. TURN LEFT (west) on Massac 1000N.

0.65 9.05 CAUTION: narrow culvert.

0.1 9.15 T-road from left--Joppa Road. CONTINUE AHEAD (west).

0.3 9.45 CAUTION: railroad crossing, 3 tracks. Chicago & Eastern Illinois Railroad (C&EI). The first 2 tracks are part of the track loop that serves the Joppa electric generating plant just to the south. The third (west) track services a cement plant a short distance to the west.

0.4 9.85 CAUTION: crossroads. The road to the left leads to the Joppa Steam Electric Station of Electric Energy, Inc. CONTINUE AHEAD (west).

0.3 10.15 View to the left of the Joppa Steam Electric Station. The fuel for this installation is coal, and more than 3 million tons are consumed
annually—about half arriving by river barge and the remainder by rail. The coal is finely pulverized before it is charged into the boilers. Six steam-driven turbo-generators produce a total of more than 1 million kilowatts per hour. More than half a million gallons of Ohio River water are treated, pumped through the plant's condensers, and returned to the river each minute. Most of the power generated here is used by the Atomic Energy Commission plant across the river, although some is used by the plant's sponsoring companies in Illinois and the St. Louis area.

The slurry pond in the foreground contains sand-sized ash from the power plant that is flushed into this area. Precipitators have been installed in this plant to keep the particulate matter formed during combustion of the finely ground coal from escaping to the atmosphere.

CONTINUE AHEAD (west).

0.15 10.3 CAUTION: entrance to Trunkline Gas Company's Joppa Station. This pumping station is on one of the major pipelines carrying gas from the southern states northward to the Chicago area industrial complex.

0.45 10.75 View to left of the Joppa Plant of the Missouri Portland Cement Company. The Joppa Plant, which began production in 1963, is the newest of the company's plants. This installation, which has 1 kiln, was designed for an annual production of 3 million barrels of cement (1 barrel of cement equals 4 sacks of cement). Additionally, this plant was so designed that 3 similar kilns and other necessary facilities could be added at a later time. At present a second kiln, which will more than double the plant's capacity, is under construction.

High-calcium Ste. Genevieve Limestone (Mississippian) used here in the manufacture of cement comes from the company's Cave-in-Rock Quarry located about 65 miles upstream along the Ohio River shore above the town of Cave-in-Rock. Nearly 3,000 tons of stone per day have been produced by this quarry, whose capacity, of course, will be increased when the new kiln becomes operational. Company-owned barges towed by commercial tugs ply the river between quarry and plant, bringing in raw materials--limestone and sandstone--for the cement-making operation. In addition, coal and gypsum are brought in by rail, and fly ash is piped in from the nearby Joppa Steam Electric Station.

CONTINUE AHEAD (west).

0.15 10.9 CAUTION: T-road intersection and entrance on left to Missouri Portland Cement Company plant. TURN RIGHT (north) on Massac 300E.

0.65 11.55 View to south. From the crest of this roadcut there is an excellent view back toward the cement plant. The silos to the right are at the feed end of the rotary kiln, the long, narrow structure sloping from right to left. The raw materials are roasted, or burned, to form a clinker in this kiln and are discharged from the left end. The clinker is later ground into the fine cement we are all familiar with. The long, flat-topped, shed-like building at the left end of the kiln houses raw materials and some slinker before it is ground up.

CONTINUE AHEAD (north).

0.35 11.9 STOP—1-way. T-road intersection. TURN LEFT (west) on Massac 1100N. NOTE: to the west, this blacktop road will change its number designation several times. Since the area is laid out on a grid system, the road will assume the number of the grid line that is closest to it. Stay on the main road until instructed to do otherwise!
1.05 12.95 T-road from right (Boaz Road). CONTINUE AHEAD (northwest) on Massac 1125N.

1.55 14.5 View to north-northwest (upper right) just before descending hill. The lowland is the Cache River-Bay Creek Valley, which will be discussed at a later stop.

0.3 14.8 The Mounds ("Lafayette") Gravel is exposed along the inside of this curve.

0.1 14.9 Enter Pulaski County.

0.55 15.45 Stop 1. Pleistocene and Pliocene deposits in abandoned gravel pit (ESSE, Sec. 1, T. 15 S., R. 2 E., Pulaski County, La Center 15' Quadrangle).

CENOZOIC ERA
Quaternary System
Pleistocene Series
Wisconsinan Stage
Woodfordian Substage and later
Peoria Loess

Loess, light brown with some mottling along vertical joints and close to roots, fine-grained, non-calcareous; stands vertically and weathers to a miniature "Badlands" type of topography; Modern Soil developed in top; grades downward into...

Silt, similar to above but darker; almost chocolate color when moist, non-calcareous, fairly hard; contains scattered, small pebbles like those below. The material in this unit may have been deposited in one of three ways: (1) as water-laid silts, hence the scattered pebbles; however, bedding structures are not now readily apparent; (2) as loess that later was reworked by water and as a result incorporated the pebbles from below; or (3) as loess in which the pebbles migrated upward because of frost action when moisture and temperature conditions were optimum before the loess thickness became great.

Tertiary-Quaternary Systems
Pliocene-Pleistocene Series
Mounds ("Lafayette") Gravel Formation

Gravel, primarily composed of sub-angular to rounded, yellow-brown and red-brown chert pebbles up to 4" across interbedded with thin irregular zones of sand and clayey silt up to 8" thick; non-calcareous throughout; some irregular limonite-cemented zones 1' - 2' thick in upper part of exposure; base not exposed because of slumping.

The Mounds Gravel is an alluvial deposit laid down by a system of braided streams. Typically it consists of stratified sands and chert gravels locally cemented by limonite and hematite, which give the formation a distinctive brown or reddish-brown color. The color of the chert pebbles is a surface coloration. The coarseness of the gravel indicates that the streams which transported and deposited it must have been quite swift. The fairly high degree of abrasion and rounding of the gravel may indicate long transport from distant sources. There is the
possibility that the pebbles were carried by streams that drained the eastern Appalachian highlands.

Another possibility is that the pebbles were derived from deeply weathered deposits of relatively nearby cherty limestones and carried only short distances by a shorter braided stream system. Locally some of the gravel pebbles resemble pebbles derived from nearby tripoli deposits.

