GUIDE LEAFLET
GEOLOGICAL SCIENCE FIELD TRIP

CARROLLTON AREA

Greene, Jersey, and Counties
Roodhouse, Pearl, Hardin, and Jerseyville 15-Minute Quadrangles

David L. Reinertsen, Dwain J. Berggren, and Myrna M. Killey

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

April 24, 1976
September 18, 1976

Urbana 61801
Erratum: Add 1.0 mile to mileage figure 1.5 in the left-hand column. Also add 1.0 mile to mileage figure 2.8 in the right-hand column and to each succeeding cumulative mileage figure.
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
1. About 4.5 billion years ago: The Earth forms. The theoretical age obtained by analyzing radioactive elements in some meteorites dates the beginning of the geologic history of the Earth—and Illinois. Scientists theorize that the solar system (and the meteorites) formed when an interstellar cloud of dust and gas collapsed. As the cloud shrank and condensed, gaseous matter became liquid and then solid, dividing into bodies that became our sun and its satellites. On the earth, no rocks as old as the meteorites have been found.

2. About 1.5 to 1.2 billion years ago: The oldest rocks in Illinois form. Late in the Precambrian Era, molten rock from deep in the earth squeezed up into the outer crust in the region that includes Illinois and solidified to become the pink granites (\( \times \times \times \times \times \times \times \)) that have been found at the bottom of a few very deep wells. Radioactive elements in the rocks date them. The coarse-grained texture of these igneous rocks indicates that they cooled slowly under a thick cover of rock—very possibly under mountains. Granite intruded into the crust commonly forms the "roots" of mountains.

3. About 600 million years ago: The Illinois region begins to collect sediment. By this time, possibly 600 million to 900 million years of erosion had removed the rocks covering the Precambrian granite and left it exposed at the surface of a hilly terrain. Now, at the beginning of the Paleozoic Era, the earth's crust in the Illinois region began to sink very gradually. Although parts would rise and stay still, in general it would continue to sink—intermittently, slowly, and at different rates—until the end of the Paleozoic, more than 300 million years later. Much of the time the region was covered by shallow warm seas in which sediment collected. Mud and sand carried to them by rivers off the land became layers of shale and sandstone. Broken shell sediments and chalky muds that formed in the seas became limestone and dolomite beds.
4. About 400 million years ago: Reefs grow in a Silurian sea. About midway through the Paleozoic Era a shallow, warm sea covered the region. In it, generations of sea plants and animals, interlacing and cementing their skeletons and crusts together as they grew, built low platforms and mounds called "reefs." During this time and throughout the Paleozoic, different parts of the region were slowly warped up and eroded and then covered again by the sea. As a result, the Paleozoic rocks do not represent a continuous accumulation of sediment. As a record of geologic history, the rock layers in the region are like a book from which most of the pages have been randomly torn.

5. About 300 million years ago: Swamps and shallow seas alternately cover the region. In the latter part of the Paleozoic Era (late Mississippian and Pennsylvanian Periods) the Illinois region was still sinking, but in such a way that large parts of it were alternately covered by very shallow seas and swampy river deltas and floodplains lying just above sea level. Typically a cycle of deposition produced a set of marine limestone and mudstone layers and then buried it with a set of river-laid sandstones and mudstones. In the Pennsylvanian Period, peat beds accumulated in the dense swamp forests growing on the floodplains and were buried. These became Illinois' rich coal seams.

6. Between about 280 million years ago and 1 million years ago: The region is deeply eroded. Geologists who advocate the plate tectonics theory believe that early in this time interval a large block of the earth's continental crust began to pull apart--its fragments ultimately forming the present continents of North and South America, Africa, Europe, and Antarctica. Since sometime after the Pennsylvanian Period (near the end of the Paleozoic Era), most of the Illinois region remained above sea level. A thickness of as much as 5000 feet of rock may have been eroded away during this long interval, which includes the
Permian, Triassic, Jurassic, Cretaceous, and Tertiary Periods. Small gravel deposits in western Illinois and a belt of Cretaceous and Tertiary sands, clays, and gravels across the tip of southern Illinois are the only sediments representing this time in Illinois.

7. Between about 1 million years ago and the present: The region is glaciated during the Pleistocene Epoch. At least four times during the Pleistocene, the world climate cooled and ice sheets grew that covered Canada and northern parts of Europe. Glaciers from the Canadian ice sheets flowed into Illinois through the basins that now hold the Great Lakes. Ice, meltwater, and wind left deposits of loose sediment—silt, sand and gravel, sandy clay—over about 90% of the state. These deposits provide fertile, deep soils and abundant construction materials and water. The last glaciation ended about 7000 years ago and the time since, called the Holocene Stage, may be a warmer interval between glaciations.
INTRODUCTION

The Carrollton area is located near the east bluffs of the Illinois River in Greene County, western Illinois. Slow-moving continental ice sheets, called glaciers, flowed across all or parts of the area during the Kansan and Illinoian glaciations, the second and third glacial intervals of the Great Ice Age (NOTE Pleistocene appendix, blue pages of this leaflet). Deposits of the older, Kansan glacier, which covered parts of Illinois from about 700,000 until nearly 600,000 years ago, occur beneath the younger, Illinoian drift, but exposures are rare. The Kansan drift is thin and patchy in this area because of post-Kansan erosion. Illinoian drift, consisting of till and outwash deposited sometime between 300,000 and 175,000 years ago, occurs extensively over the bedrock surface throughout the area and is exposed at many places. The last glacier to invade Illinois, the Wisconsinan, stopped about 75 miles east-northeast of here. However, thick sand and gravel outwash deposited by meltwater streams from this glaciation are present in the Illinois Valley. Thick deposits of Wisconsinan loess, windblown silt that was derived from this outwash, mantle the bluffs of the Illinois Valley and the upland to the east, forming the surficial material throughout the area of the field trip.

Physiographically, the field trip area lies along the western edge of the region covered by the Illinoian ice. It occupies that portion of the Till Plains Section of the Central Lowland Province called the Springfield Plain (see attached map of Physiographic Divisions of Illinois). The present topography of this region is the result mainly of the deposition of drift by the Illinoian glacier, the erosional and stream dissection of these deposits during post-Illinoian time, the deposition of the thick Wisconsinan loess, and the subsequent erosion and stream dissection of all of these deposits during post-Wisconsinan time. The glacial deposits are fairly thick, ranging from 50 to 100 feet near the Illinois Valley bluffs, but thinning to about 25 feet, and occasionally even less, across the upland surface to the east. In the field trip area, irregularities in the bedrock surface generally do not strongly influence the topography. The undulating upland is well drained, as numerous valleys are cut deeply into the till plain surface. Remnants of the till plain are preserved as narrow, relatively flat to gently undulating interstream areas (see Itinerary Map). The Illinois Valley is the most prominent topographic feature in the field trip area: its broad, flat bottom sharply contrasts with the undulating upland terrain. The valley walls, which rise abruptly 100 to 200 feet above the floodplain, expose sheer limestone cliffs 40 to 60 feet high above which the upper slopes are formed by smoothly rounded thick glacial deposits.

The much older, consolidated bedrock that underlies the glacial deposits in the field trip area consists of approximately 3,600 feet of sedimentary strata (fig. 1). These strata consist mainly of sandstone, shale, limestone, and dolomite with minor amounts of clay and coal; they were deposited layer by layer in the ancient shallow seas that invaded the midcontinent region during the Paleozoic Era, between about 550 and 270 million years ago. The Paleozoic strata are divided into major subdivisions known as systems, each of which was deposited during a specified period of geologic time. The systems are in turn subdivided into many formations on the basis of mineral composition and fossil content. The uppermost 350 to 400 feet of these sedimentary strata, which include formations of the Pennsylvanian and Mississippian Systems, are exposed in the Carrollton area (fig. 2) (see attached Pennsylvanian and Mississippian supplements). Progressively older formations of Devonian, Silurian, Ordovician, and Cambrian ages are known from deep wells that penetrate them and from other areas of Illinois where they are exposed at the surface. The base of the Cambrian strata rests upon an ancient basement of Precambrian igneous and possibly metamorphic rocks that are more than 1 billion years old.
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<th>ERA</th>
<th>SYSTEM</th>
<th>SERIES</th>
<th>GROUP</th>
<th>FORMATION</th>
<th>THICKNESS</th>
<th>GRAPHIC COLUMN</th>
<th>DESCRIPTION</th>
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<tr>
<td>C. Q</td>
<td>Pleistocene</td>
<td>Kewanee</td>
<td>Warsaw Shale</td>
<td>30'</td>
<td>70'</td>
<td><strong>Loess &amp; drift</strong>&lt;br&gt;Shale, sandstone, coal, silts, silts, limestones.</td>
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<td>Burlington-Keokuk Limestone</td>
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<td><strong>Limestone &amp; chert</strong>&lt;br&gt;140'.</td>
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<td>Hannibal Shale &quot;Glen Park&quot; Limestone</td>
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<td><strong>Light to dark green shale</strong>&lt;br&gt;400'.</td>
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<td>Black &amp; gray shale</td>
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<td><strong>Dolomite &amp; limestone</strong>&lt;br&gt;642'.</td>
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<td><strong>Sandy dolomite</strong>&lt;br&gt;1200'.</td>
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<td>Very pure quartz sandstone</td>
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<td><strong>Sandy dolomite</strong>&lt;br&gt;1600'.</td>
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<td>Sandy dolomite with chert; th: sandstone and shale</td>
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<td><strong>Cherty dolomite</strong>&lt;br&gt;2000'.</td>
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<td>Very pure quartz sandstone</td>
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<td><strong>Cherty dolomite</strong>&lt;br&gt;2400'.</td>
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<td>Sandstone with sandy dolomite</td>
<td>110'</td>
<td>240'</td>
<td><strong>Browne to pinkish gray dolomite</strong>&lt;br&gt;2800'.</td>
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<td>Sandy dolomite</td>
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<td>300'</td>
<td><strong>Limestone, oolitic limestone, dolomite, sandstone, &amp; shale</strong>&lt;br&gt;3200'.</td>
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<td>Mt. Simon Ss.</td>
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<td><strong>Sandstone</strong>&lt;br&gt;3600'.</td>
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<td><strong>Limestone</strong>&lt;br&gt;5'.</td>
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<td><strong>Limestone</strong>&lt;br&gt;1'.</td>
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<td>Mt. Simon Ss.</td>
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Fig. 1 - Classification and description of sedimentary units in the Carrollton area. Interval between asterisks taken from Cities Service Production Co. Well, Gerson No. 1 (ISGS Greene Co. No. 162), Sec. 13, T. 10 N., R. 12 W. Lower units described in ISGS Bulletin 95 (Willman et al., 1975). C = Cenozoic; Q = Quaternary; P = Pennsylvanian.
PENNSYLVANIAN SYSTEM
- Carbondale Formation
- Spoon Formation

MISSISSIPPIAN SYSTEM
- Middle Valmeyeran Series (Warsaw Shale)
- Lower Valmeyeran Series (Burlington-Keokuk Limestone)
- Kinderhookian Series

DEVONIAN SYSTEM
- Upper Devonian Series
- Middle Devonian Series

SILURIAN SYSTEM

ORDOVICIAN SYSTEM
- Maquoketa Shale Group

Illinoian glacial boundary

MAP SCALE
0 2 4 6 8 10 miles
0 3.2 6.4 9.7 12.9 16.1 kilometers
Fig. 2 - Geologic map of the bedrock units in the Carrollton field trip area (adapted from Geologic Map of Illinois, Willman and others, 1967). Numbers refer to field trip stops.

