GUIDE LEAFLET

GEOLOGICAL SCIENCE FIELD TRIP

Sponsored by
ILLINOIS STATE GEOLOGICAL SURVEY, URBANA

PARIS AREA

Edgar County
Paris Quadrangle

Leaders
George Wilson, David Reinertsen, and William Cote
Urbana, Illinois
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HOST: Paris High School
To the Participants:

The Geological Science Field Trip program is designed to acquaint you with the landscape, 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 trips that have been held in the past, may be obtained free of charge by writing to the Illinois State Geological Survey.

We hope you enjoy today’s trip and will come again.
INTRODUCTION

General Geology of the Paris Area

Physiographically the Paris field trip area is situated within the southeast portion of the Bloomington Ridged Plain of the Till Plains Section. Relief is fairly low with elevations ranging from about 525 to 785 feet above sea level. East-central Illinois, including the Paris area, was glaciated during the Kansan, Illinoian, and Wisconsinan (glacial) Stages of the Pleistocene Epoch (fig. 1). The field trip area is situated just to the north of the Wisconsinan glacial boundary, which is marked by the Shelbyville (end) Moraine. North of the Shelbyville Moraine the Wisconsinan drift, which includes a thin upper veneer of loess two to four feet thick, forms all of the surface materials (fig. 2). Older Illinoian and Kansan drift and bedrock are exposed only where erosion has locally cut through the Wisconsinan deposits, mainly along stream valleys.

The glacial deposits, which range in thickness from a thin veneer to as much as 200 feet, rest upon a bedrock surface with about the same relief as the present land surface. However, the glacial deposits have largely buried the preglacial landscape, and the present topography is essentially the result of glacial deposition and subsequent erosion of the glacial drift by streams. Over most of the area the topography is flat to gently rolling, but adjacent to stream valleys, especially south of Paris where the streams cross the Shelbyville Moraine, the terrain is quite hilly. The major streams flow south and southeast toward the Embarras and Wabash Rivers. The present stream valleys are cut into the glacial deposits and none date from preglacial time.

The glacial deposits are thickest in the western and southern parts of the field trip area and are thinnest to the east and northeast of Paris within a broad area where the bedrock surface is high. Within this area of thin drift the bedrock crops out in many places. The bedrock formations which immediately underlie and are exposed in the Paris area belong to the Pennsylvanian System (fig. 3). They consist of about 800 to 900 feet of sandstone, limestone, shale, and coal, which were deposited in coastal marshes or in shallow seas that repeatedly invaded the Midwest more than 200 million years ago. Approximately 2600 feet of older sedimentary rocks (Mississippian, Devonian, Silurian, Ordovician, and Cambrian) occur beneath the Pennsylvanian strata above a crystalline, granitic Precambrian basement. All of these sedimentary layers, which were originally deposited horizontally, were later warped and tilted by forces acting within the earth's crust.

Geologically the Paris area occurs on the eastern shelf of the Illinois Basin, a large spoon-shaped depression, 250 to 300 miles in diameter, which covers most of Illinois, southwestern Indiana, and western Kentucky (see attached geologic map). Crustal movements which formed the Illinois Basin began as early as Ordovician time, about 440 million years ago. West of the Paris area the strata are deformed into a complex series of gentle folds (anticlines and synclines) (fig. 4). These features form part of a narrow band of folded rocks, the LaSalle Anticlinal Belt, which extends from Ogle County southeast to Wabash County. In the immediate field trip area the sedimentary strata are inclined downward to the west along the eastern flank of the Marshall Syncline, a broad structural feature which lies to the east of and parallel to the LaSalle Anticlinal Belt.
Crude oil is the only mineral resource presently being exploited in the Paris area. Oil has been produced from Pennsylvanian, Mississippian, and Devonian strata. The Pennsylvanian strata contain several coal beds, four of minable thickness, but none is being mined at the present time. In the past, coal has been strip-mined from the Danville #7 Coal northeast of Paris. The area has potentially valuable limestone deposits which have been sporadically quarried in the past for roadstone and agricultural lime. The glacial drift contains sand and gravel deposits which are also potentially valuable as roadstone and concrete aggregate for the construction industry. Ground water, another important natural resource, has been obtained from sand and gravel deposits at many places in the Paris area. Good domestic and farm water supplies have also been obtained from shallow Pennsylvanian sandstones and limestones.

Glacial History of Illinois

A knowledge of Illinois glacial history and the glacial deposits is necessary for full appreciation of many points of geologic interest in the Paris area. The following summary is a brief introduction to these subjects and should be read before the field trip begins.

Thousands of years ago much of northern North America was covered by huge glaciers. These glaciers, which advanced from centers in eastern and central Canada, developed when the mean annual temperatures were a few degrees lower than they are now, and the winter snows did not completely melt during the summers. After many years a sheet of ice accumulated that was so thick its weight caused it to flow outward, carrying with it the soil and rocks on which it rested and over which it moved.

The Pleistocene Epoch or "Great Ice Age" began about one million years ago and ended about five thousand years ago. During this epoch, there were four major stages of glaciation, each followed by a long interglacial stage characterized by climatic conditions much as they are today (see figure 1 and attached Pleistocene Time Table).

The oldest glacial stage is the Nebraskan, named after the state of Nebraska where extensive Nebraskan deposits are buried beneath the younger glacial deposits. In Illinois the Nebraskan deposits are also buried, and there are only rare exposures of Nebraskan till in extreme western Illinois. A warm climatic interval, called the Aftonian (interglacial) Stage, followed the melting of the Nebraskan glacier.

The next glacial climate produced the Kansan glacier, which left thick deposits of fine rock materials and outwash sand and gravel in Illinois when it melted away. The Kansan Stage was followed by the Yarmouthian (interglacial) Stage. During this stage, erosion carved valleys and hills, and soils were formed in the Kansan deposits.