The Mounds Gravel has a maximum thickness of about 50 feet in southern Illinois. In the field trip area, immediately south of the Cache Valley, it is commonly 20 to 30 feet thick; but north of the valley, it occurs only as thin erosional remnants on the tops of a few ridges. The Mounds Gravel or its stratigraphic equivalents occur as a sheet-like deposit over a wide area of the Midwest in parts of Illinois, Indiana, Kentucky, Tennessee, and Missouri. In the Embayment region it unconformably overlies marine sediments of early Tertiary and late Cretaceous ages.

Throughout the field trip area, numerous gravel pits have been opened in these deposits around the higher hilltops in order to obtain gravel for drives and country roads. Because of its high chert content, however, the gravel is unsuitable for use as a concrete aggregate.

0.0 15.45 Leave Stop 1. CONTINUE AHEAD (west).

0.2 15.65 Before descending hill, note view, slightly to left, of Ohio River and low hills along the north shore.

1.05 16.7 Stop 2. Post Creek Cutoff (W½ SE½ SE½ NW¼ Sec. 2, T. 15 S., R. 2 E., Pulaski County, La Center 15' Quadrangle).

CAUTION: 1) Park well off the roadway.
2) Be careful of oncoming traffic when leaving your car.
3) Descend only along the path on the east side of the stream on the south side of the highway.
4) Do NOT throw rocks, stones, etc.

The Cache Valley in its primitive state was only sluggishly drained by the Cache River and Bay Creek. The valley had a low gradient and was easily flooded—not so much by the overflow of the Ohio River as by the high waters of the small streams entering it which could not drain from the valley quickly. There were numerous ponds, sloughs, and swamps along the length of the Cache Valley, and flooded bottomlands were likely to be under water for months.
Wetlands, and the consequent malaria and bad water, kept people from farming much of the valley bottomlands until this century. Intensive lumbering in the 19th century, which cut the marvelous stands of timber out of the valley, and the large drainage projects begun after 1900 finally brought the Cache Valley under general cultivation.

The Post Creek Cutoff - The Post Creek Cutoff is a ditch and deepened stream drawing high water from the Cache River into the Ohio River (see the itinerary map). This part of the cutoff, the lower part, which goes through the hills separating the Ohio and Cache Valleys, follows the original course of Post Creek. The greater part of its length to the north is a ditch that enters the Cache River east of Karnak. Evidently, the ditch cut through and drained a large pond—Swan Pond—that occupied the bottom a mile southeast of Karnak (Worthen, V.I). Construction of the Post Creek Cutoff began in 1912. It was one of the first of a number of drainage improvement projects carried on in the Cache Valley by organized drainage districts which were funded and coordinated by state and federal agencies. Apparently the cutoff was enlarged sometime after 1921 (Pickels and Leonard, 1921).

Geology - The excavation that enlarged the Post Creek Cutoff through the hills exposed the layers of sediment and rock shown in figure 5, a geologic section along the east side of the cutoff. An arrow at the top of the section shows where the Grand Chain-Joppa Road crosses it and, therefore, the point at which we walk down into the cut. The following description of the units shown in the section is modified from ISGS Circular 332 (Pryor and Ross, 1962). The thicknesses given here apply to that part of the section between points one hundred yards north and one hundred yards south of the bridge.

Quaternary System

Pleistocene Series

Peoria Loess ........................................ 6'±

Equality Formation - sands, silts, clays (valley fill material). ........................................ 20'±

Tertiary - Quaternary Systems

Pliocene-Pleistocene Series

Mounds Gravel Formation - gravel, brown; chert pebbles, with sand lenses up to 5' thick north of bridge; thins to south ........................................ 5'–18'±

Cretaceous System

Gulfian Series

McNaury Formation - sand, white to gray, well-sorted, very micaceous; silty clay laminae near base; well cross-stratified; sharp contact with underlying unit ........................................ 9'–20'±

Tuscaloosa Formation - gravel, white to light gray; pebbles and cobbles range from ½" to 20" in diameter, but dominant size is 1" to 3"; pebbles and cobbles angular to subrounded, composed of light gray fossiliferous chert and dense black chert. Matrix light gray to white, compact to soft fine-grained silica and/or clay ........................................ 6"±

Little Bear Soil - iron oxide, yellow-brown to vermillion, interlaminated with light gray, greasy, carbonaceous clay; contains silicified remains of bryozoans and crinoids. The iron oxides (goethite, lepidochrosite, and hematite) are vesicular and in convolute beds. Grades downward into red to reddish brown clay, very greasy, poorly laminated near bottom, with silicified bryozoan remains. Sharp contact with underlying limestone ........................................ 2'±
Mississippian System
Valmeyeran Series
St. Louis Limestone - light gray, fossiliferous (silicified); several thin shale beds; numerous large black chert nodules. Upper surface extremely irregular.

Creek level

The St. Louis Limestone is well exposed in the bottom of the cut, on the south side of the bridge. The creek falls over the outcrop. The St. Louis Limestone is the oldest rock unit we will see on the field trip (see fig. 3).

The Little Bear Soil, found on top of the limestone, contains large, heavy lumps of iron ore that resemble bubbly rust-red-and-brown slag. The iron oxides and clays that make up the Little Bear Soil are what remains of the St. Louis Limestone and other Paleozoic carbonate strata that were exposed to weather and changed into soil before they were buried by Cretaceous sediments. Limestones typically contain small amounts of iron and clay. When the calcite which makes up most of a limestone is dissolved and carried away by ground water charged with carbon dioxide, the insoluble iron compounds and clays may remain in place. If the clay and iron residues are not eroded, they accumulate on the land surface. Red soils formed in this manner are found in many parts of the world. The Little Bear Soil is a "fossil" soil formed before Cretaceous time, perhaps more than 130 million years ago.

0.0 16.7 Leave Stop 2. CONTINUE AHEAD (west).

0.16 16.85 For the next 0.4 mile notice the drainage lines to the right. Observe how steep-sided the tributary gullies are in this area. The Post Creek Cutoff has established the local base level to which the tributaries are attempting to lower their own slopes. The result is that, with such steeply sloped bottoms, or gradients, the streams downcut much more rapidly than they cut laterally. Given enough time and a minimum of correction by man, these small streams could effectively lower the entire area to the north some 30 to 40 feet.