Geologically, the Carrollton area is on the Western Shelf of the Illinois Basin, a large, spoon-shaped bedrock structure that underlies most of Illinois and adjacent parts of Indiana and Kentucky (figs. 3 and 4). In western Illinois the bedrock formations generally are tilted gently down to the east and southeast toward the deepest part of the Illinois Basin. In the field trip area, south and southwestward the bedrock formations rise toward the Cap au Grès Faulted Flexure in southern Jersey and Calhoun Counties; westward they rise onto the Mississippi River Arch, a broad bedrock uplift in extreme western Illinois; and northwestward they
rise onto the southeastward-plunging Pittsfield-Hadley Anticline, a relatively small structure located on the east flank of the Mississippi River Arch, in Pike County (fig. 4). As the Illinois Basin was forming during the Paleozoic Era, it was gradually filled with Paleozoic sedimentary rocks. Toward the deepest part of the basin, in extreme southeastern Illinois, the Paleozoic rocks thicken to more than 14,000 feet. Pennsylvanian rocks are the youngest Paleozoic strata in the basin and may represent the last of the marine invasions that occurred during the Paleozoic Era. However, it is likely that marine conditions persisted into the Permian Period, the sea finally withdrawing from the Illinois Basin for the last time at the close of the Paleozoic Era, about 225 million years ago. Since then, most of the region has remained above sea level, exposed to erosion. During this long interval of time, any Permian strata that may have been deposited and a considerable thickness of Pennsylvanian rocks were removed by erosion. The nearest rocks of Permian age are found in eastern Kansas, about 325 miles to the west.

Brief marine invasions reached northward from the Gulf of Mexico to submerge the southern tip of Illinois during the Cretaceous Period of the Mesozoic Era about 100 million years ago and again during the early part of the Tertiary Period of the Cenozoic Era about 60 million years ago (see attached Geologic Map of Illinois). These invasions by shallow seas did not reach as far north as the Carrollton area. Nonmarine, alluvial sand and gravel deposits of Cretaceous age occur about 30 miles to the northwest, in Pike County. These sediments were carried into that area by streams flowing from regions lying much farther northwest.

ECONOMIC GEOLOGY

Stone - In 1974 (the most recent year for which we have statistics), broken and crushed limestone was the only mineral material mined in Greene County. Four quarries produced a total of 385,319 tons of limestone for surfacing and fill material, soil conditioner (ag lime), and concrete and asphalt aggregate.
In 1974, Illinois produced a total of 63.2 million tons of broken and crushed limestone and dolomite. The total value of this tonnage is estimated to be $121.8 million, and its average cost $1.93 per ton.

All of the quarries mine the thick beds of Burlington-Keokuk Limestone exposed in the east bluff of the Illinois Valley and in the deep tributary valleys cutting through the bluff. These are the lower Valmeyeran units shown on figure 1.

Burning limestone to make lime for plaster and mortar and quarrying building stone were among the first industries taken up by Americans settling new lands. According to the 1868 report of Illinois' pioneer geologist, A. H. Worthen, most of the cut stone used in Carrollton came from a limestone quarry on Link's Branch about one mile and a half south of town and "about half a mile east of the State road from Carrollton to Jerseyville...."

Coal - According to records of the Illinois State Department of Mines and Minerals, 693,191 tons of coal were mined in Greene County in the period from 1883 to 1967. According to Worthen's 1868 report, several mines were operating in the county at that time, one having opened in 1864. No coal mining has been reported since 1967.

Two coal seams supplied almost all of the coal. The Colchester (No. 2) Coal Member has been worked by many small mines east of Whitehall and Roodhouse in the valleys of tributaries to Apple Creek. It underlies the whole area shown as Carbondale Formation on figure 2.

The Herrin (No. 6) Coal Member, which lies about 100 feet above the Colchester Coal, was mined about a mile northeast of Greenfield. In the county the Herrin Coal is present only along the eastern edge, between Athensville and Greenfield.

In addition, minor amounts of a coal known as the Roodhouse Coal Member have been mined extensively from a small area southeast of Roodhouse, a mile or two north of this field trip area. This coal, locally as much as 8 feet thick, occurs about 30 feet above the Colchester Coal.

A Geological Survey study (Circular 311, W.H. Smith, 1961), estimated that 500.7 million tons of Colchester Coal and 97.3 million tons of Herrin Coal were present as strippable coal reserves in Greene County. ("Strippable reserves" consist of coal seams 18 or more inches thick and 150 feet or less below the surface. The study reports the amounts of coal that are estimated to be present--not the amounts of coal that can be recovered.)

Clay - No manufacture of clay products has been reported since 1973. A thick clay bed under the Colchester Coal in the White Hall vicinity had been used since the late 19th century to make terra cotta, refractory and building brick, tile and pipe, and stoneware.

The clay bed is named the Cheltenham Clay Member. It occurs in the Spoon Formation and has been mined at places along the outcrop belt shown for the Spoon Formation on figure 2. (The clay bed extends under the Carbondale Formation as well.) The Cheltenham Clay in Greene County is a refractory clay. Unlike ordinary clays, a refractory clay does not fuse and melt at high furnace temperatures and can be used to make containers for molten metals and bricks for lining furnaces.
In 1868, A.H. Worthen reported the presence of the Cheltenham Clay under the Colchester Coal along Wolf Run, east of White Hall. Citing the clay bed's 8- to 10-foot thickness, its proximity to White Hall and a railroad, and the presence of the coal for kiln fuel, he declared it was "one of the most valuable deposits of potter's clay known in the state."

His appraisal seems to have been realistic. A Survey report published in 1907 (Bulletin 4, Bain and others) lists four plants operating in the area. At White Hall were the White Hall Sewer Pipe and Fire Clay Works, Western Stoneware Company, and the Ruckel and Son plant; the Roodhouse Novelty Pottery Company operated at Roodhouse, about 2.5 miles northeast of White Hall. Clay pits were also operated at Drake, a village about 4 miles northwest of White Hall. The latter pits yielded the most widely shipped clay in the state up until about 1918. The clay mined at Drake ranged in thickness from 5 to 26 feet, with a well at one of the pits indicating another 8 feet of clay below the floor of the pit.

Water - In Greene County, domestic and municipal water supplies are obtained from creviced and fractured bedrock and from sand and gravel beds buried in glacial and stream deposits. The Burlington-Keokuk Limestone is the source of most private and municipal water supplies. In the eastern half of the county, Pennsylvanian rocks and the Salem Limestone supply domestic wells.

The stream deposits that partly fill the valleys of the Illinois River, Macoupin Creek, and Apple Creek contain beds of sand and gravel that are fair to excellent aquifers. On the uplands, farm wells sometimes penetrate pockets of sand and gravel in the glacial drift that yield enough water for home use.

**ITINERARY**

0.0 0.0 Assemble on south side of Carrollton Community High School. Head west on driveway (Virginia Avenue extended).

0.0 0.0 **Stop 1.** A self-conducted tour along the front of the Carrollton Community High School Building. (NW SE SW Sec. 23, T. 10 N., R. 12 W., Roodhouse 15' Quadrangle.)

Our towns and neighborhoods are good places to study geology. Walk along a street or around a building. If you look, you will see many of the same things that have excited geologists to study the earth and wonder how the world has come to be as it is and how it is changing.

You do not have to go far from your home to study and collect rocks, minerals, and fossils. The blocks and panels of cut and polished stone used in buildings generally provide a better view of the structure and contents of rocks than could be found at their natural exposures. Minerals and fossils native to a region can be collected from the crushed stone and gravel used loose as ground cover and road surfacing.

Almost everywhere one looks in town, stone and metal exposed to weather are changing and breaking down. Erosion occurs on the sides of buildings and in street gutters just as it does in unsettled hills and valleys. The same slow processes that over millions of years have worn down mountains are, by almost imperceptible degrees, leveling our towns.
Take a few minutes now to look at the geologic features that are present at points along the front of the school. Figure 5 shows you where they are. To guide you, a list of questions and instructions is given below. Following the list are discussions of the points. The questions and discussions are separated so that you can enjoy the role of scientist yourself and think about these features before they are explained.

![Fig. 5 - Map of the front of Carrollton High School (Carrollton, IL) showing the numbered points at which the features described at Stop 1 occur.](image)

**Point 1.** Look at the materials used to cover the ground, walk, and driveway here. What are the names of the different surfacing materials? What are they made of and which of their ingredients probably came from the Carrollton area?

**Point 2.** Examine the manhole cover, the brown spots in the bricks, and the bottom section of pipe in the gutter drain. What is the brown material that covers or makes up these features? What element (or metal) does the brown material indicate is present in the features?

**Point 3.** Examine the bricks in the wall and the mortar between them. (Use a 10X hand lens if you have one.) What is the difference between concrete and mortar? What is the aggregate in the mortar? What kind of tool was used to texture the surface of the bricks?

**Point 4.** Examine the window sills and the metal window frames. What are the window sills made of? What metal are the window frames made of, and what do you think of the patterns on their surfaces?

**Point 5.** Study the surface of the sidewalk. What do you find in the bottom of the shallow pits that pock its surface? What could be causing the occasional short, curved cracks?

**Point 6.** Look closely at the slabs that cap the ends and sides of this wall. Is the material concrete? What kinds of grains make up the material? Where could grains like this be formed?

**Point 7.** Examine the narrow channel running along the north side of the sidewalk. What has probably formed it? What evidence is there for your conclusion?

**Point 8 (not on map).** Walk into the middle of the school grounds west of the building, away from places where construction activity may have mixed up the soil material. Dig a pinch of earth and rub it apart in the palm of your hand. Are most of the grains larger than sand, the same size as sand, or smaller? (If the material is dry,
what does it feel like: talcum, flour, or sand? Blow gently on the powdered soil. How much of it blows away?) What natural process could have put the soil material here--landsiding? slumping? deposition by lake, stream, wind, or glacial ice?

**Discussion**

**Point 1.** Different sizes of screened crushed limestone from quarries near Carrollton are used as ground cover beside the building and as aggregates in the concrete sidewalk and blacktop driveway. Aggregates are the "fillers" in concrete and blacktop. They are the relatively cheap--but very important--materials that take up space in the mixtures so that less of the much more expensive binders, cement and asphalt, need to be used. (In 1974 the average value in Illinois of a ton of portland cement was $28.10; in contrast, $1.93 was the average value of crushed stone.) Crushed stone, sand, and gravel aggregates are usually mined within a few tens of miles from where they are used. The farther aggregates are hauled the more they cost, and builders are anxious to buy them as cheaply as possible.

Blacktop is a mixture of sand, crushed stone, and asphalt. Asphalt is produced in Illinois as a by-product of petroleum refining. Different grain sizes of washed sand are obtained from local sand and gravel pits.

Concrete is made by mixing certain proportions of sand, gravel or crushed stone, water, and cement to make a pasty fluid that hardens some hours after it is mixed. The cement which binds the sand and crushed stone together is made by pulverizing the clinker that forms when limestone is fused (or "burned") with clay or shale at red heat. Cement mixed with water hardens because the minerals produced by burning combine with water to form new minerals that grow crystals--the crystals interlock to bind each other and the other solids into a rock-like mass. Cement has been produced in Illinois since 1830.

**Point 2.** The brown material is rust. Rust covering or coloring a substance indicates that the substance contains iron. Rust forms when iron, iron alloys, or other iron-bearing substances are exposed to moist air and combine with water, carbon dioxide, and oxygen. The common mineral name given rust is limonite, a single name even though rust is composed of several different iron oxide minerals.

Iron is an abundant element and makes up about 5%, by weight, of the earth's crust. It is not surprising, then, that most rocks and earth materials are colored by iron--either by the rust brown, red, and yellow iron minerals (the ferric compounds) or by the green, gray, and black minerals (the ferrous compounds).

Rusting is a particular kind of weathering. "Weathering" is the word used to describe the changes in earth and rock that result simply from their being exposed to the earth's surface environment. Weathering is caused by the reactions of earth and rock with water, with the atmosphere, and with life processes. It is an erosion process with little or no transport of altered materials.