The third glacial stage, the Illinoian, is particularly important to the residents of Illinois. The Illinoian glacier, in three separate advances (Liman, Jacksonville, Buffalo Hart), covered 80 percent of the state, reaching southward to Carbondale and Harrisburg. After several thousand years, a warm stage caused the Illinoian ice sheet to melt. During this warm stage, the Sangamonian, the upper part of the deposits left by the glacier was weathered and soil developed,
Figure 1. Pleistocene glacial and interglacial intervals in Illinois
Figure 2 - Glacial Geology of Paris Area.

Figure 3 - Bedrock Geology of Paris Area.
Figure 4 - Major geologic structures in and adjacent to Clark and Edgar Counties.

Figure 5 - Geologic cross section showing structure and thicknesses of Pennsylvanian formations over LaSalle Anticlinal Belt.
as in the preceding Yarmouthian interval. These ancient Sangamonian soils resemble present-day soils in color, texture, and depth, suggesting that the climate during interglacial times was similar to our present climate.

The last and most recent glacial stage in Illinois was the Wisconsinan, which began about 70,000 years ago. The Wisconsinan comprised three major glacial advances—the Altonian, the Woodfordian, and the Valderan. Little is known about the extent of the Altonian glacier, as its deposits were overridden by later glaciers, except in Northern Illinois. The Woodfordian glacier advanced southward from the Lake Michigan basin to the present sites of Shelbyville, Decatur, Charleston, and Peoria. The Valderan glacier reached its maximum extent near Milwaukee, Wisconsin, and did not enter Illinois.

When the glaciers melted, they released the rock materials they had picked up as they advanced. These materials are called "glacial drift." Some of the glacial drift was washed out with the meltwaters. The coarsest material (gravel, sand) carried by the meltwater was deposited nearest the ice front, and the finer material (silt, clay) was carried farther away, with some possibly carried all the way to the sea. Where the outwash material was spread widely along the front of the glacier, it formed an outwash plain. Where the outwash was restricted to the stream valleys, it formed valley train deposits. Many valley trains in Illinois are buried beneath younger glacial drift.

Glacial drift deposited directly by the ice is called till. It is unsorted and unstratified and consists of a mixture of all kinds and sizes of rock fragments. As the Wisconsinan glacier wasted away, the ice front melted back and readvanced many times, creating a complex sequence of till deposits in northeastern Illinois, the most outstanding of which are end moraines. More than 50 successive end moraines were formed by the Wisconsinan glacier in Illinois alone. The major ones are shown on the accompanying glacial map of northeastern Illinois.

An end moraine is an accumulation of drift at the ice margin when the rate of advance and the rate of melting of a glacier are essentially in balance. As more and more rock debris is brought to the edge of the glacier, it piles up and forms a ridge.

The surface relief of end moraines is generally greater than that of the surrounding area and is referred to as swell-and-swale or knob-and-kettle topography. At some places there are large gaps in the moraines where subglacial streams presumably carried away most of the drift. The flatter areas behind end moraines are called ground moraines or till plains.

At times, especially in the fall and winter, the meltwaters subsided, exposing the valley trains. The wind picked up silt and fine sand from their floodplains and dropped these materials on the bluffs and uplands to form deposits of loess. Loess mantles most of Illinois. Near the large river valleys it may be as much as 60 to 80 feet thick, but it thins rapidly away from the valleys.

The importance of the Pleistocene Epoch to Illinois is emphasized by the rich soils formed from the glacial deposits and by the abundant deposits of sand and gravel. The glacial outwash, especially buried valley trains, is an important source of groundwater. The state would not have these valuable resources if the glaciers had not invaded Illinois.
Itinerary

0.0 0.0 Assemble on east side of Paris High School. Turn left on West Crawford Street.

0.1 0.1 STOP. Turn left (south) on South Central Avenue (Routes 1 and 150).

0.4 0.3 STOP. Intersection with Route 133. Turn right (west) on West Jasper Street (Routes 133 and 16).

0.7 0.3 Railroad crossing. CAUTION. Continue ahead (west).

0.8 0.1 SLOW. Turn left on South Jefferson. Proceed south on oil and brick road.

0.9 1.5 Ascending backslope of Shelbyville Moraine.

2.1 3.6 Approaching crest of Shelbyville Moraine. Note the rugged, hummocky topography.

4.5 0.9 Crossing the crest of the Shelbyville Moraine. This point is the highest along the field trip itinerary (elevation approximately 782 feet).

5.1 0.6 T-road intersection. Turn left (east) on gravel road.

5.2 0.1 Note till exposed in road cut on south side of road. For the next seven miles the itinerary follows the crest of the Shelbyville Moraine.

6.3 1.1 STOP. Crossroads intersection with Route 1. Continue straight ahead across the highway. CAUTION. Stop along the south side of the gravel road immediately east of the highway. Stop 1 is located about 300 yards to the south, along the grass shoulder on the east side of Route 1.

Stop 1. Discussion of Shelbyville Moraine.

This stop is near the top of the Shelbyville Moraine, the southernmost end moraine of the Wisconsinan glacier in Illinois (see fig. 2 and Glacial Map of Northeastern Illinois). Note the moraine's pronounced arcuate or lobate regional form, which reflects the strong influence of the Lake Michigan basin on the flow of the Woodfordian glacier.

The topography on the Shelbyville Moraine in the Paris area is quite hilly and can be characterized as typical "knob and kettle" topography. The moraine stands locally as high as 150 feet above the Illinoian till plain to the south and is the most prominent feature of the landscape. Towards the south and southwest from here, the Shelbyville outwash plain slopes gently down to the level of the Illinoian till plain.