0.55 17.4 Mounds ("Lafayette") Gravel is exposed along the inside (right) of this road curve.

0.35 17.75 Ohio Chapel Methodist Church to right.

0.3 18.05 Prepare to turn right.

0.1 18.15 T-road intersection. TURN RIGHT (north) onto narrow gravel road.

0.6 18.75 T-road intersection. TURN LEFT (north).

0.5 19.25 T-road intersection. TURN RIGHT (east).

0.65 19.9 T-road intersection. TURN LEFT (north).

2.2 22.1 CAUTION. Enter southeast edge of Karnak.

0.1 22.2 STOP - 1-way. Intersection with Illinois Route 169. TURN RIGHT (east) on Route 169 and leave Karnak.

0.7 22.9 Cross Post Creek Cutoff.

1.35 24.25 Enter Massac County. Note the flat, even bottom of the alluvium-filled backwater areas of the Cache Valley in this vicinity.
1.4 25.65  CAUTION.  Boaz crossroad. CONTINUE AHEAD (east) on Route 169.

2.2 27.85  Less than 3.5 miles north of this locality, a gas test well is being drilled by the Texas Pacific Company to the Precambrian granitic rocks at an anticipated depth of approximately 13,000 feet. As the drill site is considerably south of known oil production in the Illinois Basin, there is little expectation of striking oil here. However, it is hoped that commercial quantities of gas will be found.

0.1 27.95  CAUTION.  Railroad crossing (BN).

0.05 28.0  STOP - 1-way. Intersection with U.S. Route 45. TURN RIGHT (southeast) on Route 45.

0.3 28.3  Prepare to stop along the right shoulder of the highway.

0.1 28.4  Stop 3. Valmeyeran (Mississippian) rocks exposed in the Mermet Quarry of the Columbia Quarry Company (ESE NE, Sec. 22, T. 14 S., R. 3 E., Massac County, Vienna 15' Quadrangle).

USE EXTREME CAUTION IN THIS AREA. Enter through gate ONLY. At the scalehouse, get permission to visit the quarry.

NOTE: 1) Do NOT go down into the pit.
2) Do NOT throw rocks, stones, etc.
3) STAY AWAY from the edge--the limestone can be seen along the east end of the pit on the upper level.

The limestones quarried here are the St. Louis Limestone and the overlying Ste. Genevieve Limestone of the Valmeyeran Series. The Ste. Genevieve conformably overlies the St. Louis and attains a maximum thickness of about 200 feet in the field trip area; it consists largely of massive, fine-grained, gray limestone of very high purity. Some zones are cherty, and there are a few beds of cross-bedded, oolitic calcarenite. Some beds are almost white and consist entirely of oolites. The presence of oolites indicates bottom conditions of high energy when they were formed; i.e., bottom sediments were winnowed back and forth by wave action, indicating that the sea must have been quite shallow at times. A high-energy bottom is further attested to by the fact that although the limestone is fossiliferous, most of the fossils are broken. The St. Louis Limestone now lies below water level in the pit, but some 12 feet or so were quarried in the past.

The upper surface of the Ste. Genevieve Limestone is very irregular because of solution by percolating waters during the process of weathering. The enlargement of joints by percolating ground water has produced solution cavities, some of which extend downward to form small caves. USE CAUTION NEAR THEM SO THAT YOU DON'T SLIDE INTO ONE OF THEM.

Immediately overlying the limestone is a clayey chert residuum, which is as much as 5 to 6 feet thick in the solution cavities. Above the cherty residuum is a thin layer of intense red, hematitic clay with brown and black limonite nodules. This red zone is the Little Bear Soil, an ancient residual soil formed on the Paleozoic rocks and later buried by Cretaceous and Tertiary sediments. Isolated remnants of this weathered zone, as thick as 7 feet occur beneath these sediments throughout the middle Mississippi Valley. Above the soil here are several feet of red and yellow Cretaceous sand and clay and of Pleistocene (?) cherty colluvium and loess.
From the top of the spoil pile on the north side of the pit, there is a good view of the Cache Valley. A few moments spent here observing this view and reading the discussion for the last stop will be beneficial. The last stop on the trip occurs in the Cache Valley several miles east of here and is a short distance from the east end of the valley.

0.0 28.4 Leave Stop 3. CONTINUE AHEAD (southeast).

1.0 29.4 CAUTION. Enter village of Mermet. CONTINUE AHEAD (south-southeast) on U.S. 45.

0.25 29.65 Leave Mermet.

5.6 35.25 CAUTION. Joppa Road intersection. CONTINUE AHEAD (southeast).

3.3 38.55 CAUTION. Enter Metropolis.

1.35 39.9 CAUTION. Stoplight (Market Street). CONTINUE AHEAD (southeast) on Tenth Street and U.S. 45.

0.05 39.95 STOP - 4-way. Intersection with Ferry Street. TURN RIGHT (southwest) on U.S. 45 and Ferry Street.

0.35 40.3 STOP - 4-way (Fifth Street). TURN LEFT (southeast) on Fifth Street and U.S. 45.

0.7 41.0 CAUTION. Railroad crossing (ICG).

0.35 41.35 CAUTION. Southwest entrance to Massac State Park. CONTINUE AHEAD (northward) on U.S. 45 around the curve. The pavement narrows.

0.2 41.55 TURN RIGHT (east) at Fort Massac State Park entrance. Follow directions for parking.

Stop 4. Lunch and visit to Fort Massac restoration (SE\%SE\%SE\% Sec. 1 and E\%E\%NE\% Sec. 12, T. 16 S., R. 4 E., Massac County, Paducah 15' Quadrangle).