Weathering occurs when rock and earth materials that were not formed in the earth's natural surface environment are brought into it. For example, the metallic iron in the manhole cover and gutter pipe was produced from iron ores--one of the red, yellow, or brown oxides of iron--in a furnace. The furnace environment was very hot (near 1600°C. or 2880°F.) and waterless--oxygen could not react with the iron. Now, in this much cooler, wet, oxygen-rich environment, the iron is changing back to a mineral, limonite.
The rust spots in the bricks result from the alterations of grains of an iron mineral—perhaps pyrite—in the brick clay. Kiln heat and weathering cause the rusting.

Point 3. Mortar is the bonding material that holds the bricks in a wall together. Mortars today are made by mixing cement, sand, and water. Cement makes a much stronger mortar than the lime-sand mixture that was generally used in masonry before this century.

The sand in the mortar and concretes made in the Carrollton area contains a number of different minerals, most of which have been worn by weathering and by stream erosion from the igneous and metamorphic rocks brought from Canada and our northern states by glaciers. A transparent pink, red, or orange sand grain may be garnet. A green grain may be either hornblende or epidote; an opaque, black grain, either ilmenite or magnetite. Clear and light to dark brown flakes are mica. However, most of the sand grains are quartz and feldspar, quartz being the more abundant. Quartz grains are clear and faintly yellow or colorless. Feldspar grains are translucent white to gray or pink.

Brick is a synthetic stone that resembles some natural metamorphic rocks: mudstones fired underground over burning coal beds and those baked by contact with molten rock, for example. The surfaces of a brick often bear marks that show how it was formed and handled before firing. Decorative textures are applied to some bricks. Colors, some surface finishes, and deformations are the result of clay composition, the way the brick was stacked in the kiln, the kiln temperature, and the kiln atmosphere around the brick.

Point 4. The window sills are concrete. The window frames are made of zinc-coated steel, which is called galvanized steel. Iron and steel products are galvanized by dipping them in molten zinc. Galvanizing prevents rust, at least until the zinc coating is worn through.

The frosted pattern on galvanized steel—like the ice flowers on a cold window—was created by intersecting growths of zinc crystals on the steel surface. Most substances crystallize as they cool from the fluid to solid state. Galvanized metal is made in Illinois, and both zinc and steel are refined in the state.

Point 5. The shallow pits are called popouts. Popouts occur when pieces of stone buried near a surface of a concrete structure swell and break out a flake of concrete. A stone swells if it is soaked with water and freezes or if weathering changes it to a different mineral that takes up more space. Typical popouts are shallow cone-shaped pits. Usually, part of the stone that made the popout is still in the bottom of the hole. Curved cracks several inches long often show where popouts are beginning.

Chert pebbles caused the popouts here. Chert is a type of silica (silicon dioxide, SiO₂). It occurs in nodules and thin layers in limestones and dolomites across the state, so chert pebbles are often found in crushed stone from quarries and in natural gravel deposits. A great deal of the chert makes an excellent concrete aggregate, but some causes popouts.

Cherts are usually brown, white, or light gray rocks that a knife or common nail will not scratch. Solid chert is an apparently grainless mineral that breaks with smooth, slightly curved fractures like those showing on Indian arrowheads. Almost all Indian arrowheads in Illinois are made of chert, which is commonly called flint.
Some porous chert pebbles absorb water, freeze, and pop out. Others react with chemicals in the concrete and pop out. (A reaction between hydrated silica in chert and sodium compounds in the cement can produce sodium silicate, which causes swelling and popouts.)

In our state, ironstones--pebbles of pyrite (iron sulfide, FeS₂) and siderite (iron carbonate, FeCO₃)--commonly cause popouts. Ironstone pebbles swell when they weather because water and oxygen turn siderite and pyrite to limonite, which has a larger volume than the original minerals. Ironstones are common in the shales of the Pennsylvanian rocks that underlie the southern three-quarters of Illinois, and glaciation and stream erosion have mixed them into our gravel deposits.

Popouts caused by pyrite are rust-stained. Popouts caused by siderite have earthy, rust-brown pebbles in their bottoms. A knife or common nail will scratch ironstones.

Salting concrete to melt ice can start popouts and a shallower but more continuous scaling called salt fretting.

Point 6. The slabs are sawed panels of limestone, a sedimentary rock. The visible rock grains are shells, shell fragments, and calcite pellets that were formed, washed about, and deposited in an ancient sea that once covered the Midwest. Having been deposited between 305 and 350 million years ago, the stone is Mississippian in age. The limestone slabs used in the school were quarried in the vicinity of Bedford, Indiana. One of the trade names for the stone is "Indiana Limestone." It has been a very popular cut stone for many years, so pieces of it are easy to find in midwestern buildings. Limestone deposits of the same age occur in Illinois and are quarried for crushed stone, lime, and also at times for building stone.

Note that the edges of some of the panels show slightly curved layering somewhat like wood graining. Thin layering, called lamination, is characteristic of sedimentary rocks. The loose sediments that became these rocks--chalky muds and broken-shell and calcite sands--were deposited intermittently, layer by layer, by sea currents. Each layer represents a separate episode of water flow.

The faces of the panels have been sawed nearly parallel to the rock's lamination and, therefore, nearly parallel to the surfaces that were the sea floor at different times. On several panels, one can see swirled and looped patterns left by the burrowing and feeding of sea animals in the soft sediments. Such "traces" of ancient living things are called "trace fossils." ("Body fossils" are the actual remains or impressions of the remains of the animals.)

Point 7. The streamlined bar deposits in the channel, the sinuous small channels within the larger channel, grain sorting, and the channel's downhill slope--all are evidence that the channel has been cut by running water. This little channel, which drains rain, snow water, and sediment from the school grounds, provides models of much larger stream and river features.

Point 8. Greene County east of the Illinois River bluffs is covered by this wind-deposited material. Geologists call it loess (pronounced "luess"). It was blown from the Illinois Valley and deposited during the last glaciation of Illinois, during the period between about 75,000 and 12,500 years ago. (See also "Introduction" and Stop 8.) The loess is probably more than 10 feet thick here.

0.0 0.0 Leave Stop 1. STOP before leaving driveway at Third Street. CONTINUE AHEAD (west) on Virginia Avenue.
0.2 0.2 STOP. Fifth Street and State Route 267. TURN RIGHT (north) on Fifth Street.

0.5 0.7 STOP, 4-way; South Main Street. CONTINUE AHEAD (north). CAUTION--business district.

0.1 0.8 STOP, 4-way; North Main Street. CONTINUE AHEAD (north).

0.2 1.0 CAUTION--unguarded crossing, Illinois Central Gulf (ICG) Railroad.

0.3 1.3 Leave Carrollton. CONTINUE AHEAD (north).

1.5 2.8 Prepare to turn right at T-road intersection.

0.1 2.9 TURN RIGHT (east) on gravel road.

0.75 3.65 CAUTION--unguarded ICG railroad crossing at Pegram.

0.05 3.7 To the right is the site of an abandoned brick and tile plant owned at one time by the Carrollton Clay Corporation. The kilns were located close to the chimneys along the west side of the property. Clay for this operation was mined from beneath the No. 2 Coal about 0.3 mile to the east-southeast from the plant site. The clay was trucked to the plant site along the haulageway marked by the east-west tree line at the south edge of the plant site ruins.

Many small brick and tile plants experienced difficulties with their raw materials and their manufacturing operations. Some were able to solve them by trial and error; others sought and received assistance from the Survey; others had to suspend operations.

This particular plant was not able to get enough water from shallow wells to meet its needs. In addition, World War II fuel shortages, transportation restrictions, curtailment of non-war effort-oriented construction, and acute labor shortages combined to make this operation unprofitable.

0.6 4.3 STOP 2. Pleistocene and Mississippian Warsaw Formation exposures along northeastward-flowing tributary to Whitaker Creek and in roadcut along lane to the south. (NW¼ SE¼ NW¼, Sec. 1, T. 10 N., R. 12 W., Roodhouse 15' Quadrangle.)

The glacial till here (figure 6) is one of the more accessible till exposures in the field trip area. When the exposure is dry, the relationships and contacts of the various units are more discernible.

The Warsaw Shale exposed here is the youngest Mississippian-age rock to be studied on this field trip. It was deposited between about 340 million and 330 million years ago in fairly shallow, quiet seas that covered the midcontinent region. Limestones present in the Warsaw generally are thin and discontinuous, both laterally and vertically, indicating that conditions varied from place to place throughout this time. Moderate wave action in the shallow seas disaggregated crinoids and broke fronds from screw-shaped bryozoans, Archimedes, which are quite abundant locally. The many flattened geodes found throughout the Warsaw are of particular interest (note attached yellow pages--ORIGIN OF GEODES).

0.0 4.3 Leave STOP 2. TURN AROUND and retrace itinerary (west).
CENOZOIC ERA THEM

Quaternary System
Pleistocene Series
Wisconsinian Stage
Woodfordian Substage and later (Modern Soil in upper 18" of section)

Pecoria Loess - light brown; clayey in lower 3'; noncalcareous; 7'

Altonian Substage

Roxana Silt - light grayish brown with pinkish cast; quite clayey;
noncalcareous; 5'

Illinoian Stage

Till - dark brownish gray, weathers red; slightly pebbly; contains
numerous manganese blebs; noncalcareous; 2' (Sangamon Soil)

Till - medium gray with yellow cast; noncalcareous; contains a few
scattered pebbles; occasional manganese blebs toward top; 9'

Till - light yellowish gray; noncalcareous; very pebbly and cobbly;
weathered; 21'

PALEOZOIC ERA THEM

Mississippian System
Valmeyerian Series
Warsaw Shale Formation

Shale - olive gray; rather blocky; contains flattened geodes up to
10" in diameter; lighter color in top 5'; fairly soft and
weathered in top 2'; 116'

Limestone - medium gray with rusty brown weathered surface; fine-
to
medium-grained; quite fossiliferous, crinoid stem fragments, bryo-
zoans, and Archimedes especially abundant; a few flattened geodes;
beds up to 10" thick; interbeds of gray shale up to 4" thick; 2'

Covered interval 216'

Fig. 6 - Generalized section of Pleistocene and Mississippian strata exposed at Stop 2.

0.65 4.95 CAUTION--unguarded ICG railroad crossing at Pegram.

0.75 5.7 STOP. T-road intersection with SR 267. TURN RIGHT (north).

1.05 6.75 Descend into the broad valley of Apple Creek, one of the major streams
drainage the area to the east.

1.2 7.95 Cross Apple Creek.

0.55 8.5 To the right the south bank of a small tributary to Apple Creek exposes
Mississippian limestone.
Here the itinerary crosses the higher portion of the upland area, and there is a good panoramic view of this upland surface in all directions.

Just ahead, Seminary Creek valley has Mississippian limestone exposed in it, especially in the area to the left.

Cross Seminary Creek and prepare to turn right.

TURN RIGHT (east) at T-road intersection. This blacktop road is at the south edge of White Hall.

CAUTION--ICG railroad crossing. CONTINUE AHEAD (east).

CAUTION--Burlington Northern (BN) Railroad crossing. CONTINUE AHEAD (east).

Prepare to turn left.

TURN LEFT (north) at crossroad.

STOP. TURN RIGHT (east) at T-road intersection.

Prepare to turn left.

TURN LEFT (north) on gravel road at T-road intersection.


BEAR RIGHT (easterly) at T-road intersection just southeast of bridge.

Stop 3a. Roadcut to right exposes Pennsylvanian strata above the Chester (No. 2) Coal. (SW 1/4 SE 1/4 Sec. 29, T. 12 N., R. 11 W., Roodhouse 15' Quadrangle.)