The particular significance of the Shelbyville Moraine is that it marks the line of maximum southward advance of the Wisconsinan glacier in Illinois. However, the advance of the glacier during Shelbyville time was not the first advance of the Wisconsinan glacier. The
Shelbyville Moraine was deposited by ice of the Woodfordian lobe about 20,000 years ago, but between 60,000 and 28,000 years ago the earlier Altonian lobes entered Illinois. Except in extreme northwestern Illinois, the Altonian glacial drift was overridden by the Woodfordian ice and is buried beneath the younger drift.

The topography of the Shelbyville area is mainly the result of the deposition of drift by the Wisconsinan and Illinoian glaciers, and subsequent erosion and stream dissection of these deposits after the glaciers wasted away. The topography is young geologically throughout the entire area, but a distinct contrast exists between the areas north and south of the Shelbyville Moraine. This contrast is related to differences in time elapsed since each area was glaciated. Behind the moraine on the Wisconsinan till plain (Bloomington Ridged Plain) there is much less relief than in front on the Illinoian till plain (Springfield Plain). Probably no more than 20,000 years have passed since the Shelbyville glacier melted back, while the Illinoian till plain has been exposed at least 200,000 years.

The Wisconsinan till plain is flat and poorly-drained with few streams flowing in narrow, shallow valleys. On the other hand, the Illinoian till plain is rolling and well-drained with many streams comprising a well-integrated drainage system. The valleys are considerably wider and deeper than those on the Wisconsinan drift. The Illinoian glacial drift is also thinner, and the relief of the bedrock surface has considerable influence on the surface topography on the Illinoian till plain.

0.0 6.3 Leave Stop 1. Continue ahead (southeast).
1.4 7.7 Note the view to the right (south and southeast) across the Illinoian till plain.
0.3 8.0 Descend hill. SLOW.
0.2 8.2 Cross ford over Clear Creek. Note the exposure of till in the east bank of the creek on the right.

Clear Creek has cut a narrow, fairly steep-walled valley across the front part of the Shelbyville Moraine. South of the moraine the valley follows the approximate course of an older preglacial bedrock valley, now partially buried beneath the glacial deposits, which has probably influenced the present course of the stream. The stream which cut the bedrock valley was part of a preglacial drainage system which flowed south and southeast toward the Ancient Embarras and Wabash Rivers. The preglacial Wabash drainage system in southeastern Illinois was considerably smaller than the present drainage system and terminated only a mile or so north of the Shelbyville Moraine in Coles and Edgar Counties. Present tributary streams of the Wabash drainage basin have extended about 80 miles north from the moraine, cutting their valleys into the glacial deposits. Except for Clear Creek Valley to the south of the Shelbyville Moraine, the present stream valleys both north and south of the moraine are generally unrelated to the preglacial topography. The present streams probably originated near the end of the
Illinoian glaciation about 200 thousand years ago, many as meltwater streams, and became established on the Illinoian till plain during the Sangamonian Stage which followed. Later during the Wisconsinan glaciation, the upper portions of some of these streams were covered by the Wisconsinan glacier and were obliterated. The present extension of these streams northward onto the Wisconsinan till plain has taken place during and after Wisconsinan time.

1.1 9.3 One-lane wooden railroad overpass. SLOW.

0.1 9.4 STOP. T-road intersection with blacktop. Turn right (southeast).

2.5 11.9 Entering Elbridge Oil Field. Note the oil well jack on the right.

0.3 12.2 Stop 2. Elbridge Oil Field.

The Elbridge pool, discovered in 1949, covers an area of 390 proved acres. Three pay zones have been found in this pool: (1) a 3' Pennsylvanian sandstone at a depth of about 760'; (2) a 3' Mississippian limestone at a depth of about 950'; and (3) a 20' Devonian limestone at a depth of about 1950'. The discovery well (CONOCO-Cockcroft #1), located about 1000' south of this stop, had an initial production of 50 barrels of saltwater from the Fredonia Limestone Member (Mississippian).

The Elbridge oil pool is located in a small dome that is situated on the west-sloping limb of the Marshall Syncline (fig. 6). This dome was formed by younger, sedimentary strata being draped over a Silurian reef structure. Deformation and tilting of the rocks in this area occurred intermittently from Ordovician through Pennsylvanian times.

Forty wells have been completed in Elbridge dome; of this number, 37 have been to the Mississippian, the largest producing horizon. There were 19 producing wells at the end of 1965. Although the pool produced only 10,160 barrels of oil during 1965, it has had a cumulative production of 1,474,095 barrels of oil. Although some oil has been produced by secondary recovery methods, primarily by waterflooding, the pool has not been extensively worked over.

Midwestern Gas Transmission Company is using the structure at depth (below the oil-producing zones) for a gas storage project, so that gas would be available during times of peak winter consumption in large cities to the north and east. The gas "bubble" is being placed in the Silurian reef and a porous Devonian limestone aquifer (fig. 7). Nonporous Upper Devonian limestones and dolomites and the overlying New Albany Shale (Mississippian) form a gas-tight cap or sealing cover for the gas bubble.

0.0 12.2 Leave Stop 2.

0.1 12.3 SLOW. Prepare to turn left. Continue ahead (southeast).

0.1 12.4 T-road intersection from the left. Turn left (north) on gravel road (Edgar County Highway 3).
Figure 6 - Structure contours on top of Devonian limestone showing dome structure at Elbridge Pool (1" = 1 mile; elevations below sea level; contour interval 40 feet).

Figure 7 - Geologic cross section of Silurian reef structure.
1.3 13.7 SLOW. Sharp left turn.

0.1 13.8 Concrete bridge over Sugar Creek.

0.1 13.9 Stop 3. Exposure of Wisconsinan (Shelbyville) and Illinoian (Mendon) drift in hillside on east side of road.