Fort Massac, Illinois' first state park, was purchased in 1903. It is one of 5 former French forts that are in our state park system. Since this is a strategic site on the Ohio River, it is thought that the Indians may have had fortifications here. According to tradition, De Soto's Spaniards protected themselves from Indians here as early as 1654. Although the French first used the site for a trading post in 1702, it was not extensively fortified by them until 1757. This fort, which was under the control of Fort de Chartres, was the last of the Ohio forts built by the French, who used it until they surrendered the territory to the British. However, the British did not use the fort, and it was not occupied again until 1794, when President George Washington ordered it rebuilt and manned in order to keep the settlers from siding with the Spaniards against the French. The fort was abandoned and never used again after 1814 because the frontier had moved far westward and the fort was no longer needed to protect the settlers.

Below the fort is an interesting geologic section that is visible during times of low-water levels on the Ohio. From the top downward the section shows:
Wisconsinan silty terrace deposits

Pliocene-Pleistocene chert gravel (Mounds Formation)

Cretaceous sands (McNairy Formation)

Although the McNairy sand is faulted, the overlying cemented chert gravel is not.

0.0 41.55 Leave Stop 4. RETURN TO PARK ENTRANCE and pick up new mileage figure. TURN RIGHT (North) on U.S. 45.

0.2 41.75 CAUTION. Railroad crossing (IGC). CONTINUE AHEAD (north).

0.55 42.3 CAUTION. Narrow bridge across Massac Creek.

1.1 43.4 CAUTION. Approaching Interstate 24 junction. CONTINUE AHEAD (east) on U.S. 45.

0.45 43.85 Cross over I-24.

0.3 44.15 CAUTION. T-junction to left with Illinois Route 145. CONTINUE AHEAD (east) on U.S. 45.

0.5 44.65 Cross Fourmile Creek.

0.9 45.55 Here the itinerary traverses some of the upper terrace level deposits. Ahead the road dips down on to the lower terrace level, some 30 feet lower.

0.5 46.05 Here, before the curve, the itinerary crosses the lower terrace deposits. From this lower level observe the very uniform upper terrace upon which most of the homes and farm buildings in the area are situated.

0.25 46.3 Cross Sevenmile Creek.

0.65 46.95 Near the south end of the curve, the itinerary is again across upper terrace level deposits.

0.35 47.3 View to south of bridge to Paducah. Begin descent to lower terrace deposits.

1.1 48.4 Prepare to turn left.

0.1 48.5 CAUTION. Crossroad. TURN LEFT (east) on Unionville Road (Massac 400N).

0.4 48.9 STOP - 4-way (Massac 1700E). CONTINUE AHEAD (east).

0.1 49.0 Cross through levee gate.

1.15 50.15 Notice how flat the lower terrace surface is here. To the south streams with low gradients produce a very slightly undulating surface along the outer portions of the terrace.

2.95 53.1 STOP - 4-way. Village of Unionville. CONTINUE AHEAD (east) on Massac 360N. The itinerary here is along a portion of the upper terrace surface.
0.25 53.35 View to right. The trees in the distance are along the outer slopes of the lower terrace and on the floodplain of the Ohio River. The floodplain, called the "Black Bottom," is subject to flooding, especially during the spring.

0.8 54.15 To the left is a small gravel pit in lower terrace deposits.

2.05 56.2 Enter Pope County.

2.35 58.55 CAUTION. Enter village of New Liberty. TURN HARD LEFT (northwest) at U.S. Post Office.

1.1 59.65 To the right, upper terrace deposits are exposed in the denuded banks of a farm pond.

1.75 61.4 Roadcut to the left exposes the Bethel Sandstone Formation, the lowest Chesterian (upper Mississippian) strata observed in the field trip area. A small fault 0.5 mile to the northeast brings the older Ste. Genevieve Limestone up alongside the Bethel Sandstone. The projected trace of this fault intersects the itinerary between 0.1 and 0.15 mile south of the roadcut.

0.25 61.65 A fault crosses the itinerary just to the south of this exposure, but grading and vegetation have obscured the stratigraphic relationships.

0.4 62.05 Just north of the farmhouse on the east side of the road are large blocks of Mississippian limestone that have been identified as belonging to the Golconda Group.

0.7 62.75 The roadcut to the left and the ditch to the right expose portions of the Chesterian Cypress Sandstone Formation.

0.3 63.05 The ditch to the left contains a higher part of the Cypress Sandstone than noted previously. This portion includes a zone of shale-pebble conglomerate impressions from which most of the shale has been eroded. A zone in which plant impressions occur is near the conglomeratic zone. This exposure lies close to the mapped contact (Circular 360, Ross, 1964) between the Cypress Sandstone (Mississippian) and the overlying McNairy Sandstone (Cretaceous). The materials exposed along this ditch, however, do not appear to be significantly different from bottom to top; therefore, the contact as mapped is questionable.

0.35 63.4 View to right (east-northeast) across Ohio River Valley.

0.3 63.7 The farm pond to the right (north) has a pronounced red zone part way up the bare west-facing slope. This red zone is the Little Bear Soil.

0.5 64.2 Stop 5. Chesterian Sandstone (Mississippian) exposed in east side of roadcut (SW1/4SE1/4 and W1/4NW1/4 Sec. 19, T. 15 S., R. 7 E., Pope County, Smithland 15' Quadrangle).

Bedrock strata exposed in this roadcut appear to be on the flanks of a small anticline that is plunging toward the southwest. The beds themselves at this location show a dip to the south-southwest.
LOESS

LITTLE BEAR SOIL (?)
Shale, gray with pronounced yellow- and red-brown staining on bedding surfaces; some thin sandstone interbeds

Sandstone, fine-grained, gray to light brown with yellow and red surface cast, beds up to 10" or more thick, highly jointed and contorted; contains some shale-pebble conglomerate and some small fucoid markings; contains some thin silty shale interbeds

Shale, gray, fissile, with discontinuous iron lenses

Sandstone, gray and yellow-brown, fine-grained, hard, highly jointed, iron-stained; shale interbeds

Shale, gray, fissile, smooth, very finely micaceous; contains a few ferruginous silty layers near top

Sandstone, light brown to tan, fine-grained, sugary, thin- to thick-bedded; iron-stained surface; contains thin shale interbeds

Shale, drab to yellow-brown with some red-brown streaks, silty, finely micaceous; contains thin fine-grained sandstone lenses

Shale, olive gray mottled with darker gray, becomes lighter in color upward, thin-bedded, fissile, smooth

Shale, olive drab mottled with drab, blocky, smooth

Clay, yellow-brown, plastic when wet

Fig. 6 - Exposure of upper part of Ridenhower Formation and lower part of Cypress Formation.
Approximately 60 feet of the lower part of the Cypress Sandstone Formation is exposed here. Where the whole sequence of Cypress strata is found in this region, the thickness is about 110 feet. In some areas the lower part of the Cypress is described as being a massive sandstone unit. The massive sandstone may represent a channel phase of development, because thick sands are more commonly found in the distributary channels of deltas rather than in the interstream areas. Since this location shows a considerable number of thick shale interbeds, it appears that this exposure represents deposition in an interstream mud tidal flat in which sands occasionally were swept out from the channels across the mud flat. The lower contact of the Cypress is irregular, indicating that it was deposited across the uneven eroded surface of the underlying Ridenhower Formation.