Bedrock of Pennsylvanian age exposed in this vicinity was deposited on lowlands and in shallow tidal basins and seas adjacent to an ancient river delta system that existed between about 320 million and 310 million years ago. As noted in the accompanying Pennsylvanian supplement, this period of geologic history is noted for variability of sedimentation conditions and resultant differences in rock types from one locality to another. Although there are some notable exceptions, depositional conditions generally were of short duration and the bedrock units, therefore, are relatively thin, especially when compared to older sediments nearby.

Unfortunately, because of slumping, the whole geologic section cannot be observed down to the horizon of the coal at this stop. However, the coal may be studied at Stop 3b about 1/4 mile to the northeast. Of particular interest, though, is the difference in rock types from one exposure to the other, a difference which represents a change in sedimentation conditions. By comparing figures 7 and 8 with figure 9, one can readily see what a small part of this record is available for study on this field trip. Figure 9, a generalized columnar section of Pennsylvanian rocks in western Illinois, shows graphically how complex sedimentation was at that time in geologic history.

Leave Stop 3a. CONTINUE AHEAD (east).
Fig. 7 - Geologic section exposed at Stop 3a.

0.2 16.15 **Stop 3b.** East-facing cutbank along Wolf Run about 0.1 mile north of gate on left side of road. (N:\S\SW\SW Sec. 28, T. 12 N., R. 11 W., Roodhouse 15' Quadrangle.)

**ATTENTION:** Make sure that the gate is closed and secured both when you enter and when you leave this property.

Notice the differences in the units in the stratigraphic interval below the Pleasantview Sandstone at this exposure from those at Stop 3a, as shown in figures 7 and 8. Compare these sections with the diagram of an ideal cyclothem included in the Pennsylvanian supplement. How many cyclothems can you recognize?

**CLOSE and SECURE GATE.**

0.0 16.15 Leave Stop 3b. CONTINUE AHEAD (east).

0.25 16.4 T-road intersection. TURN RIGHT (south).

0.5 16.9 T-road from left. CONTINUE AHEAD (south) and then CURVE RIGHT (west).
Fig. 8 - Geologic section exposed at Stop 3b.

0.7 17.6 T-road from right. CONTINUE AHEAD (west).

0.3 17.9 CAUTION--prepare to turn left just beyond brow of hill.

0.1 18.0 T-road from left. TURN LEFT (south) on gravel road.

0.7 18.7 STOP. Crossroad. CONTINUE AHEAD (south).

0.5 19.2 T-road from left. TURN LEFT (east).

1.05 20.25 CAUTION--narrow bridge.

0.1 20.35 Fossiliferous (crinoidal hash) Mississippian limestone (Warsaw?) exposed in small road cut.

NOTE: The itinerary from this location southward for the next 1.25 miles is easily flooded.
<table>
<thead>
<tr>
<th>GROUP</th>
<th>FORMATION</th>
<th>COMPOSITE SECTION</th>
<th>NAMED MEMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOND</td>
<td></td>
<td></td>
<td>Little Vermilion Ls.</td>
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<td></td>
<td></td>
<td></td>
<td>LaSalle (Shoal Creek) Ls.</td>
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<td>Hall Ls.</td>
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<td>Cramer Ls.</td>
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<td></td>
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<td></td>
<td>Chapel (No.8) Coal</td>
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<td>Trivoli Ss.</td>
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<td>MODESTO</td>
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<td>Exline Ls.</td>
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<td>Lonsdale Ls.</td>
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<td>Gimlet Ss.</td>
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<td></td>
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<td>Farmington Sh.</td>
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<td>Danville (No.7) Coal</td>
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<td>Copperas Creek Ss.</td>
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<td>Pokeberry Ls.</td>
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<td>Brereton Ls.</td>
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<td>Herrin (No.6) Coal</td>
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<td>Big Creek Sh.</td>
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<td></td>
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<td></td>
<td>Vermilionville Ss.</td>
</tr>
<tr>
<td>KEWANEE</td>
<td>CARBONDALE</td>
<td>(cont'd)</td>
<td>Canton Sh.</td>
</tr>
</tbody>
</table>

Approximate Scale in Feet:

0 25 50

Fig. 9 - Generalized columnar section of Pennsylvanian strata in northern and western Illinois (fig. 1, IGS Guidebook 8, W. H. Smith et al., 1970).
0.2 20.55 CAUTION--narrow bridge across tributary to Apple Creek.

0.7 21.25 To the right is a meander loop of Apple Creek.

0.15 21.4 To the left is another meander loop of Apple Creek. Note this location on the itinerary map. Because of frequent flooding, this narrow neck of land separating these two meander loops is a potential new channel location for Apple Creek. During a flood of sufficient size and duration, it might well be possible for downcutting to breach this neck to sufficient depth to permanently change the course of the creek in such a way that a meander loop to the south, where the next bridge is located, would be abandoned. Flooding makes this a trouble spot for road maintenance, as attested to be the stretches of newly applied crushed stone on the road here.

0.2 21.6 CAUTION--narrow bridge. Apple Creek.

0.05 21.65 T-road intersection. TURN LEFT (east).

0.35 22.0 CAUTION--narrow bridge. Bear Creek.

1.1 23.1 T-road intersection. TURN RIGHT (east).

1.25 24.35 Y-intersection. BEAR RIGHT (southeast and then east).

0.6 24.95 CAUTION--crossroad. TURN RIGHT (south).

0.85 25.8 Cross Bear Creek. Do NOT park on bridge. CONTINUE AHEAD (southwest) beyond bridge.

0.05 25.85 Stop 4. Exposure of the Pleasantview Sandstone Member of the Carbondale Formation (Pennsylvanian) in the bluff to the southeast of the new road. (SE ½ NE ½ SE ½ SW ½ Sec. 13, T. 11 N., R. 11 W., Roodhouse 15' Quadrangle.)

The Pleasantview Sandstone Member, throughout its occurrence in western Illinois, is known either as a thick-bedded, massive, channel sandstone occupying ancient stream valleys, or as a thin-bedded, sheety, nonchannel sandstone. The non-channel phase of this unit reportedly ranges from 2 to 20 feet in thickness about 50 miles to the north in Fulton County, in the area of the Pleasantview type section. (The type section of a stratigraphic unit is the place at which that rock unit is exposed in such a way that its essential characteristics are shown and from which its name is derived.) The channel phase of this sandstone has been reported to be as much as 80 feet thick, filling channels cut through underlying strata down to the Colchester (No. 2) Coal Member and, in some places, through it.

In the ditch on the south side of the old road to the east, the Pleasant­view is yellow-brown to gray-brown and is fine- to medium-grained. It has a sem­blance of thin bedding up to 2 inches thick, which may be a result of weathering rather than an indication of the nonchannel phase. As the exposure is traced to the east and south, the sandstone is found to be thick bedded to massive in character and looks quite similar to channel exposures of this unit to the north. The exposure here may represent a southern extension of channel deposits recognized in Cass County about 40 miles to the north which are thought to be closely related to a large channel in southwestern Fulton County.

At many places the Pleasantview is conglomeratic in the lowest 3 feet of the channel phase and contains rounded chunks of Purington Shale and fossiliferous
Oak Grove Limestone up to 6 inches in diameter. The lower 2 or 3 feet of this sandstone in many places has a concentration of stem impressions of various Pennsylvanian plants. Thin coaly streaks in the sand are the result of the carbonization of driftwood logs carried by ancient Pennsylvanian streams. The 20 feet or so of sandstone exposed here does not show the basal portion of the rock unit. The Pleasantview Sandstone represents the beginning of the Summum Cyclothem. (A cyclothem is a cycle of deposition. See Pennsylvanian supplement.)

Some geologists studying this area think that Bear Creek is flowing in what is probably a preglacial valley. They have noted several sandstone outcrops along the south side of Bear Creek valley, but most exposures are of Pleistocene deposits extending down into the valley. In addition, the valley is more mature in its development than valleys cut into bedrock since Pleistocene time.

0.0 25.85 Leave Stop 4. CONTINUE AHEAD (southwesterly).

0.1 25.95 Y-intersection. BEAR RIGHT (westerly).

1.25 27.2 T-road intersection. TURN LEFT (south).

0.25 27.45 CAUTION--enter village of Wrights. CONTINUE AHEAD (south and then southwest).

0.25 27.7 CAUTION--do NOT cross railroad tracks here. TURN RIGHT (northwest) and continue parallel to tracks.

0.15 27.85 Y-intersection. BEAR SHARP LEFT (south). CAUTION--cross BN railroad tracks and leave Wrights.

0.1 27.95 T-road from right. CONTINUE AHEAD (south).

0.5 28.45 CAUTION--offset crossroad. CONTINUE AHEAD (south).

1.25 29.7 Curve left and prepare to turn right.

0.35 30.05 TURN RIGHT (southwest and then south) on blacktop.

0.75 30.8 BEAR LEFT (south) on blacktop.

1.2 32.0 BEAR LEFT (south) on blacktop.

0.4 32.4 Prepare to turn right.

0.1 32.5 TURN RIGHT (west) on to gravel road at the former village site of Daum.

0.1 32.6 To the left, the two rows of trees within the two fence lines are along the abandoned Chicago and Alton Railroad right-of-way.

1.5 34.1 Notice the general evenness of the upland surface in this area, called "String Prairie."

0.05 34.15 T-road from right. CONTINUE AHEAD (southwest).

0.6 34.75 Curve left and prepare to turn right.

0.1 34.85 T-road from right. TURN RIGHT (west).
Prepare to turn right.

T-road from right. TURN RIGHT (north).

Stop 5. Exposure of the Hanover Limestone Member of the Carbondale Formation (Pennsylvanian) at the waterfall in the creek to the left side (west) of the road. (NE ¼ SW ¼ NW ¼ and E ¼ SE ¼ NW ¼ Sec. 18, T. 10 N., R. 11 W., Roodhouse 15' Quadrangle.)

This exposure shows the typical appearance and character of the Hanover Limestone (see figure 10 for the details of the geologic section exposed here). The type section of the Hanover Limestone is 4 miles southeast of here in the NE ¼ SW ¼ Sec. 27, T. 10 N., R. 11 W., down a small valley just south of Hanover School (note itinerary map).

The Hanover, a thin marine limestone, rarely exceeds 4 feet in thickness. In some places it appears only as limestone nodules slightly larger and slightly more extensive than the limestone nodules in the shale below the waterfall here. In a few places the Hanover is reduced to a thin, concentrated layer of fossils, most of them brachiopods. This unit, therefore, must have been deposited in a very shallow sea that had scattered shoals, which produced conditions unsuitable for the deposition of thick limestone.

The nodular and brecciated appearance of the Hanover Limestone usually makes the unit easily recognizable. Therefore, it is an important marker bed, or datum plane, that is, a unit that can easily be identified and correlated from place to place over wide areas. The Hanover, although generally absent in southern Illinois...

Fig. 10 - Geologic section exposed at Stop 5.
and western Indiana, is one of the most widespread Pennsylvanian limestones in the midcontinent region. It is equivalent to the Blackjack Creek Limestone of Missouri, Kansas, and Oklahoma.

The Hanover Limestone is not only the uppermost and, therefore, the youngest member of the Summum Cyclothem to be studied on this field trip, but it is also the youngest bedrock unit exposed on the trip. The basal member of the Summum Cyclothem is the Pleasantview Sandstone, seen at Stops 3 and 4. Compare the diagram of an ideally complete cyclothem (Pennsylvanian supplement) with the section exposed here.