Geologic Section 1 (in back of guide leaflet) shows the units exposed here along the north wall of Sugar Creek Valley. The stream has cut through the Shelbyville till sheet and exposed the underlying Illinoian till, which is probably the Mendon. The Shelbyville till is quite sandy here due to the nearness to the end moraine, and has been deeply weathered and thoroughly oxidized, giving it a distinctive red-brown color. Only the lower part of the Shelbyville till is unleached and calcareous. As will be seen later at Stop 7, where it is unoxidized, the Shelbyville is usually a dark gray color.

The Illinoian till is easily distinguished from the Shelbyville here by its light gray color, firmness, and stony texture. Of particular significance, is the Sangamon Soil which is developed in the upper part of the Illinoian till. The Sangamon Soil is widely developed in the top of the Illinoian drift sheet throughout Illinois and is an important stratigraphic marker between the Wisconsinan and Illinoian Stages. This ancient soil, formed during the warm Sangamonian Stage (200 to 70 thousand years ago) is readily recognized by its characteristic red-brown color wherever it occurs. At this exposure it is somewhat difficult to distinguish below the red-brown Shelbyville till. It is best seen in the south part of the exposure and can be traced as the grassy zone which occurs about half-way up the slope. The acid test assists in locating the soil zone, which has a somewhat mottled brown and gray color and contains numerous limonite and manganese stains. When tested with dilute acid the unleached till bubbles due to reaction (the release of carbon dioxide) between the acid and the carbonate minerals. The acid test is an important tool that Pleistocene geologists use to determine the presence of buried weathered zones in the glacial drift. The Afton, Yarmouth, and Sangamon Soils are important time markers, and their presence is often determined by the acid test.

Till is an ice-laid deposit. It is characterized by its lack of sorting and lack of stratification. Note the wide range of particle sizes from clay to pebbles and cobbles in this exposure. Many of these were eroded from local bedrock by the glaciers, especially the large erratics of Pennsylvanian sedimentary rocks. Note also the variety of sedimentary, igneous, and metamorphic rocks in the till. Some of the rock fragments are faceted and striated from having been abraded during transport by the ice.

0.0 13.9 Leave Stop 3. Continue ahead (north).

0.3 14.2 Crossroads. Continue ahead (north).

1.1 15.3 Crossroads. Continue ahead (north) on blacktop.

0.5 15.8 T-road intersection from left. Continue ahead (north).
0.5 16.3 T-road intersection from right. Continue ahead (north).
1.0 17.3 SLOW. Entering village of Vermilion.
0.1 17.4 Turn left (west) on blacktop. Continue ahead on blacktop along the south edge of town.
0.2 17.6 Angle intersection with concrete street from right. Turn right (northeast). Vermilion E. U. B. Church on the left.
0.1 17.7 Railroad crossing. CAUTION. Continue ahead (northeast).
0.2 17.9 Bear north and leave village of Vermilion.
0.2 18.1 Crossing the Wisconsinan till plain. Note the flat topography.
0.6 18.7 Crossroads. Continue ahead (north).
1.1 19.8 STOP. Intersection with Route 150. Turn right (east) on Route 150.
1.0 20.8 Crossroads. Continue ahead (east) on Route 150.
0.9 21.7 SLOW. Prepare to turn left.
0.1 21.8 Crossroads. Turn left (north) on gravel road.
1.1 22.9 Crossroads. Continue (north).
0.4 23.3 SLOW. One-lane bridge over Coal Creek.

Stop 4. Exposure of Pennsylvanian (McLeansboro) Bond and Modesto Formations in creek bed west of bridge.

All of the bedrock formations that will be seen along the field trip itinerary belongs to the McLeansboro Group, the upper part of the Pennsylvanian System in Illinois. The exposures to be seen will include parts of several cyclothems in the Bond, Modesto, and Mattoon Formations, which form the bedrock surface over most of the Paris Quadrangle (fig. 3).

The most prominent rock unit exposed here at Stop 4 is the Shoal Creek Limestone (Member), which is the basal member of the Pennsylvanian Bond Formation. The shale, siltstone, and sandstone below the Shoal Creek are part of the Modesto Formation.

The Shoal Creek Limestone Member, about 3' thick here, is an excellent marker bed throughout most of the area underlain by strata of the McLeansboro Group (Upper Pennsylvanian) in Illinois. In the Paris region it is quite easily recognized by the presence of marine fossils, and by its distinctive brown color on weathered surfaces, as well as numerous, small, irregularly rounded, black phosphatic nodules. Geologic Section 2 in the back of the guide leaflet has a graphic representation of this exposure and detailed descriptions of the various units present.
The Shoal Creek Limestone Member is the second marine limestone that occurs above the coal in the ideal cyclothem. (See discussion below). Most of the units of the Shoal Creek Cyclothem are not present in this locality. A thin coal and limestone belonging to the underlying Macoupin Cyclothem occur to the east about .3 of a mile down the creek. About 1 1/2 miles to the east in Indiana, the Danville No. 7 Coal Member of the Carbondale Formation (Kewanee Group) is present in the creek bank. The No. 7 Coal has been mined at nearby localities in eastern Edgar County and in adjacent Indiana.

Sedimentary History of the Pennsylvanian Rocks

Pennsylvanian sedimentary rocks form the bedrock surface over approximately four-fifths of Illinois and have a maximum cumulative thickness of about 3000 feet. They were deposited between about 270 and 300 million years ago, and contain all of Illinois' minable coal beds, whose recoverable reserves are estimated at 137 billion tons. In 1965, over 58 million tons of coal valued at over $217 million were mined in Illinois, ranking the state fourth among the coal-producing states in the nation.