The Reelsville Member of the Ridenhower Formation is the only part of the formation exposed in this roadcut. This limestone is thick-bedded to massive and fine to medium grained and contains numerous fossils.

0.0 64.2 Leave Stop 5. CONTINUE AHEAD (north).

0.95 65.15 View to the left (south) across the field shows sandstone exposed in newly forming gullies. There is not very much surface material above bedrock here.

0.55 65.7 Cypress Sandstone is exposed in this roadcut. Incipient bedding structures are being etched out in the weathering process; thus the exposure is more thinly bedded than it might appear on a fresh surface.

1.05 66.75 Mounds ("Lafayette") Gravel exposed in roadcut to left.

0.3 67.05 Cypress Sandstone in roadcut to left.

0.1 67.15 Mounds Gravel working gravel pit to the left (northwest).

0.1 67.25 To the right (east and southeast) is a good view from the high area near the house of the Ohio River Valley and surrounding uplands.

1.1 68.35 CAUTION. Begin to descend hill and prepare to stop.

0.1 68.45 Stop 6. Middle and upper parts of Cypress Sandstone exposed in new roadcut (N\textsuperscript{\textdegree}SW\textdegree}NE\textdegree, S\textsuperscript{\textdegree}NW\textdegree}NE\textdegree, & SE\textsuperscript{\textdegree}NE\textdegree}NW\textdegree} Sec. 1, T. 15 S., R. 6 E., Pope County, Paducah and Smithland 15" Quadrangles).

USE EXTREME CAUTION. KEEP OFF THE ROAD--visibility is poor for oncoming traffic.

Charles A. Ross (1964) has identified the sandstone and shale beds exposed along the road as the middle and upper parts of the Cypress Sandstone Formation. The Cypress is one of the formations in the Chesterian Series of the Mississippian System--its stratigraphic relation to the other Chesterian units is illustrated by figure 4. Figure 7 is a drawing of this outcrop.

The sandstone and shale beds in the outcrop were deposited between about 325 million and 320 million years ago. The composition of the rocks and the features that they contain indicate that they formed from mud and sand deposited by streams. In sand deposits, different kinds of water flows leave different thicknesses and inclinations of bedding and different kinds of current markings--scour marks, tool marks, ripple marks, and other features.
Loess

Sandstone, 25'+

Light red and gray shale, 14'

Interbedded shale and very fine sandstone, 18'

Covered, 8'

Gray and red sandstone, 2'

Covered, 20'

Light gray, very fine, silty sandstone, 3'

Covered, 40'-45'

Sandstone and siltstone, 15'+

The kinds of animal remains and markings found in the rocks also indicate in what kind of place the sediments were deposited. In addition, the size of the sediment grains indicates how strongly the flow was moving. The composition of the grains in a rock can tell where the particles came from and how they were made.

Studies of the features and characteristics of the Cypress Sandstone and other Chesterian sandstone units have led geologists to several conclusions about their origins. It is thought that the sands and muds in the sandstones and shales were eroded from the northeastern part of the Canadian Shield, the part of the Shield that contains the Province of Quebec. (The Canadian Shield is the large area north of the St. Lawrence River and the Great Lakes where Precambrian rock is exposed at the surface.) The sand and mud from the northeastern Canadian Shield were brought here by a large river that flowed southwestward from the Quebec area into the Illinois Basin. At that time much of the Illinois Basin area was covered by a shallow sea. The Cypress and the other Chesterian sand and mud units were laid down in deltas that the rivers built out into the sea. (For a more complete explanation, see the section titled "Mississippian Deposition" in the back of this leaflet.)

Fig. 7 - Outcrop of Cypress Sandstone in the roadcut just south of Bay City. Section extends north and west from the top of the hill toward the base of the hill.

The Cypress Sandstone often contains petroleum and is the most productive unit in the Illinois Basin. Henry Englemann named the sandstone in 1863 for Cypress Creek in Union County, Illinois, where he found and studied the formation in the bluffs along the creek.

0.0 68.45 Leave Stop 6. CONTINUE AHEAD (north and west) down hill.

0.3 68.75 T-road intersection. BEAR RIGHT (north and then northeast) to Bay City.

0.1 68.85 Glen Dean Limestone Formation exposed in roadcut to right. Faulting in this area has brought the limestone down to a lower elevation than that of the Cypress, which occurs below it stratigraphically.

0.2 69.05 Stop 7. Exposure of Hardinsburg, Glen Dean, and Tar Springs Formations in Ohio River bluff (SW\(^\frac{1}{2}\) SE\(^\frac{1}{2}\) Sec. 36, T. 14 S., R. 6 E., Pope County, Smithland and Golconda 15' Quadrangles).
Fig. 8 - Chesterian strata exposed along the Ohio River bluff at Bay City.

CAUTION NOTES: 1) Park as far off the blacktop as possible.

2) Do NOT block driveways or boat ramp approach.

3) Watch for approaching traffic.

4) Do NOT throw rocks, etc.

5) Walk down boat ramp to river's edge, where the discussion will be held.