Downward-percolating ground water has dissolved Hanover Limestone along vertical cracks and joints, thereby enlarging them. The shales underlying the limestone are relatively impervious to the downward movement of ground water; therefore, when the water reaches the shales, it moves laterally toward the small valley containing this stream. Shale particles are flushed out from beneath the limestone. As this process continues, the flow of water is concentrated, resulting in increasingly rapid erosion of the shale from beneath the limestone. Erosion by water couples with freeze-thaw cycles to remove a fairly large amount of the underlying shale. The limestone, being more resistant to erosion than the shale, remains to form a horizontal, overhanging ledge across the stream valley. Increasing solution along some of the vertical cracks and joints in the stream course enlarges them so much that most of the normal flow of this small stream disappears down these enlargements. (Enlarged joints and cracks that capture most of a stream's normal flow are called swallow holes.) During times of increased runoff there is enough water in the stream to flow across the ledge and form a waterfall.

Adjacent to the northwest side of the stream several small sinkholes have been developed in the relatively soft, unconsolidated glacial deposits overlying the Hanover Limestone. Enlargement of vertical cracks and joints in the limestone has permitted the easily eroded glacial materials to be flushed down through the limestone and carried away by running water. The resulting sinkholes here occur above the back part of the overhanging ledge or just slightly upstream from it.

DO NOT CRAWL UNDER THE LEDGE--IT CAN COLLAPSE! The large blocks below the lip of the ledge are the result of previous collapses.

The position of the Summum (No. 4) Coal Member is shown by a 2-inch brownish black shale nearly 2 feet below the bottom of the main ledge of limestone. This coal is named for the town of Summum, Fulton County, about 65 miles north of here. The Summum Coal generally ranges from a fraction of an inch to 4 inches in thickness, but in a few scattered local areas it is 3 to 5 feet thick. The No. 4 Coal or its recognized position is another of the important widespread stratigraphic marker beds in Illinois and adjacent states. Generally a black shale that contains large, black limestone concretions separates the No. 4 Coal from the overlying Hanover Limestone. Conditions were unfavorable for the deposition of the black shale, the Excello Shale Member, here.

0.0 35.65 Leave Stop 5. CONTINUE AHEAD (north).

0.1 35.75 To the right are large blocks of the Hanover Limestone in an area that was the old road here. To the left, in the creek bottom, is the greenish gray shale below the Hanover Limestone.

0.15 35.9 To the right, notice slumping of Pleistocene materials in the road cut.
0.9 36.8 Prepare to turn left.

0.1 36.9 T-road from left. TURN LEFT (west).

0.6 37.5 CAUTION--steep hill ahead.

0.05 37.55 CAUTION--narrow concrete bridge. Creek bed exposures on both sides of the bridge show Warsaw (Mississippian) limestones. The top surface of the limestone to the left is an excellent example of pitting caused by solution, the pits being generally 3 to 4 inches in diameter and 5 to 8 inches deep.

About 50 years ago, several small coal mines operated along the steep west valley wall to the south. The coal mined was the Colchester (No. 2) Coal, which occurs about 8 to 10 feet above the Warsaw. The interval between the No. 2 Coal and the Warsaw is a variegated blue, red, yellow, and gray clay and underclay. The clay in this sequence is called the Cheltenham Clay Member. The Cheltenham and the underclay were both mined less than 1 mile to the northwest at the Carrollton Clay Corporation plant site noted on the way to Stop 2.

0.9 38.45 Prepare to turn right.

0.1 38.55 T-road from right. TURN RIGHT (west).

0.05 38.6 CAUTION--narrow culvert.

1.15 39.75 Note indiscriminate dumping in the shallow draw to the right.

0.8 40.55 CAUTION--TURN RIGHT (west) across unguarded ICG railroad crossing. Enter Carrollton.

0.05 40.6 T-intersection with First Street. CONTINUE AHEAD (west) along north side of Carrollton City Park.

0.05 40.65 Stop 6. LUNCH.

0.0 40.65 Leave Stop 6. CONTINUE AHEAD (west) and then TURN LEFT (south).

0.2 40.85 CAUTION--unguarded ICG railroad crossing. TURN RIGHT (west) on Walnut Street (parallel to track).

0.3 41.15 STOP. Fifth Street and SR 267. TURN LEFT (south) on Fifth Street.

0.1 41.25 CAUTION--entering Carrollton business district.

0.05 41.3 STOP, 4-way; North Main Street. CONTINUE AHEAD (south).

0.1 41.4 STOP, 4-way; South Main Street. CONTINUE AHEAD (south) on SR 267.

1.5 42.9 Leave Carrollton. CONTINUE AHEAD (south).

0.8 43.7 Mississippian limestone exposed in the creek banks on both sides of highway.

0.5 44.2 To the right (west) about 3.75 miles away is a hill that stands some 120 feet above the general upland level. A well drilled on its east side indicates that the hill is not a bedrock high but rather is composed of glacial materials.
Cross Macoupin Creek bridge. Channelization of this stream has produced the straight course noted on both sides of the bridge.

The flat areas on both sides of the highway that are some 20 feet above the floodplain level of Macoupin Creek are terraces. These terraces and other isolated flat areas at about this same elevation are all that remain of a former floodplain that developed in this valley. Rejuvenation of the stream, probably because of regional uplift, renewed downcutting and lateral erosion of the former floodplain. These terraces merge downstream with similar features along the Illinois Valley.

Prepare to turn right.

Kane crossroad. TURN RIGHT (west) at Old Kane.

Note the upland area in the southern part of the field trip. Jerseyville is about 5 miles to the southeast. Carrollton is about 7 miles to the north across Macoupin Creek.

The crest of the high glacial hill noted previously, at mileage 44.2, is slightly more than 6 miles to the northwest from here.

T-road from right. CONTINUE AHEAD (west).

Just ahead is Shanks Hill, an erosional remnant of the upland surface which at an earlier time was more extensive than it is now.

Crest of Shanks Hill.

Illinoian till exposed in road cut to right. Slightly downhill the Burlington-Keokuk (Mississippian) Limestone is exposed on both sides of the road cut.

Stop 7. Entrance to Valstad Quarry, Inc., to right. Burlington-Keokuk Limestone exposed in the working faces at this quarry. (NE\(^2\) NW\(^2\) NE\(^2\) NW\(^2\) Sec. 34, T. 9 N., R. 12 W., Jerseyville 15' Quadrangle.)

FOR YOUR SAFETY, PLEASE OBSERVE THE FOLLOWING:

1) Get permission at the office (the large metal building beyond the scalehouse) to enter this quarry to study and collect.
2) Watch out for all quarry equipment. Do not climb on equipment.
3) PLEASE DO NOT WORK ON OR CLOSE TO THE QUARRY FACES. Blocks are likely to fall from the shattered walls. Specimens are more abundant in the piles of broken stone on the quarry floor and are easier to collect there.
4) PLEASE DO NOT THROW ROCKS.
5) DO NOT CLIMB ON QUARRY FACES.

The Valstad Quarry mines limestone, dolomite, and chert to produce crushed and broken stone. The products—agricultural limestone, aggregate, road stone, and broken stone—are trucked from the quarry.

The Burlington-Keokuk Formation - The rock beds exposed in the quarry are units of the Burlington-Keokuk Limestone (see figure 11). They were deposited during
the Mississippian Period—the interval of geologic time estimated to have lasted about 25 million years between 345 million and 320 million years ago (see figure 1, the geologic column). The Burlington-Keokuk beds were laid down relatively early in the period.

The Burlington-Keokuk Limestone is easily recognized in Greene County. It is the thick limestone that forms the bluffs along the Illinois Valley and crops out in creek valleys in the western half of the county. Typically, it is light gray and contains nodules and thin layers of chert. Crinoid debris—particularly the patterned cylindrical columnals or "Indian beads"—makes up a large part of many beds.

The Burlington-Keokuk Limestone is found in central and west-central Illinois and southeastern Iowa. It accumulated in part of a shallow sea that covered most of the Midwest. Sea currents swept the chalky muds, animal shells and skeletons and broken-shell sand into layers that became the beds of limestone and dolomite that we see in the quarry. The coarser of these sediments can be seen in rock fragments from the quarry.

In the northern area of its extent, geologists divide the Burlington-Keokuk Limestone into two formations: the Burlington Limestone and the Keokuk Limestone above it. The division is made at the base of a very cherty limestone unit that is generally about 30 feet thick and readily identified. The formations cannot be easily told apart in the southern part of their extent, which includes Greene County, because the upper part of the Burlington here is also quite cherty. Although fossils can be used to tell the two formations apart, it is usually easier to refer to them collectively as the Burlington-Keokuk Limestone.

<table>
<thead>
<tr>
<th>THINGS YOU CAN DO HERE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Collect fossils, calcite crystals, and specimens of limestone, dolomite, chert, terra rosa, and stylolites (&quot;crow-feet&quot;).</td>
</tr>
<tr>
<td>2. Look around and see where and how the different quarry operations are carried out: (1) drilling shot holes and shooting; (2) loading shot rock; and (3) crushing, screening, and stockpiling.</td>
</tr>
<tr>
<td>3. Estimate the weight of some of the large limestone blocks by assuming that one cubic foot of stone weighs 166 pounds—the average weight of Illinois limestones and dolomites.</td>
</tr>
</tbody>
</table>

Features in the Quarry - A number of rocks and rock features can be examined in the quarry:

1. Limestone and dolomite: Limestones are sedimentary rocks composed mainly of the mineral calcite (calcium carbonate, CaCO₃). Dolomites in Illinois are altered limestones composed of the mineral dolomite [calcium magnesium carbonate, CaMg(CO₃)₂]. The two rock types look much alike. However, many dolomites have a sugary crystalline texture and, if they are weathered, a distinctive light brown or tan color. A test with 10% hydrochloric acid is a better indicator than texture or color in many cases. A drop or two of acid on limestone (calcite) produces an instant fizzing, frothing reaction. On dolomite, the acid's reaction with the rock is slow and subdued—so much so, at times, that if the rock does not react, one has
to test powder scratched up or battered on the rock's surface. If the rock is dolomite, acid reacts with the powder. Limestone and dolomite are softer than chert: a knife or common nail scratches both.

2. Calcite crystals: Masses or "nests" of calcite crystals several inches in diameter occur in the limestone beds here. They are transparent to translucent, clear to white masses that resemble ice. The crystals react like limestone with 10% hydrochloric acid, and they cleave into very regular rhombs (denoted) with glossy smooth surfaces. The intersecting cleavage planes that form the rhombs can be seen passing through the crystal masses.

3. Chert: Nodules and thin layers of chert are easy to see in the limestone beds. Chert masses are commonly white to gray, and may be banded with several tones of these colors. Chips broken off solid chert have razor-sharp edges and slightly curved, often grainless, fracture surfaces that resemble unglazed porcelain. A knife or common nail will not scratch chert. Prehistoric American Indians made tools and weapons from chert.

4. Terra rosa: Terra rosa is the red earth that can be seen covering the top of the rock in the quarry and filling the crevices in the uppermost beds.

Rain falling through the atmosphere and water percolating through the soil pick up carbon dioxide from the air and from decaying organic matter in the soil. Water (H₂O) with carbon dioxide (CO₂) forms weak carbonic acid (H₂CO₃). Carbonic acid dissolves limestone.

Water percolates down through the soil into cracks in the limestone beds, dissolves calcite from the rock, and carries it away. In time the cracks may be widened into crevices, sinkholes, and caverns. However, not all the rock dissolves. Traces of iron and varying amounts of clay minerals and quartz silts and sands in the limestones do not dissolve, and they remain to form deposits of terra rosa.

5. Stylolites: Stylolites are the dark zig-zag lines (\(\backslash /\backslash /\)) , like graph lines, that run through blocks and beds of limestone. They form seams that vary from a fraction of an inch to several inches in width. (They are more easily seen in the light-colored beds.) Stylolites extend through the rock in planes that are commonly parallel to the bedding (layering). Along stylolite seams two beds of limestone make shallow jagged penetration into each other.