Unlike the older sedimentary rocks in Illinois, which consist of fairly thick units of limestone, dolomite, sandstone, and shale, the Pennsylvanian strata are made up of comparatively thin rock units, often only a few inches thick and rarely exceeding 30 feet. They are characterized by frequent and abrupt vertical changes in rock type. Several hundred individual units - sandstone, shale, siltstone, clay, limestone, and coal - are present in the Pennsylvanian System. Many of these individual units are quite variable in thickness and grade laterally from one rock type to another. However, some units, especially the limestones, are very persistent laterally and can be traced over large areas of the state.

About 30 years ago, geologists at the Illinois Geological Survey noted from their field studies of the Pennsylvanian strata that the various individual rock units occur in regular sequences which are repeated many times. Each regular sequence represents a cycle of sedimentation during which the individual units were deposited under environmental conditions that changed with time. Each cycle of sedimentation, called a cyclothem, consists of several lithologic units, part of which were deposited under marine conditions and part under nonmarine conditions. Based on extensive studies of the entire Pennsylvanian System in Illinois and the Midwest, the geologists determined that an ideally complete cyclothem consists of ten distinct sedimentary units. The attached chart shows the arrangement of units in the ideal cyclothem. Only a few of the approximately 50 cyclothems that have been described in Illinois contain all ten units. Usually one or more units are missing, but the order of arrangement is almost always the same. The units which are most commonly present are a basal sandstone overlain by an underclay, coal, black slaty shale, limestone, and gray shale.

The variety of sedimentary rock types in the Pennsylvanian System, the thinness of individual units, the abrupt and frequent vertical changes in rock types, and the lateral variations in thickness and lithology of most units, indicate a wide range of depositional conditions which changed fairly rapidly with time. The cyclical character of the sedimentary sequences also indicates that the depositional conditions during Pennsylvanian time changed in a regular
manner. The geologic framework which produced these conditions is not exactly known, but it was unique to the Pennsylvanian Period, because no other system of sedimentary rocks in the geologic column exhibits a comparable development of cyclic sediments.

Geologists have offered several explanations for the Pennsylvanian cycloths, too numerous and detailed to discuss at the present time. The presence of both marine and nonmarine deposits in each cyclothem requires that invasion and withdrawal of the sea occurred during the formation of each cycle. The repeated alternations of marine and nonmarine sedimentary rocks also indicate that there were many intervals of invasion and withdrawal. In general, the sandstone-underclay-coal portion (the lower 5 units) of each cyclothem is nonmarine and was deposited on coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partially marine. The units above the coal are marine sediments which were deposited during the invasion part of the cycle. The exact mechanism which caused these repeated relative changes in sea level is not known, but the occurrences of cyclic Pennsylvanian sediments on many of the continents suggests that the sea level fluctuations were world-wide. The following discussion briefly explains the geologic conditions that probably existed in the Illinois-Indiana region during the Pennsylvanian Period.

During Pennsylvanian time the region northeast of the Illinois Basin was a broad swampy lowland bordering a shallow sea which lay to the south. This lowland stood only a few feet above sea level, so that only slight changes in relative sea level caused great shifts in the position of the shoreline. A slight rise in sea level would have caused submergence of the low borderland, followed by marine deposition, and conversely, a slight lowering would cause emergence of the lowland and much of the shelf of the Illinois Basin, followed by nonmarine deposition.

An ancient river system (fig. 8) flowed across the low borderland from the northeast. This river system carried sand and mud eroded from highlands far to the northeast in what is now Canada and deposited these materials in the Illinois Basin. A great delta, much like the present-day Mississippi River delta in Louisiana, was built out into the sea. Throughout Pennsylvanian time the Illinois Basin was slowly subsiding (sinking), which, along with the world-wide sea level changes, caused the position of the shoreline to change continually. The delta front oscillated northward and southward for hundreds of miles due to the changes in sea level, intermittent subsidence of the basin, and variations in the rates of sediment supply from the land.

At various times conditions at any place 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, and in deeper water beyond the near-shore zone of sand deposition. Limestone, which formed by chemical precipitation from the sea and the accumulation of limy shells of marine plants and animals, were usually deposited farther from shore than the sandstone and shale, but some limestone was formed in nearshore areas where little sand and mud were being deposited. 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.
Figure 8 - Paleogeography of Illinois-Indiana region during Pennsylvanian time.
The 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. Many of the channel sands are preserved as elongate channel deposits in the cyclothems. Some of these sand bodies, 100 or more feet thick, cut through many of the underlying rock units. The shales were deposited mainly on floodplains. Freshwater limestones and some shales were deposited locally in freshwater lakes and swamps. The coals were formed by the accumulation of plant material, usually where it grew, beneath the quiet waters of extensive swamps. Lush forest vegetation, which thrived in the warm, moist Pennsylvanian climate, covered the region. The origin of the underclays beneath the coals is not exactly known, but they were probably deposited in the swamps as slack-water muds before and during the formation of the coals. The formation of coal marked the end of the nonmarine portion of the depositional cycle. Resubmergence of the borderland by the sea interrupted nonmarine deposition, and the marine portion of the cyclothem was then laid down over the coal.

0.0 23.3 Leave Stop 4. Continue ahead (north).
1.2 24.5 Crossroads. Turn left (west) on gravel road.
0.5 25.0 STOP. Y-intersection with one-lane pavement from right. Continue ahead (west).
0.5 25.5 T-road intersection from right. Continue ahead (west).
1.0 26.5 Crossroads. Continue ahead (west).
2.0 28.5 Follow curve to left. Stay on pavement.
0.4 28.9 SLOW. Curve right.
1.2 30.1 Y-intersection with road from left. Continue ahead (southwest).
0.9 31.0 Railroad crossing. CAUTION. Continue ahead on blacktop.
0.3 31.3 Cross Sugar Creek.
0.6 31.9 SLOW. Entering the east edge of Paris.
0.3 32.2 Paris city limits.
0.1 32.3 T-road intersection with Manier Avenue. Turn right (north).
0.1 32.4 Turn left (west) on Union Street.
0.2 32.6 STOP. Intersection with North High Street. Turn right (north) on North High Street.
0.1 32.7 Railroad Crossing. CAUTION. Continue ahead (north).
0.8 33.5 Sunrise Drive on right. Continue ahead (north) on gravel road.
0.4 33.9 STOP. Turn left on oiled road.
0.4 34.3 STOP. Intersection with Routes 1 and 150. Cross highway and head west. CAUTION.