Figure 8 is a generalized section of the strata exposed at this stop. The upper part of the Hardinsburg Sandstone Formation is exposed along the Ohio River shore. This formation is the thickest Chesterian formation in the field trip area; it attains a thickness of nearly 250 feet in a well a few miles away. The Hardinsburg Sandstone can be traced across most of southern Illinois and eastward into southwestern Indiana and northwestern Kentucky. Normally in this area its thickness ranges from about 90 to 110 feet. The formation thins to the west and southwest and grades into a shale in Union County. This sandstone was deposited in a shallow marine environment by distributaries of a delta that was advancing, or growing, seaward, much like the present-day Mississippi River delta. The sand was reworked by
waves and spread as a thin sheet over the shallow sea floor in front of the advancing delta. A branching network of the ancient distributary channels is preserved in the Hardinsburg. Some of these channels were even cut downward into the underlying Haney Limestone Formation of the Golconda Group. Within the deeper channels, the Hardinsburg attains its greatest thicknesses. These channel sands bifurcate, or branch, toward the southwest, indicating that that was the direction of current flow. Cross-bedding in the sandstone also exhibits preferred orientation toward the southwest.

Depositional conditions were different when the overlying Glen Dean Limestone Formation was deposited. The seas were still relatively shallow as indicated by the broken fossils and oolites that are present—wave action formed the oolites but broke the fossils. Although the limestone contains shale interbeds, the limestone itself is not shaly. In this part of the basin, at least, little sand was being washed in. The muds that accumulated appear to have done so rather slowly, as delicate fossil remains have been found at several horizons—fenestrate bryozoans are preserved along bedding surfaces. The Glen Dean is the most highly fossiliferous formation encountered on the field trip. Fossils from the Glen Dean include:

<table>
<thead>
<tr>
<th>Brachiopods</th>
<th>Composita trinuclea</th>
<th>Productus ovatus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Productus inflatus</td>
<td>Reticularia setigera</td>
</tr>
<tr>
<td>Bryozoans</td>
<td>Prismopora serrulata</td>
<td>Archimedes laxus</td>
</tr>
<tr>
<td>Echinoderms</td>
<td>Pterotocrinus bifurcatus</td>
<td>Pentremites brevis</td>
</tr>
<tr>
<td></td>
<td>Pterotocrinus acutus</td>
<td></td>
</tr>
</tbody>
</table>

The Tar Springs Sandstone Formation in Illinois consists of alternating buff sandstones and varicolored siltstones and shales. The formation ranges from perhaps 80 to slightly more than 100 feet in this part of Illinois and thins to about 40 feet in the western part of the state. These sandstones are cross-bedded and exhibit other sedimentary structures, including ripple marks and flute casts, that are characteristic of sands deposited in deltas. Here the Tar Springs is a massive sandstone that is medium to coarse grained. There are no marine fossils, a condition which suggests rapid deposition under brackish conditions that were unfavorable for marine life.

0.0 69.05 Leave Stop 7. CONTINUE AHEAD (northwest).

0.95 70.0 Cross Barren Creek.

1.05 71.05 T-road intersection, TURN RIGHT (east) on the blacktop road toward Golconda.

0.75 71.8 Menard Limestone Formation exposed in roadcut to left. The following is a list of fossils common to the Menard Limestone:

<table>
<thead>
<tr>
<th>Pelecypods</th>
<th>Sulatopinna missouriensis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachiopods</td>
<td>Composita subquadraata</td>
</tr>
<tr>
<td>Bryozoans</td>
<td>Batostomella nitidula</td>
</tr>
<tr>
<td>Echinoderms</td>
<td>Pterotocrinus menardensis</td>
</tr>
<tr>
<td></td>
<td>Pentremites cherokeeus</td>
</tr>
</tbody>
</table>

0.4 72.2 Cross Bay Creek, the stream that drains the eastern part of the Cache River-Bay Creek Valley.
Stop 8. Discussion of the history of the Cache Valley drainage (SW cor. NW¼ SE¼ Sec. 15, T. 14 S., R. 6 E., Pope County, Brownfield 15' Quadrangle).

East from this stop are the hills of Kentucky beyond the Ohio River. Slightly to the east-northeast is the point of land, Ropers Landing, around which the river flowed when it occupied this valley. The higher parts of this valley are sand ridges formed as the water coursed westward through this area.

Ancient and Modern Drainage in the Midwest - The general pattern of drainage across Illinois and the Midwestern States was set millions of years ago (long before the Pleistocene glaciations), when the region became the lowland between the Appalachian and Rocky Mountains. For eons rivers from the north, east, and west have met in the low-lying Illinois region to flow southward to the sea. However, until near the end of the Pleistocene Epoch, only a few thousand years ago, the courses of many of the ancient large rivers in the Midwest did not follow present-day drainage lines. Figure 9a shows some of the river systems that existed before the last glaciation began. Not all of the streams shown existed at the same time.

The Pleistocene glaciations changed ancient drainage lines north of Missouri and Kentucky. One glacier after another diverted and buried river valleys and released immense quantities of meltwater which eroded new channels across the region. The last glaciation created the present-day drainage system, shown in figure 9b.

Figure 9a, which shows drainage that no longer exists, is based on a great deal of direct evidence. There are, for example, large valleys like the Cache which are too deep and wide to have been cut by the little streams they now contain and which were, in fact, made by large rivers diverted from them during the glaciations. More evidence comes from studies made of thousands of wells penetrating the thick deposits of mud, sand, and gravel covering the glaciated region. These show that the bedrock surface buried under river and glacier deposits is not smooth but is channeled by valleys covered over by the glaciers. Furthermore, it can be shown that parts of the modern Ohio, Mississippi, Missouri, and Illinois Rivers skirt the edges of glacial deposits—indicating that the streams developed these parts of their courses along the edges of glaciers. In other places the alignments of river and stream valleys and the deposits in the valleys identify them as channels cut by meltwaters draining from glaciers.

The Cache Valley - The origin of the Cache Valley has been a problem of interest to many geologists. Most have concluded that the valley served as the channel for the Ancient Ohio River before the river was diverted into the modern Ohio Valley.