Stylolites show where calcite has been dissolved and carried away. The dark lines are films of the insoluble residues that were left behind. But why didn't the solution and removal of calcite from along the bedding planes through the limestone produce crevices--openings--like those found near the top of the quarry? Apparently some force--perhaps the weight of several thousand feet of rock and sediment then covering the beds but long since eroded away--kept the bed pressed together while solution took place.

0.0 52.05 Leave Stop 7. CONTINUE AHEAD (southwest and west from entrance to quarry).

0.05 52.1 CAUTION--narrow bridge across Wines Branch.

0.25 52.35 T-road intersection. TURN LEFT (south).

Fig. 11 - A geologic section describing beds of the Burlington-Keokuk Limestone in the Valstad Quarry. A composite of several sections described here by J.W. Baxter (USGS) in 1963.
8.0' Weathered limestone

6.5' Chert, light gray to white; and limestone, light gray to light brownish gray

5.0' Limestone, medium gray to brownish gray, chert; calcite crystals up to 5" in diameter

5.0' Limestone, light gray, very cherty; large calcite crystals

5.7' Limestone, gray to brownish gray, cherty, stylolitic; large calcite crystals

5.3' Limestone, light gray, cherty; 20" to 30" beds, most with stylolitic partings

1.1' Limestone and chert

3.0' Limestone, gray, cherty; stylolitic partings

10.0' Limestone, gray to light gray, cherty; stylolitic partings

7.0' Limestone, gray to light gray, cherty; stylolitic partings; crinoidal

3.0' Limestone, gray to brownish gray, cherty

6.0' Dolomite, brown, very cherty

8.8' Limestone, brownish gray, cherty; 0.7' chert band 1.7' above base

2.0' Dolomite, gray, cherty

1.0' Limestone, light gray

1.0' Dolomite, soft, cherty

2.5' Limestone, gray

1.0' Dolomite, light gray, calcareous

0.8' Chert

1.7' Dolomitic limestone or dolomite, light brown

0.5-0.9' Chert

2.5' Dolomite, brownish gray, calcareous

5.6' Dolomite, brown, sugary, cherty; geodes at top

2.3' Limestone, light gray, crinoidal

1.7' Limestone, brownish gray, dolomitic, cherty

* Water level in sump.
0.15 52.5 CAUTION--narrow bridge.
0.2 52.7 T-road from left. CONTINUE AHEAD (westerly).
0.1 52.8 CAUTION--narrow bridge.
0.45 53.25 T-road from left. CONTINUE AHEAD (west).
0.6 53.85 To the right, view of terrace level on the south side of Macoupin Creek. It is comparable in elevation to the top of the cutbank to the left. Note itinerary map: the top of this bank appears to be a continuation of the same terrace level.
0.3 54.15 To the left, view of the upper surface of the aforementioned terrace level.
0.45 54.6 T-road from right. CONTINUE AHEAD (south).
0.05 54.65 TURN LEFT (east).
0.05 54.7 To the left, view of terrace silts exposed in the cutbank of the small creek.
0.3 55.0 TURN LEFT (east). Enter Jersey County.
0.45 55.45 CAUTION--sharp S-turn to left.
0.45 55.9 T-road from left. CONTINUE AHEAD (east) and prepare to turn right.
0.2 56.1 T-road from right. TURN RIGHT (south).
1.0 57.1 T-road from left. CONTINUE AHEAD (south).
0.35 57.45 Prepare to turn right.
0.1 57.55 T-road from right. TURN RIGHT (west).
0.35 57.9 CAUTION--steep hill with bad curves.
0.3 58.2 Cross Boyer Creek.
0.1 58.3 To the left, Mississippian limestone exposed in road cut.
0.1 58.4 CAUTION--narrow bridge.
0.9 59.3 T-road from left. CONTINUE AHEAD (west).
0.65 59.95 Lane from right; BEAR LEFT (west).
0.4 60.35 To the right, view of Macoupin Creek valley.
0.1 60.45 Dark Hollow lane from left. CONTINUE AHEAD (westerly).
0.15 60.6 To the left, a large block of Burlington-Keokuk Limestone has rotated during slumping, resulting in steeply tilting beds.
0.25 60.85 T-road from left. CONTINUE AHEAD (northwest).

0.1 60.95 To the left, lush stand of *Equisetum*, a small-scale modern relative of the giant horsetails, one of the plants of Pennsylvanian age from which our Illinois coals were formed.

0.15 61.1 CAUTION--cross narrow Sugar Creek bridge.

0.55 61.65 Prepare to turn right.

0.1 61.75 T-road from right. TURN RIGHT (easterly). Cross one-lane Reddish Bridge, and re-enter Greene County.

0.6 62.35 To the right, close to the fence line is a U.S. Geological Survey (USGS) metal witness post. The witness post indicates that a bench mark is close by. The bench mark is a metal tablet stamped "34 WRM 1972" and placed on a copper-coated steel rod inside a 4-inch tile. According to W.R. McFarlin's USGS field notebook (1973; Book CV-2960), the elevation of this tablet is 460.870 feet above mean sea level.

An examination of the route map shows that an older bench mark (BM 468) was located about 0.2 mile west of this corner. The older bench mark consisted of a copper nail driven through a galvanized steel washer into the root of a tree. A few of these older markers have been dug out of trees in the past. The tree tends to grow around the bench mark and conceal it.

The itinerary is now ascending a meander spur of Macoupin Creek. A meander spur is a preserved portion of the upland surface that is within a meander loop. A short distance to the north, a view to the right (east) shows a steep slope down toward Macoupin Creek. This steep slope is called the undercut slope of a meander loop. It was formed when the creek impinged upon and eroded this downstream portion of a meander loop. To the left (west) the more gentle slope is called the slip-off slope of a meander loop. The undercut slope and the slip-off slope are labeled on the itinerary map; notice the spacing of the contour lines in these areas.

1.85 64.2 To the right (northwest) through the trees is a frontal view of a scarp that has formed, possibly as a result of slumping along part of the hill.

0.15 64.35 Stop 8. View of slump block of Pleistocene materials just southeast of the home of J.A. Purcell. (\(\frac{1}{4}\) SW\(\frac{1}{4}\) SW\(\frac{1}{4}\) Sec. 25, T. 9 N., R. 13 W., Hardin 15' Quadrangle.)

The south-facing, bare scarp extending eastward from near the southeast corner of the Purcell house and the disturbed hillside to the south and southeast of the scarp were formed several years ago. The disturbance responsible for forming them must have happened over a period of just a few hours at the most. Noises and shocks that would be expected from this large a disturbance were not noticed by the Purcells during the night preceding its discovery. The Purcells were both absent for several hours the morning that the disturbance was discovered. Shortly after returning home and as he was walking from the shed toward the house, Mr. Purcell noticed that the slope to the south looked different to him. He looked more closely and discovered the scarp and the disturbed area to the south of it. Trees were knocked askew and a number of them subsequently died, particularly those close to the edge of the affected area. This disturbance occurred in the spring during a time of abundant rainfall.
Some people who saw the area shortly after it was affected felt that the disturbance likely was the result of the collapse of a cave or some subterranean passage underneath the property. This is within the realm of possibility, as some limestone bedrock in this area has been dissolved by underground water. Spankey Hill, about 2.2 miles to the west-northwest, has a large, water-filled sinkhole in its top, but no other sinkholes show up on the topographic maps of this area drawn with a 20-foot contour interval. Small cave openings and solution-enlarged joints are noted in the itinerary from Spankey northward to Eldred.

Another interpretation of this situation, however is also possible. Data collected from other areas in Illinois have shown that slopes covered by relatively soft unconsolidated materials that are not adequately drained or that do not get dried out are prone to disturbance by landslides. Most of these slopes are north-facing, but a few are shaded, south-facing slopes. In some cases, homes and/or commercial developments near affected areas may have been at least partially responsible for a disturbance—watering of shrubs, lawns, and trees, concentration of rainfall runoff from gutters and driveways, and injection of waste water into shallow subsurface silt and glacial till layers adjacent to septic tanks and fields have all been known to contribute to and, perhaps, even to trigger a landslide. One or more of these conditions may have played a role in the disturbance here. Even if it were proven conclusively that this disturbance was the result of a bedrock collapse, the possibility that surface and shallow drainage problems were contributing factors still would not be negated.

The Survey has not conducted a study of this site. Therefore, our comments are conjectural.

0.0 64.35 Leave Stop 8. CONTINUE AHEAD (north).

0.35 64.7 Prepare to turn left.

0.1 64.8 T-road from left. TURN LEFT (west).

0.8 65.6 View to left (west-southwest) across Macoupin Creek valley through narrows into the Illinois Valley.

0.9 66.5 CAUTION--narrow bridge.

0.2 66.7 Construction of the road cut on the right has produced an oversteepened slope on the west end of this small ridge. The unconsolidated Pleistocene materials that compose the slope are relatively unstable and the result has been the slumping of the slope in an attempt to reach a degree of equilibrium. Note the tilted "stair step" about 10 feet below the crest of the slope. As adjustments by a series of small slumps occur, the road will become partially blocked. As the road is cleared, the oversteepened condition will again be produced and a new cycle of slumping will be introduced. It seems likely that many years will pass before any degree of stability can be maintained along this slope.

0.05 66.75 CAUTION--narrow bridge.

0.1 66.85 STOP. T-road intersection. TURN LEFT (west).

0.95 67.8 Several exposures for the next 0.25 mile or so along the right side of the road show thick deposits of colluvium, unconsolidated deposits at the base of a cliff or steep slope that were brought into position mainly by gravity. Loose blocks of cliff-forming rocks are randomly intermixed with slumped glacial till loess, and stream deposits. Macoupin Creek is to the left.
Stop. Crossroad. TURN RIGHT (north) on blacktop. The view to the right just after turning shows a high bluff line of Burlington-Keokuk Limestone capped by rounded hill prairies that are developed on glacial deposits. When the leaves are off the trees along this part of the itinerary, many small cave openings and widened joints and cracks are visible.

The reentrant (sheltered cove) in the east valley wall of the Illinois River contains the Koster Archeological Site in its northeast corner. Here the Illinois Valley is nearly 3.5 miles wide from the east side of the reentrant westward.

Prepare to turn right.

TURN RIGHT (southeast).

CAUTION--narrow culvert.

CAUTION--follow the signs eastward and northward around the large white house.

BEAR RIGHT (northwest) across small culvert to visitor parking area.

Stop 9. Koster Archeological Site. (NW 1/4 SW 1/4 NW 1/4 SE 1/4 Sec. 21, T. 9 N., R. 13 W., Hardin 15' Quadrangle.)

The Koster Site - The home of Theodore and Mary Koster is at the end of a small valley, a south-facing cove in the bluff line. The valley opens into the Illinois River floodplain and leads up into the timbered hills. A portal to the floodplain and to hill country, the valley is a well-favored homesite, watered by a spring-fed stream, sheltered by bluffs, and warmed by the sun in winter. Little wonder that humans have settled here more than 15 different times in the past 10,000 years.

The most recent settlement began in the 19th century—the rock house was built in 1831. The settlers were farmers, descendants of the same western European peoples who began to explore and colonize the Illinois Valley about 300 years ago. Buried in the Kosters' north field are the remains and artifacts of their predecessors, the descendants of hunters from northeast Asia who came to this valley before the last glacier of the Ice Age had melted from the Canadian plains. These people lived here for long periods at different times until as recently, perhaps, as 1200 A.D.

History of the Excavation - For many years archeologists and amateur collectors have known about the large prehistoric Indian site on the Koster farm. Artifacts are found scattered over a 25- to 30-acre area and are readily collected from the surface. In 1961, anthropologist Gregory Perino of the Gilcrease Institute, who was working on Indian burials nearby, dug a test square in the Koster field that revealed several cultural horizons. He suggested that the several deposits of different habitations might be very distinctly layered. The site was not examined further until 1968, when Harlin Helton, a Greene County farmer and artifact collector, brought Stuart Struever of Northwestern University to it. On the basis of that visit, Struever made nine initial test excavations the following year, 1969, which penetrated six horizons containing cultural material.