0.2 34.5 Turn right beyond cemetery and head north towards park.

0.1 34.6 SLOW. Entering Twin Lakes Park. Bear right and follow circle around to the left. One-way traffic.

0.3 34.9 Stop 5. Lunch.

0.0 34.9 Leave Lunch Stop. Return toward park entrance.

0.3 35.2 Turn left (east) before reaching park entrance. Continue ahead (east) toward main park entrance.

0.3 35.5 STOP. Main entrance to Twin Lakes Park. Turn right (north) on Routes 1 and 150.

0.1 35.6 Cross bridge over Twin Lakes. Continue ahead (north) on Routes 1 and 150.

0.7 36.3 T-road from right. Continue ahead (north) on Routes 1 and 150.

1.2 37.5 T-road intersection from right. Continue ahead (north) on Routes 1 and 150.

0.2 37.7 Crossing the Cerro Gordo Moraine.

The front of the Cerro Gordo Moraine, which lies about one and one-half miles to the south, was formed by a lobe of the Woodfordian glacier which advanced into the Paris area. After the Shelbyville Moraine was formed, the Woodfordian glacier had melted back rapidly for some undetermined distance, perhaps as far as the Lake Michigan basin in response to a warming trend in the climate. A slight cooling with increased snowfall in the northern source areas caused the glacier to readvance temporarily.

The Cerro Gordo Moraine is poorly developed in the Paris area. The low relief of the moraine suggests that the ice lobe may have been thin or that the ice margin was stable for only a short time. Farther west the moraine has more relief and is topographically more distinct. Note the moraine's pronounced lobate or arcuate form in Coles, Cumberland, Shelby, and Piatt Counties. The broad bedrock valley of Kaskaskia River may have controlled the movement of the Cerro Gordo lobe.

0.1 37.8 Note the large glacial erratic boulders on the left side of the road.

0.4 38.2 SLOW. Prepare to turn right.

0.1 38.3 T-road intersection from right. Turn right (east) on gravel road.

2.1 40.4 T-road intersection. Turn right (south) on gravel road.

0.2 40.6 T-road intersection from left. Turn left (east) on blacktop.
Note the high area on the Cerro Gordo Moraine on the right.

The view towards the north is down the backslope of the Cerro Gordo Moraine.

Crossroads. Continue ahead (east) on blacktop.

Crossroads. Continue ahead (east) on blacktop.

STOP. Crossroads. Turn left (north) on blacktop.

SLOW. Prepare to turn right.

T-road intersection from right. Turn right (east) on gravel road.

SLOW. Prepare to turn left.

Crossroads. Turn left (north) on gravel road.

SLOW. Descend steep hill.

Stop 6. Exposure of glacial drift and Pennsylvanian bedrock in north and south banks of Brouilletts Creek.

North of the bridge is an excellent exposure of 2 drift sheets (see Geologic Section 3). The upper unit, consisting of about five feet of red-brown, sandy, calcareous till, is the Cerro Gordo till. The lower unit, consisting of gray, compact, silty, calcareous till may be the Shelbyville. However, because the glacial stratigraphy of the Paris area has not been studied in detail by Survey geologists, this designation is uncertain. The lower till may actually be Illinoian or Kansan in age.

If the lower till is Illinoian or Kansan, one would expect to find a soil or weathered zone in the upper part, but none is present in this exposure. The test with acid reveals that the lower till and the lower part of the upper till are calcareous throughout. The Cerro Gordo till is extremely sandy, and the basal part consists of stratified, coarse sand. The surface or contact between the Cerro Gordo till and the lower till appears to be a sharp erosional surface, so that if a weathered zone were once present in the lower till, it has been removed.

The sandiness of the Cerro Gordo till is a function of nearness to the end moraine, where the glacial margin oscillated back and forth over a narrow zone of several miles. Mixtures of till (ice-laid) and outwash (water-laid) are typical of glacial drift in and near end moraines, where much meltwater was produced by melting of the ice margin.

South of the bridge, beneath the glacial deposits is an exposure of Pennsylvanian bedrock. The units exposed are the same ones that are exposed at Stop 4 (see Geologic Sections 2 and 4). Here the Shoal Creek Limestone is represented only by erosional remnants of limestone that were pushed into the underlying shale by the glacier. Note that individual units are thicker here than at Stop 4, and that the sandstone is
much better developed. The sandstone probably represents the basal unit of the Shoal Creek Cyclothem, but this fact is not certain. The sandstone contains marine fossils in its upper part, which may represent marine animals that lived and died in place, or they may have been eroded from older strata and washed in with the sand. If the former is true, the sandstone represents an exception to the normal cyclothem sequence, and was formed during a temporary shoaling of the sea. If the latter is true, the sandstone may be the basal unit and the usual non-marine units and the coal, which should occur above it, did not form in this area.

0.0 46.5 Leave Stop 6. Continue north.
0.1 46.6 One-lane bridge across Brouilletts Creek.
1.3 47.9 SLOW. Prepare to turn right.
0.1 48.0 Crossroads. Turn right (east).
0.7 48.7 T-road intersection from left. Continue ahead (east).
0.1 48.8 Turn right (south).
0.2 49.0 Bear left (southeast).
0.3 49.3 SLOW. Hill.
0.1 49.4 Y-intersection. Turn right (south).
0.5 49.9 Cross bridge and ascend hill.
0.1 50.0 Stop 7. Exposure of Chapel (No. 8) Coal.