Figure 10a shows the present drainage in the Metropolis field trip area. The location of the Cache Valley is shown on the figure by the lines representing the Cache River and Bay Creek, which flow through it. The Cache is a broad, flat-bottomed valley, ranging in width from 1½ to 4 miles, averaging about 3. The north valley walls are 150 to 250 feet high. Generally the valley follows the contact of the Cretaceous and Mississippian rocks (K and M on the geologic map in the appendix) across southern Illinois as far west as Cairo. Therefore, the north wall of the valley, which is cut in hard Paleozoic rock, is marked by cliffs and steep hills, whereas its south wall, cut through soft, unconsolidated Cretaceous and Tertiary sediments, is marked by gentler slopes.
Fig. 9a - Drainage systems developed before the last (Wisconsinan) glaciation.

Fig. 9b - The present drainage system.
Fig. 10a - Present drainage through the Cache, Mississippi, and Ohio valleys in southern Illinois.

Fig. 10b - Lines of drainage proposed to explain a Hamletsburg diversion of the Ancient Ohio River into the present course of the Ohio River.

Fig. 10c - Lines of drainage proposed to explain a Bay City diversion of the Ancient Ohio River into the present course of the Ohio River.
Bay Creek, in the east end of the Cache Valley, flows eastward into the Ohio River above Bay City. The Cache River flows west into the Ohio just above Cairo. Both streams are small and sluggish—the Cache Valley has very little slope and has been ditched in places. Seasonal floods from the Ohio back up into the Cache Valley and cover the floodplains of the streams in it. Hundred-year floods cover the slightly higher parts of the valley floor above these floodplains.

The Cache Valley Abandoned by the Ancient Ohio River - Most geologists believe that the Ohio River flowed through the Cache Valley until it was diverted sometime during the Pleistocene Epoch. They observe the cause of the diversion could have been the outwash and meltwater that filled the valley during times of glaciation and could have raised the river until it overtopped a low divide, ran into an adjacent river, and abandoned the Cache Valley. The various lines of evidence and reasoning used to support these conclusions are too complex to be reported in this space, but these general observations are involved in them:

1. The streams now in the Cache Valley and the present-day floods from the Ohio River could not have cut the Cache Valley. The streams are too small, high backwater floods are too infrequent, and both are too sluggish to cut a valley as deep and wide as the Cache.

2. The Cache Valley appears to be an extension of the Ohio Valley. It is connected to and in line with the Kentucky reach of the Ohio River above Bay City (see figure 10a) and is a more direct course westward than the present Ohio channel.

3. Valleys of the Ancient Cumberland and Ancient Tennessee Rivers and their tributaries could have served as channels for a diversion of the Ancient Ohio from the Cache Valley into the present Ohio Valley to the south.

4. The deep filling of stream-laid clay, silt, and sand beds in the large river valleys indicates enormous volumes of glacial meltwater and outwash that would have been sufficient to fill in the old channels and raise the rivers over low divides into their present courses. The floor of the Cache Valley, for instance, is filled in 140 to 180 feet above the original valley floor cut in bedrock.

The Hamletsburg Diversion - There are several theories that explain how the pre-modern Ohio River drainage in this area looked and how the Ohio came to occupy its present course. Most geologists have argued for a drainage pattern like that shown in figure 10b. They visualize the Ancient Cumberland River flowing northward to join the Ancient Ohio above Bay City at the east end of the Cache Valley. This theory considers the Ohio Valley between Bay City and Hamletsburg to have been the final reach of the Ancient Cumberland River. The Ancient Tennessee River followed its present course westward to Paducah, proceeding from there past Metropolis and Cairo in the valley now occupied by the Ohio River. The Ancient Ohio and Tennessee Rivers join the Ancient Mississippi south of Cairo.

According to this theory the modern drainage shown in figure 10a was established during a time of glaciation when the Ancient Ohio and Ancient Mississippi Valleys were brimming with glacial meltwater and sediments. High water in the Ancient Ohio Valley is thought to have backed up into the Cumberland Valley and spilled over a low divide (shown as —) at Hamletsburg into the Ancient Tennessee Valley. The Ohio then abandoned the Cache Valley and followed its present course.
The Mississippi, under the same conditions, established its modern course by overtopping the divide at Thebes and joining the Ohio just south of Cairo. Several workers have suggested that the diversions of the Ancient Mississippi and Ancient Ohio were caused by a particular high water episode called the Kankakee Flood. The Kankakee Flood occurred late in the Pleistocene Epoch, about 14,000 to 15,000 years ago, during the Woodfordian glaciation.

One geologist (Ross, 1964) has suggested that the diversion across the divide at Hamletsburg could have been accomplished by faulting that lowered the divide. The region contains many faults, and some of those near the supposed diversion are parallel to the valley there.

The Bay City Diversion - Figure 10c shows the reconstruction of ancient drainage suggested by Leland Horberg (1950). He theorized that only the Ancient Ohio flowed through the Cache Valley—the Cumberland, he believed, joined the Tennessee near Paducah and the Tennessee flowed on in the present Ohio Valley west of Paducah.

According to Horberg's idea, the modern drainage was established in the latter half of the Pleistocene Epoch when glacial outwash filled the lower Ancient Ohio and Mississippi Valleys and meltwater floods overtopped a drainage divide at Bay City, enabling the Ohio to flow southward into the Cumberland near Hamletsburg.

Other Theories - Other suggestions have been advanced to explain the existence of the Cache Valley. H. N. Fisk (Alexander and Prior, 1968) proposed that both the Ancient Tennessee and Cumberland Rivers flowed northwest and joined the Ancient Ohio at the entrance to the Cache Valley. He thought that floods of the Tennessee cut a gap in a divide at Metropolis and fell into a west-flowing tributary of the Ancient Ohio. This diversion, he believed, created the Ohio Valley between Paducah and a point below Cairo.

Several workers have suggested that after the Ohio had established its modern course from Bay City to Cairo, it continued to flow for a time through the Cache Valley. Similarly, Alexander and Prior (1968) have visualized the Ohio flowing in both the Cache Valley and its present valley past Metropolis, but argue that the Ancient Ohio did not persistently occupy the Cache Valley. They believe that the Cache Valley was just a spillway for high levels of meltwater from the Ohio near the end of the Wisconsinan glaciation. The ancestral Bay Creek and Cache River, they believe, cut the Cache Valley, which was later eroded by the Ohio's meltwater.