The 1969 work was the beginning of the present archeological program at Koster. In 1970, part of the excavation reached a depth of 29 feet and reached
Horizon 11 (see figure 12), which lies in the ground-water table. In subsequent years, the horizons above Horizon 11 were explored and the pit was enlarged. In 1974 and 1975 the installation of six dewatering wells to lower the water table in the pit permitted excavation of the earliest village ruin in Horizon 11. Carbon-14 dating indicates that it is about 8,500 years old. Late in the 1975 season two test squares reached Horizon 13. In 1976, more dewatering wells will be installed in an effort to dig the lower horizons extensively.

How the Koster Site was formed - Visiting the site after a rain, one can see how the colluvial deposit containing the cultural horizons was formed. Rain and snow water erode soil off the hill west of the excavation and deposit it on the lower slope where the villages were built. Because slopewash for thousands of years has carried more sediment into the valley than the little creek can remove, a thick ramp-like deposit has accumulated at the base of the hill.

Figure 12 shows the slopewash deposits, which are called colluvium, and their relation to the hill and the valley side. Most of the colluvium here is silt washed from the loess covering the hill, but pebbles and cobbles eroded from the hill also are found in it. The term "Peyton Colluvium" in the figure is used by Survey
geologists to name all the surface deposits of slopewash and gravity-propelled creep deposits that have accumulated at the base of steep slopes in the state.

The cultural horizons exposed by the excavation and shown in figure 12 are the colluvium layers that the ancient people lived on and used. Each group building and living in its village (for hundreds of years in many cases) dug and buried in the soil, trampled refuse into it, and littered its surface. So it was that each village settlement made a soil layer disturbed by post holes and pits and distinctively textured by accumulations of stone and bone artifacts, charcoal and ashes, and refuse. In addition, soil washed down into a village while it was occupied and thickened its horizon.

The layers of colluvium deposited when the site was abandoned are lighter colored than the cultural layers. Because they contain few or no human artifacts, archeologists call them "sterile" layers. In addition to separating the cultural layers, the thick "sterile" layers of calcareous loess colluvium preserved animal and plant remains in the cultural layers that shallow burial in acid soil would have destroyed.

The Importance of the Koster Site - What makes the Koster Site so important and unique is that when the Indians abandoned a village there, slopewash generally buried it, and buried it deeply enough that the next occupants of the site did not disturb it. At many other habitation sites, shallow burial or erosion left older artifacts at or near the surface, where they were mixed with younger ones. In addition, deep burial of the cultural horizons at Koster has preserved plant and animal remains, which often decompose in near-surface soil zones.

The sequence of 14 or more cultural horizons separated by "sterile" layers has given the archeologists an unparalleled opportunity to date and distinguish the different Indian cultures of the Archaic Period (about 8000 B.C. to 600 B.C.).

Not only the site is remarkable, but also the method of study brought to it: the large scale of the excavation, the use of computers to process millions of items of information from the dig, and the employment of different kinds of scientists to study materials from the site. Such a comprehensive approach to the project will not only enlarge our history of the ancient Indian cultures but also may help to discover patterns of human behavior and cultural evolution that will help us learn how we relate to our environment and to each other.
The two small mounds to the right, between the road and the cemetery, are Indian mounds.

Prepare to turn right.

Crossroad. TURN RIGHT (east) on gravel road.

The itinerary follows a road that has been cut into the thick Wisconsinan loess deposits that mantle the east valley walls of the Illinois River. For the next 0.2 mile, there are excellent loess exposures on both sides of the road.

Prepare to turn left.

T-road from left. TURN LEFT (north).

View to the right (at 4:30 o'clock) shows a glacial hill 2.5 miles to the southeast.

CAUTION--dangerous sharp right turn (north).

TURN LEFT (west).

CAUTION--descend steep hill. Note excellent road cuts in thick loess deposits.

Stop 10. Thick Wisconsinan loess exposed in road cut and borrow pit. (S\(\frac{1}{2}\) NW\(\frac{1}{4}\) NW\(\frac{1}{4}\) NE\(\frac{1}{2}\) Sec. 33, T. 10 N., R. 13 W., Pearl 15' Quadrangle.)

As much as 30 feet of loess is exposed in the vertical cuts along the north side of the road. About 12 feet of tan Peoria Loess overlies about 18 feet of pinkish-tan Roxana Silt. (Although "Roxana Silt" is the formal geologic name for the lower unit, the unit is composed largely of loess.) Illinois is covered with loess, but the thickest deposits in the state--these among them--are found in narrow belts along the bluffs and margins of the Illinois and Mississippi River floodplains. A Survey geologist, Donald E. McKay, recently measured an almost 45-foot thickness of loess in a test hole he drilled on top of the bluffs east of Eldred. In contrast, loess deposits in the eastern third of Illinois are generally less than 4 feet thick and in large areas are less than 2 feet thick.

The Roxana Silt and Peoria Loess are deposits of dust that winds blew out of the Mississippi and Illinois Valleys during the last glacial stage. The Roxana Silt was deposited during the Altonian (first Wisconsinan) glaciation, which lasted from about 75,000 years ago until about 28,000 years ago.

The glacier retreated from Illinois for a short time after the Altonian advance. In this short interglacial substage of about 6,000 years, soil formed on top of the Roxana Silt, which at that time formed the land surface over large areas. Traces of this soil can be found in many places where erosion did not remove it. In this region, there may be at the top of the Roxana a 1\(\frac{1}{2}\)- to 2-foot zone that does not react with 10% hydrochloric acid (see Stop 7). This nonreacting zone, from which calcite was leached, is part of the interglacial soil.

The second Wisconsinan glaciation--the Woodfordian--began about 22,000 years ago and lasted until about 12,500 years ago. The Peoria Loess was deposited during this time. During the glaciations, deposition of loess began when the glaciers began.
to drain into the headwaters of the Mississippi and Illinois Rivers. Outwash from
the glaciers—gravel, sand, silt, clay—was swept into the valleys by floods of melt-
water in the spring and summer. The valleys were partly filled, and broad bare
floodplains formed in them. In the fall and winter, when the meltwater floods
receded and the floodplains dried out, the prevailing winds from the northwest blew
the talcum-like clays, the flour-like silts, and the fine sands off the floodplains,
up onto the bluffs and southeastward across the state.

In general, the loess deposits thin eastward from the Illinois Valley. The
thickest loess deposits lodged on the timbered river bluffs which acted as a wind-
break. Because the Illinois Valley is relatively narrow through Greene and Jersey
Counties, the winds from the northwest had less fetch here than they had farther up-
stream. As a consequence, the belt of thick deposits along the east bluffs in these
counties is much narrower than it is between Peoria and Beardstown, where the Illi-
nois Valley is wide.

0.0 78.7 Leave Stop 10. CONTINUE AHEAD (north and west).

0.25 78.95 STOP. Intersection with blacktop county highway. TURN RIGHT (north).

0.5 79.45 CAUTION—enter Eldred, cross Hurricane Creek bridge, and prepare to stop.

0.1 79.55 Stop 11. Abandoned Eldred Stone Company limestone quarry and under-
ground mine east of county highway. (SW1/4 SW1/4 NE1/4 Sec. 28, T. 10 N.,
R. 13 W., Pearl 15' Quadrangle.)

NOTE: Park well off the county highway and walk east along
the street for about 250 feet to get a good view of the under-
ground limestone mine. The quarry is located to the east of
the mine. CAUTION—do NOT go into the mine OR work close to
the face as there is danger from falling rocks. The mine is
now used for storage.

The Burlington-Keokuk Limestone exposed here is a white to brownish,
coarsely crystalline limestone that is more than 75 feet thick. The upper 35 feet
or so of the limestone is very cherty, but the lower 40 feet has relatively little
chert. Although the cherty upper part was used for road stone, it was undesirable
for use as a concrete aggregate, and much of the chert was handpicked for discard in
order to make the stone more marketable.

The entries into the relatively chert-free lower part of the limestone are
about 30 feet high, but some of the rooms were reported to be higher than 40 feet
when the quarry and mine operated about the 1930's. The purer lower part was in
demand for a number of uses. As ag lime it was trucked within about a 10-mile radius
of the quarry and shipped by rail to Roodhouse to the north and to near Alton to the
south. The pure stone was shipped widely throughout western and northern Illinois
for use in hog mineral mixtures, which required stone having a purity higher than
96 percent CaCO3. The stone also found considerable use as poultry grit because it
could be guaranteed to contain more than 99 percent CaCO3.

0.0 79.55 Leave Stop 11. CONTINUE AHEAD (north).

0.2 79.75 STOP. Crossroad. Intersection with SR 108. TURN LEFT (west).

0.35 80.1 To the right, view of the east valley wall of the Illinois River. Note
the rounded hilltop prairie close to the bluff.
The Illinois Valley had its origin during the early part of the Ice Age, about 1,000,000 years ago or so. There is little evidence to indicate exactly what the drainage system in this region was like before that time. However, major drainage at the beginning of the Pleistocene Epoch seems to have been northward, not southward as at the present time. With the advance of the Nebraskan glacier—the first of the glacial advances—from the northwest, the northward-draining rivers were blocked by the ice. Nebraskan meltwater was forced to seek a southward escape route, and a major meltwater channel was eroded around the eastern margin of the Nebraskan glacier. This valley entered northwestern Illinois near Fulton in Whiteside County, from where it extended southeastward to the present "Big Bend" of the Illinois Valley near Hennepin. From there it followed approximately the present course of the Illinois Valley to a junction with another meltwater valley (the Ancient Iowa River) near Grafton in Calhoun County. By the end of the Nebraskan glaciation the valley had been permanently established. For most of Pleistocene time the valley was occupied by an ancestral stream called the Ancient Mississippi River. The valley was deepened and widened by the Ancient Mississippi during the Nebraskan glaciation, the Aftonian interglacial interval, and the Kansan glaciation. Evidence indicates that the valley had been cut to its greatest depth by the time the Kansan glacier invaded Illinois.

It is interesting that the Ancient Mississippi Valley was overridden by the advances of the Illinoian glacier and partly filled by drift. It is interesting to note, however, that westward diversion of the river was only temporary and that only relatively minor changes in the position of the valley took place. After the Illinoian glacier melted, the Ancient Mississippi River was able to return to its course through the Big Bend and then southward through the present Illinois Valley.

The Ancient Mississippi continued to follow its course through the Big Bend until the valley was overridden by the advance of the Wisconsinan glacier in the early part of the Woodfordian glaciation some 22,000 years ago. This advance, called the Shelbyville, forced the Ancient Mississippi River westward, where it cut through a bedrock divide at Cordova, south of Fulton, and joined the valley of the Ancient Iowa River, the course it now follows along the western side of Illinois. The valley from Fulton to the Big Bend was filled by Shelbyville drifts and permanently abandoned. The upper Illinois Valley east of the Big Bend was then cut by meltwater during the numerous advances and retreats of the Woodfordian glacier and by overflow from glacial Lake Chicago.

The Illinois Valley is about 3 miles wide between Eldred and Kampsville. About 5 miles to the north, the valley is nearly 5 miles wide.

The Illinois River is the largest segment of the Illinois Waterway, one of the busiest of our country's Inland Waterways. Willman reported in ISGS Circular 478...
that during 1969 river traffic totaled nearly 32 million tons, an increase of 28 percent from 1960, and this tonnage required about 4,000 towboat and about 20,000 barge trips each way. More than twice as much tonnage is carried up the Waterway as down. Commodities shipped by barge are divided roughly into four equal categories--farm products, coal, petroleum, and all others (largely nonmetallic minerals, chemicals, and metal products). The crude and processed minerals account for about 47 percent of the tonnage transported on the Waterway.