About four inches of the Chapel (No. 8) Coal Member (Modesto Formation) below about 30 inches of black, slaty shale are exposed in the ditch on the west side of the road. Below the coal a portion of the lower non-marine units of the Trivoli Cyclothem are also exposed (see Geologic Section 5). The No. 8 Coal, when present, is an important marker bed in the strata below the Shoal Creek Limestone seen earlier at Stops 4 and 6. The No. 8 Coal is fairly widespread throughout Illinois where McLeansboro strata are preserved, but it is generally too thin for commercial mining operations. Coal is one of the state's most important mineral resources, accounting for about one-third of the total production value, which in 1965 amounted to approximately $618,500,000. Although there was no reported production of coal from Edgar County during 1965, coal has been mined to a limited extent during the past from the Danville (No. 7) Coal, the Harrisburg (No. 5) Coal, and the Seeleyville (Indiana Coal III) 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 cyclothsms. 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 presently-existing club-mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club-mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal climatic variations. Many of the Pennsylvanian plants, such as the seed ferns, became extinct.

Plant debris from the rapidly growing swamp forest, composed of leaves, twigs, branches, and logs, accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation to water, nitrogen, and carbon dioxide. However, the cover of swamp waters, which were 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 became 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 coaification process, and the peat deposits were changed into coal.

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

Immediately below the coal here at Stop 7, there is a four-foot thick deposit of partially leached, plastic, clayey material called "underclay." This fine-grained, clayey deposit was formed as part of a normal series of nonmarine sediments on the slowly submerging Pennsylvanian coastal plain. Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached and possess a bleached appearance, and generally contain plant roots, many geologists consider them to represent the old soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shale, which occurs above the coal is uncertain. It may represent a deposit which formed under restricted marine (lagoonal) conditions during the initial part of the invasion cycle, when the region was still closed off from the open
sea. The lagoons were 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. The fossil remains of animals in the black shales are typically depauperate (dwarf) because they were stunted by toxic conditions in the sulfide-rich waters of the lagoons. The phosphatic siderite nodules, which occur here at Stop 7 in the shale beneath the coal and often in the black shales, were formed by chemical precipitation of calcium carbonate, iron carbonate (siderite), and phosphate from the brackish lagoonal waters. These features suggest slow rates of shale deposition.

0.0 50.0 Leave Stop 7. Continue south.
0.9 50.9 Turn right and then left.
0.4 51.3 T-road intersection. Turn right (west).
0.1 51.4 T-road intersection from left. Continue ahead (west).
0.8 52.2 Crossroads. CAUTION. Continue ahead (west).
1.0 53.2 STOP. T-road intersection. Turn left (south) on blacktop.
1.0 54.2 Crossroads. CAUTION. Turn right (west) on blacktop.
1.1 55.3 Crossroads. CAUTION. Continue ahead (west). St. Aloysius Church on right.
0.1 55.4 Stop 8. St. Aloysius Church Section - Livingston Limestone.

The Livingston Limestone Member, the top member of the Bond Formation, is exposed along the stream-bed west of the church and in an abandoned quarry about one-fourth of a mile north-northwest of the church (see Geologic Section 6).

The Livingston Limestone has a maximum thickness of about 30 feet where it is best developed in this part of Illinois and usually occurs in two distinct benches. Indications that in the past it was much more extensive laterally in the Paris area are: (1) the presence of numerous small outliers of the limestone beyond the main area of its occurrence, and (2) the truncation (beveling) of its upper part by erosion. Here the Livingston lies close to the surface, and the uppermost beds have been eroded off, so that a thickness of only slightly over 20 feet is present.

The top bench of the Livingston here is about six feet thick and consists of light gray, somewhat slabby, fossiliferous limestone. This unit forms the waterfall in the stream-bed and is separated from the lower bench by about seven feet of calcareous, greenish gray shale that contains numerous thin, discontinuous, fossiliferous limestone lenses. The lower bench, about ten feet thick, consists of gray, fossiliferous and somewhat slabby limestone near the top and becomes more massive toward the bottom. About six inches of greenish gray shale occurs beneath the lower limestone unit.
The strata below the limestone farther downstream are no longer well exposed. However, a three-foot bed of greenish gray shale occurs immediately beneath the limestone. The shale is underlain by a 2' 6" bed of tough, laminated black shale that lies on top of one-fourth to one foot of coal.

The Livingston Limestone Member has the characteristics of a normal marine limestone. It formed principally by the accumulation of calcareous plants (algae) and calcareous remains of marine animals, and by chemical or biochemical precipitation of calcite from sea water.

The Livingston contains abundant fossils, many of them complete, including crinoid stems, brachiopods, corals, bryozoans, gastropods, trilobites, and fish bones. Microfossils, including foraminifera (especially fusulinids), and ostracodes are also abundant.

End of Trip

DRIVE CAREFULLY ON YOUR WAY HOME
Recent Podsolic Soil developed in loess and upper part of Shelbyville till

Shelbyville till - red-brown, silty, oxidized throughout; upper part leached; calcareous in lower 2 to 3 feet

Sangamon Soil - developed in upper part of Illinoian till; red-brown, gray-mottled, limonite-manganese nodules

Illinoian till - light gray, slightly pinkish, silty, calcareous; very compact, stony

Geologic Section 1 - Exposure at Stop 3 east of gravel road

Glacial drift - Shelbyville?