Some of the evidence needed to settle points in dispute is missing or equivocal, and so questions remain to be answered about the origin of the Cache Valley. At present, however, geologists at the Survey who have worked with the problem support the view represented by figure 10b, the Hamletsburg Diversion.

END OF FIELD TRIP—HAVE A SAFE JOURNEY HOME!
References


PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, the period of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. Ice sheets formed in sub-arctic regions four different times and spread outward until they covered the northern parts of Europe and North America. In North America the four glaciations, in order of occurrence from the oldest to the youngest, are called the Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. 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 during periods 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 cooler periods 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 probably enough to lower sea level more than 300 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 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 unstratified (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.

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.

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. Cone-shaped mounds of coarse outwash, called kames, were formed where meltwater plunged through crevasses in the ice or into ponds along the edge of 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 quickly lost speed and almost immediately dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were moved across 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 trains may be both extensive and thick deposits. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess 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 such deposits of windblown silt and clay. The silt was blown from the valley trains on the floodplains. Most loess deposition occurred in the fall and winter seasons when 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 those that survive serve as keys to the identity of the beds 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 as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.
1. The Region Before Glaciation - Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks--layers of sandstone, limestone, and shale. Millions of years of erosion have planed down the bedrock, 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 spreads out from its snowfield, it scours the soil and rock surface and quarries--pushes and plucks up--chunks of bedrock. These materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow, the ice "current" slides up over the blocked ice on innumerable shear planes. Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" 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 some old valleys before the ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain. The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, except near its margin. Its ice front advances perhaps as much as a third of a mile per year.
3. The Glacier Deposits an End Moraine - After the glacier advanced across the area, the climate warmed and the ice began to melt as fast as it advanced. 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 was 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 superglacial 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) was left 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) remained a low spot in the terrain. As soon as its ice cover melted, meltwater drained down the valley, cutting it deeper. Later, outwash partly refilled 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.

4. The Region after Glaciation - The climate has warmed even more, the whole ice sheet has melted, and the glaciation has ended. 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.

Slopeswash 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

<table>
<thead>
<tr>
<th>STAGE</th>
<th>SUBSTAGE</th>
<th>NATURE OF DEPOSITS</th>
<th>SPECIAL FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HOLOCENE</strong></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>7,000</td>
<td>Soil, youthful profile of weathering, lake and river deposits, dunes, peat</td>
<td></td>
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<tr>
<td></td>
<td>Valderan</td>
<td>Outwash, lake deposits</td>
<td>Outwash along Mississippi Valley</td>
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<tr>
<td></td>
<td>11,000</td>
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<tr>
<td></td>
<td>Twocreekan</td>
<td>Peat and alluvium</td>
<td>Ice withdrawal, erosion</td>
</tr>
<tr>
<td></td>
<td>12,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WISCONSINAN</strong></td>
<td>Woodfordian</td>
<td>Drift, loess, dunes, lake deposits</td>
<td>Glacieration; building of many moraines as far south as Shelbyville; extensive</td>
</tr>
<tr>
<td>(4th glacial)</td>
<td>22,000</td>
<td></td>
<td>valley trains, outwash plains, and lakes</td>
</tr>
<tr>
<td></td>
<td>Farmdalian</td>
<td>Soil, silt, and peat</td>
<td>Ice withdrawal, weathering, and erosion</td>
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<td>28,000</td>
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<tr>
<td></td>
<td>Altonian</td>
<td>Drift, loess</td>
<td>Glacieration in northern Illinois, valley trains along major rivers</td>
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<td>75,000</td>
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<tr>
<td><strong>SANGAMONIAN</strong></td>
<td>175,000</td>
<td>Soil, mature profile of weathering</td>
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<tr>
<td>(3rd interglacial)</td>
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<tr>
<td></td>
<td>Jubileean</td>
<td>Drift, loess</td>
<td>Glaciers from northeast at maximum reached Mississippi River and nearly to southern</td>
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<tr>
<td></td>
<td>Monican</td>
<td></td>
<td>tip of Illinois</td>
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<td></td>
<td>Liman</td>
<td>Drift, loess</td>
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<tr>
<td></td>
<td>300,000</td>
<td>Soil, mature profile of weathering</td>
<td></td>
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<tr>
<td><strong>YARMOUTHIAN</strong></td>
<td>600,000</td>
<td></td>
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<tr>
<td>(2nd interglacial)</td>
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<tr>
<td></td>
<td>700,000</td>
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<tr>
<td><strong>KANSAN</strong></td>
<td>900,000</td>
<td>Soil, mature profile of weathering</td>
<td>Glaciers from northwest and northwest covered much of state</td>
</tr>
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<td>(2nd glacial)</td>
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<td>1,200,000 or</td>
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<td><strong>AFTONIAN</strong></td>
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<td>1,200,000 or</td>
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<tr>
<td><strong>NEBRASKAN</strong></td>
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<td>(1st glacial)</td>
<td>1,200,000 or</td>
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<td>or more</td>
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SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS

1. NEBRASKAN inferred glacial limit
2. AFTONIAN major drainage
3. KANSAN inferred glacial limits
4. YARMOUTHIAN major drainage

5. LIMAN glacial advance
6. MONICAN glacial advance
7. JUBILEEAN glacial advance
8. SANGAMONIAN major drainage

9. ALTONIAN glacial advance
10. WOODFORDIAN glacial advance
11. WOODFORDIAN Valparaiso ice and Kankakee Flood
12. VALDERAN drainage

(From Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)
GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

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.-p.2
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 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 terrigenous 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.

![Fig. 4 - Paleogeography at an intermediate stage during Chesterian sedimentation.](image-url)
GEOLOGIC MAP OF ILLINOIS
showing
BEDROCK BELOW
THE GLACIAL DRIFT
1970
(From Willman and Frye, 1970.)

Pleistocene and
Pliocene not shown

TERTIARY

CRETACEOUS

PENNYSYLVANIAN
Bond and Mattoon Formations
Includes narrow belts of older formations along La Salle Anticline

PENNYSYLVANIAN
Carbondale and Modesto Formations

PENNYSYLVANIAN
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 Complex - Ordovician to Pennsylvanian Fault
METROPOLIS
GEOLOGICAL SCIENCE FIELD TRIP
APRIL 19 and OCTOBER 25, 1975