0.0 82.9 Leave Stop 12a. CAUTION--board ferry. The Illinois River is about 0.2 mile wide here. Enter Calhoun County half way across river. CONTINUE AHEAD (west) after landing.

0.15 83.05 STOP. Crossroad. Intersection with SR 100. TURN LEFT (south) on SR 100.

0.2 83.25 Stop 12b. Visit to Kampsville Archeological Museum. (SW₁/₄ NE₁/₄ SW₁/₄ Sec. 2, T. 9 S., R. 2 W., Pearl 15' Quadrangle.)

The museum is in Kampsville, three and one-half blocks south of the intersection of Illinois Highways 100 and 108. Housed in an old meat market, it is one of 29 residences and buildings converted to laboratories and other facilities of the Field Education and Research Center of the Northwestern Archeological Program.

According to the Koster Expedition's newsletter, Early Man, the museum "houses exhibits dealing with the trade system of eastern North America 2,000 years ago, prehistoric diseases, and artifacts from Koster." Our most recent information states that admission to the museum is free, and that it is open daily during the digging season, a period lasting from early June until late October. The Center's Demonstration Lab for Environmental Archeology is also open in this season.

More precise information about opening dates, programs at Kampsville and the Koster site, and costs for tours and visiting lectures can be obtained by writing or calling the Northwestern Archeological Program at Northwestern University (Box 1499, Evanston, IL 60201; phone 312-492-5300) or at Kampsville, IL 62053 (phone 618-653-4395).

END OF TRIP

Property Owners:

Stop 2: Ms. Nellie Samson, St. Louis, Missouri.
Stop 3b: Mr. Fred Strang, 314 N. Main St., White Hall, Illinois 62092.
Stop 4: Mr. Edward Whitlock, Carrollton, Illinois 62016.
Stop 8: Mr. J.A. Purcell, Carrollton, Illinois 62016.
Stop 9: Mr. Theodore Koster, Eldred, Illinois 62027.
Stop 11: The owner of the quarry at Stop 11 in Eldred lives in the first house north of the quarry on the east side of the road.
REFERENCES


Early Man, Newsletter of the Koster Expedition and other explorations of the Northwestern University Archeological Program in Southern Illinois, Holiday Issue, 1975, 12 p.


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 (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.

2. The Glacier Advances Southward - As the glacier (G) spreads out from its snowfield, it scours (SC) the soil and rock surface and quarries (Q)—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 (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before the ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, 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>HOLOCENE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soil, youthful profile of weathering, lake and river deposits, dunes, peat</td>
<td>Outwash along Mississippi Valley</td>
</tr>
<tr>
<td></td>
<td>7,000</td>
<td>Valderan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11,000</td>
<td>Twocreekan</td>
<td></td>
</tr>
<tr>
<td>WISCONSINIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4th glacial)</td>
<td>12,500</td>
<td>Woodfordian</td>
<td>Ice withdrawal, erosion</td>
</tr>
<tr>
<td></td>
<td>22,000</td>
<td>Farmdalian</td>
<td></td>
</tr>
<tr>
<td></td>
<td>28,000</td>
<td>Altonian</td>
<td>Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes</td>
</tr>
<tr>
<td></td>
<td>75,000</td>
<td></td>
<td>Ice withdrawal, weathering, and erosion</td>
</tr>
<tr>
<td>SANGAMONIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3rd interglacial)</td>
<td>175,000</td>
<td>Soil, mature profile of weathering</td>
<td></td>
</tr>
<tr>
<td>ILLINOIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3rd glacial)</td>
<td>300,000</td>
<td>Jubileean</td>
<td>Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois</td>
</tr>
<tr>
<td></td>
<td>600,000</td>
<td>Monican</td>
<td></td>
</tr>
<tr>
<td></td>
<td>700,000</td>
<td>Liman</td>
<td></td>
</tr>
<tr>
<td>YARMOUTHIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2nd interglacial)</td>
<td>900,000</td>
<td>Soil, mature profile of weathering</td>
<td></td>
</tr>
<tr>
<td>KANSAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2nd glacial)</td>
<td>1,200,000 or more</td>
<td>Drift</td>
<td>Glaciers from northwest invaded western Illinois</td>
</tr>
<tr>
<td>AFTONIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1st interglacial)</td>
<td>1,200,000 or more</td>
<td>Drift</td>
<td></td>
</tr>
<tr>
<td>NEBRASKAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1st glacial)</td>
<td>1,200,000 or more</td>
<td>Drift</td>
<td></td>
</tr>
</tbody>
</table>

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.—pl. 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 Archs. 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 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.
Geodes are usually globular although they also may be irregular, discoid, or sometimes shaped very much like fossils. They are usually found in limestone, but they may also form in shaly rocks. Most of them are hollow, but many have become filled with minerals growing from the walls inward.

A typical geode sawed or broken in two will disclose a sequence of layers from the outside-in as follows: (1) a thin clay layer; (2) a layer of noncrystalline chalcedony; (3) crystals (usually quartz) projecting into the hollow interior. Less commonly calcite or dolomite crystals will form next to the outer chalcedony layer instead of quartz, and sometimes the inside of a geode will be nothing but chalcedony; and (4) a deposit of minor minerals, commonly as crystal druses of pyrite, ankerite, magnetite, hematite, kaolin, aragonite, millerite, chalcopyrite, sphalerite, limonite, smithsonite, malachite, gypsum, fluorite, barite, marcasite, geothite, pyrolusite, and possibly tenorite and chalcocite. Perhaps the most thought provoking and rarest of geodes are those which contain petroleum or some thicker bituminous material.

By what processes and under what conditions did these interesting features originate? There are many theories, none of which are completely adequate. The following discussion is an attempt to compile some of them into a brief summary.

First of all, it is generally agreed that geodes are cavity fillings. The agreement ends here, for the stumbling block is the origin of the initial cavity. One idea is that the cavities are "vugs" caused by gas pockets or by shrinkage of the rock. However, vugs are integral parts of the rock in which they are contained, whereas geodes are complete entities which can be broken out of the rock formation with comparative ease. Some geologists have suggested that they are merely special types of concretions, but geodes grow from the outer shell inward, whereas concretions build up from a central core. Bassler (1908, pp. 133-154) has shown that some geodes originate in fossil cavities and upon growth of the geode, the fossil bursts. Upon further growth, the fragments of the fossil are dissolved or absorbed by the growing geode and are lost. Van Tuyl (1916, pp. 34-42) believes that the original cavity is the space which was occupied by a concretion. Concretions are easily removed from the rock by percolating waters and would thus leave a likely cavity in which a geode could grow. The fact that some geodes contain calcareous clay concretions lends support to this theory.

Pettijohn (1957, pp. 204-205) gives a rather complex process by which geodes grow after the formation of an initial cavity. This process may be summarized in the following steps: (1) a cavity is formed in the rock by some means; (2) a salty solution fills the cavity and pore spaces in the rock; (3) a layer of gelatinous silica is then deposited, isolating the salt solution in the cavity; (4) later the water in the surrounding pore spaces becomes fresh. This sets up what is known as an osmotic cell. This particular osmotic cell consists of two different types of solutions separated by a membrane of gelatinous silica which will allow the fresh solution to pass into the geode cavity, but will not allow the salt to pass out of it; (5) the fresh water flowing into the cavity by osmosis builds up internal pressure
which pushes on the walls of the geode; (6) this pressure, exerted outward against the surrounding limestone, dissolves the limestone, leaving an insoluble residue which becomes the thin clay layer on the outer surface of the geode; (7) the above process continues until the salt solution is so diluted by the incoming fresh water that the osmotic cell no longer operates. The geode has reached maturity; (8) gradually the silica gel dehydrates and crystallizes; (9) shrinking and cracking then follow; (10) finally, mineral-bearing waters flowing through the cracks deposit the innermost layer of minerals. These cracks may eventually seal, leaving a completely closed geode.

The process by which some of the geodes of the Warsaw beds came to contain petroleum is also very much a mystery. Frank Fleener (1961) gives an interesting account of the problem. He envisions the petroleum having migrated up into the Warsaw Formation from the oil-bearing rocks to the south. There partially formed geodes were found with loose quartz crystals (some doubly terminated) adrift in the thick bitumen. The influx of the bituminous material stopped the growth of the geodes, but the mechanism by which the bitumen was enclosed and hermetically sealed remains a matter of conjecture. We believe that many of these geodes are hermetically sealed because the bituminous material will sometimes squirt out with force when the geode is punctured. This phenomenon is presumably due to the sudden expansion of the material when the pressure under which it was formed is relieved.

A more plausible explanation for the petroleum is that it was derived from the enclosing shale and shaly limestone. The weight of overlying sedimentary rocks could easily have freed hydrocarbons from the organic matter in the shale and shaly limestone. The hydrocarbons then migrated to zones of lowest pressure, and these most likely would be the cavities inside the geodes. It appears that such a pressure difference would exist because the hard shell of the geode could withstand a great amount of lithostatic pressure.

The above discussion of the origin of geodes is incomplete and generalized, but we hope that it will stimulate interest in these remarkable features. Perhaps as you break them open in search of beautiful crystals, you will reflect upon their history and feel a greater appreciation for the intricate processes by which nature is continuously altering the crust of the earth.

REFERENCES


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 non-marine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an ideally complete cyclothem consists of 10 sedimentary units. The chart on the next page shows the arrangement. Approximately 50 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, horse-tails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate. Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

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

The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests and initiated marine conditions of deposition. The peat deposits were buried by marine sediments. Following burial, the peat deposits were gradually transformed into coal by slow chemical and physical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coalification process, and the peat deposits were changed into coal.
Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

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

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

Limestone; contains marine fossils.

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

Limestone; contains marine fossils.

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

Coal; locally contains clay or shale partings.

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

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

Shale, gray, sandy.

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 OF ILLINOIS
showing
BEDROCK BELOW
THE GLACIAL DRIFT
1970
(From Willman and Frye, 1970.)

MILES
0 20 40 60

KILOMETERS
0 40 80

Pleistocene and
Pliocene not shown

TERTIARY

CRETACEOUS

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

PENNSYLVANIAN
Carbondale and Modesto Formations

PENNSYLVANIAN
Caseyville, Abbott, and Spoon
Formations

MISSISSIPPIAN
Includes Devonian in
Hardin County

DEVONIAN
Includes Silurian in Douglas,
Champaign, and western
Rock Island Counties

SILURIAN
Includes Ordovician and Devonian in Calhoun,
Greene, and Jersey Counties

ORDOVICIAN

CAMBRIAN

Des Plaines Complex - Ordovician to Pennsylvanian
Fault
**PELECYPods**

Nucula (Nuculopsis) giryi 1x

Edmonia ovata 2x

Astartella concentrica 1x

Dunbarella knighti 1½ x

Cardiomorpha missouriensis "Type A" 1x

Cardiomorpha missouriensis "Type B" 1½ x

**GASTROPODS**

Euphemites carbonarius 1½ x

Trepospiro illinoisensis 1½ x

Donaidina robusta 8x

Naticopsis (Jedria) ventricosa 1½ x

Trepospira sphaerulata 1x

Knightites montfortianus 2x

Glabrocingulum (Glabrocingulum) grayvillense 3x
BRACHIOPODS

- Wellerella tetrahedra 1\(\frac{1}{2}\)x
- Juresania nebrascensis 2\(\frac{1}{3}\)x
- Derbya crossa 1x
- Composita argentia 1x
- Neospirifer cameratus 1x
- Chonetes granulifer 1\(\frac{1}{2}\)x
- Mesolobus mesolobus var. evamygus 2x
- Marginifera splendens 1x
- Grurithys planoconvexa 2x
- Linoproductus "cora" 1x