Shale - lavender and olive gray, fissile, calcareous

Limestone (Shoal Creek) - gray, weathering brown, thin-bedded to massive, black phosphate nodules, fossiliferous
Shale - olive-gray, fissile, calcareous; blocky with red streaks at top
Limestone - gray, weathering brown, argillaceous, fossiliferous
Shale - olive-gray, blocky, silty, micaceous, calcareous; sideritic and noncalcareous in lower part
Sandstone - gray, weathers brown, argillaceous, calcareous, fine-grained, fossiliferous
Shale - gray, silty, calcareous, thin-bedded
Shale - olive-gray, fissile, calcareous
Shale - gray, silty, calcareous, thin-bedded

Geologic Section 2 - Composite section of exposure at Stop 4 west of bridge
Top of roadcut - 24 -

Cerro Gordo till - reddish brown, sandy, silty, calcareous
- reddish brown, sandy, silty, calcareous, thin
limonitic sand layers
- reddish brown, very sandy, calcareous, coarse sand at base

Shelbyville till - dark gray, silty, calcareous, very compact, stony

Geologic Section 3 - Exposure at Stop 6, north of bridge.

Top of hill

Peoria Loess - brown, mottled gray, leached

Cerro Gordo till - brown, silty, leached

Shoal Creek Limestone - gray, silty, weathered brown, residual blocks

Shale - thin-bedded, greenish gray, weathered reddish brown, silty, calcareous at base, siderite nodules

Limestone - gray, weathers reddish brown, argillaceous, fossiliferous

Shale - greenish gray, silty, thin-bedded, calcareous, siderite nodules in upper half, uneven bedding in lower half

Sandstone - gray, weathering reddish brown, fine-grained, silty, thin-bedded, fossiliferous, numerous worm borings, upper part actually limestone

Shale - greenish gray, silty, thin-bedded, tends to be blocky, large siderite concretions

Bottom of roadcut - about 25' above creek

Geologic Section 4 - Exposure at Stop 6, south of bridge
Grass line at top of roadcut
Shale - gray, silty, calcareous, siderite nodules
Shale - black, fissile, calcareous
Chapel (No. 8) Coal
Underclay - dark gray at top, noncalcareous; grades downward to light gray and then dark gray in lower part; calcareous at bottom
Shale - gray, iron-stained, massive, silty, noncalcareous
Shale - gray, thin-bedded, calcareous, silty, thin sandstone lenses, calcareous nodules; lower part to bottom of exposure contains large siderite nodules

Geologic Section 5 - Exposure at Stop 7.

Bed of Creek

Limestone - light gray, slabby, fossiliferous; large crinoid columnals near top of unit
Shale - greenish gray, calcareous, with thin lenses of fossiliferous limestone
Limestone - gray, slabby, fossiliferous, massive near bottom
Shale - greenish gray

Geologic Section 6 - Exposure near St. Aloysius Church.
GENERALIZED GEOLOGIC COLUMN SHOWING KEY UNITS PRESENT IN PARIS AREA PRINCIPAL SYSTEM

- Livingston Limestone
- Shoal Creek Limestone
- Macoupin Limestone
- Chapel (No. 8) Coal
- West Franklin Limestone
- Danville (No. 7) Coal
- Jamestown Coal
- Herrin (No. 6) Coal
- Briar Hill (No. 5) Coal
- Harrisburg (No. 5A) Coal
- Summum (No. 4) Coal
- Colchester (No. 2) Coal
- Seeleyville Coal
PHYSIOGRAPHIC DIVISIONS OF ILLINOIS

GEOLOGIC MAP OF ILLINOIS

showing

BEDROCK BELOW

THE GLACIAL DRIFT

1961

(Illinois State Geological Survey, Urbana)
<table>
<thead>
<tr>
<th>STAGE</th>
<th>SUBSTAGE</th>
<th>NATURE OF DEPOSITS</th>
<th>SPECIAL FEATURES</th>
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<tbody>
<tr>
<td>RECENT</td>
<td>Valderan</td>
<td>Soil, youthful profile of weathering, lake and river deposits, dunes, peat</td>
<td>Outwash along Mississippi Valley</td>
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<td>Twoocreekan</td>
<td>Peat and alluvium</td>
<td>Ice withdrawal, erosion</td>
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<td>Woodfordian</td>
<td>Drift, loess, dunes, lake deposits</td>
<td>Glaciation, building of many moraines as far south as Shelbyville, extensive valley trains, outwash plains, and lakes</td>
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<td>22,000</td>
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<td>50,000 to 70,000</td>
<td>Soil, mature profile of weathering, alluvium, peat</td>
<td>Glaciation in northern Illinois, valley trains along major rivers, Winnebago drift</td>
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<td>Buffalo Hart</td>
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<td>ILLINOIAN</td>
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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 except 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; variable from massive to thin-bedded; usually with 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)
PENNSYLVANIAN SECTION

1a--1c  Juresania nebrascensis (Owen)
2a--2c  Crurithyris planoconvexa (Shumard)
3a--3c  Composita argentea (Shepard)
4a--4b  Cardiomorpha missouriensis Shumard
5      Lophophyllidium profundum (Edwards and Haime)
6a--6c  Mesolobus mesolobus var. euamygus (Girty)
7a--7c  Mesolobus mesolobus var. decipiens (Girty)
8a--8b  Euphemites carbonarius (Cox)
9a--9c  Linoproductus "cora"
10a--10b Astartella concentrica (Conrad)
11a--11b Glabrocingulum grayvillense (Norwood & Pratten)
12      Trachydomia wheeleri (Swallow)
13      Dunbarella knighti Newell
14a--14c Marginifera splendens Norwood & Pratten
15a--15b Naticopsis altonensis McChesney
16a--16b Cymatospora montfortianus (Norwood & Pratten)
17a--17b Desmoinesia muricatina (Dunbar & Condra)