GUIDEBOOK 27

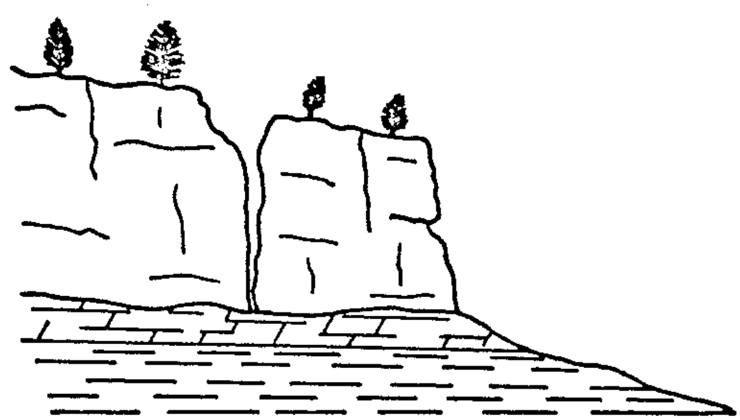
Geological Society of Iowa - Annual Meeting Field Trip

KARST TOPOGRAPHY ALONG THE SILURIAN ESCARPMENT IN SOUTHERN CLAYTON COUNTY, IOWA

September 13, 1975

Compiled by Jean C. Prior

Iowa Geological Survey



Leaders

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INTRODUCTION

The Niagara Escarpment, a cuesta of resistant carbonate rocks of Silurian age, is a structural feature extending for many miles through the Great Lakes region of North America. It becomes a prominent physiographic feature in the Niagara Falls area of New York State, from which the Niagaran Series of the Silurian is named. It reappears as a feature of the surface terrain in northeastern Iowa and it is along this escarpment, the outcrop area of the Niagaran Series in Iowa, where this field trip will take place.

Leonard, in the Geology of Clayton County (1906), describes the Niagara Escarpment as follows:

> "South of the Volga and Turkey rivers the country is very rough and much cut up by the many streams joining these rivers from that direction. The Niagara escarpment, produced by the outcropping edges of the beds of this formation, here forms a conspicuous topographic feature. It has been deeply incised by the numerous streams which cut their valleys far back into the Niagara, making its line of outcrop a very sinuous one winding back and forth along the sides of the valleys and extending out in the ridges and divides between these. At the escarpment the surface rises abruptly from 100 to 200 feet. The precipitous slope is commonly wooded and covered by huge masses and blocks of limestone broken off from above. The roads often follow along near the base, and where they climb to the top they are steep and rocky."

The dominant theme of the field trip will be to examine the geomorphic features that have developed in association with these Silurian strata. In humid environments, lands underlain by carbonate rock units, such as the Silurian dolomites, are subject to dissolution of the rock by movement of surface and groundwater into and along joints, or planes of weakness in the rock. This process can result in extensive underground cavern systems, in development of sinkholes by undermining and collapse of the land surface, in the occurrence of springs issuing from hill sides, or in the sudden disappearance of surface streams into subterranean channels. These geomorphic features are all characteristic of classic "karst" topography, or terrain resulting from subsurface hydrologic activity in soluble limestone and dolomite rock units.

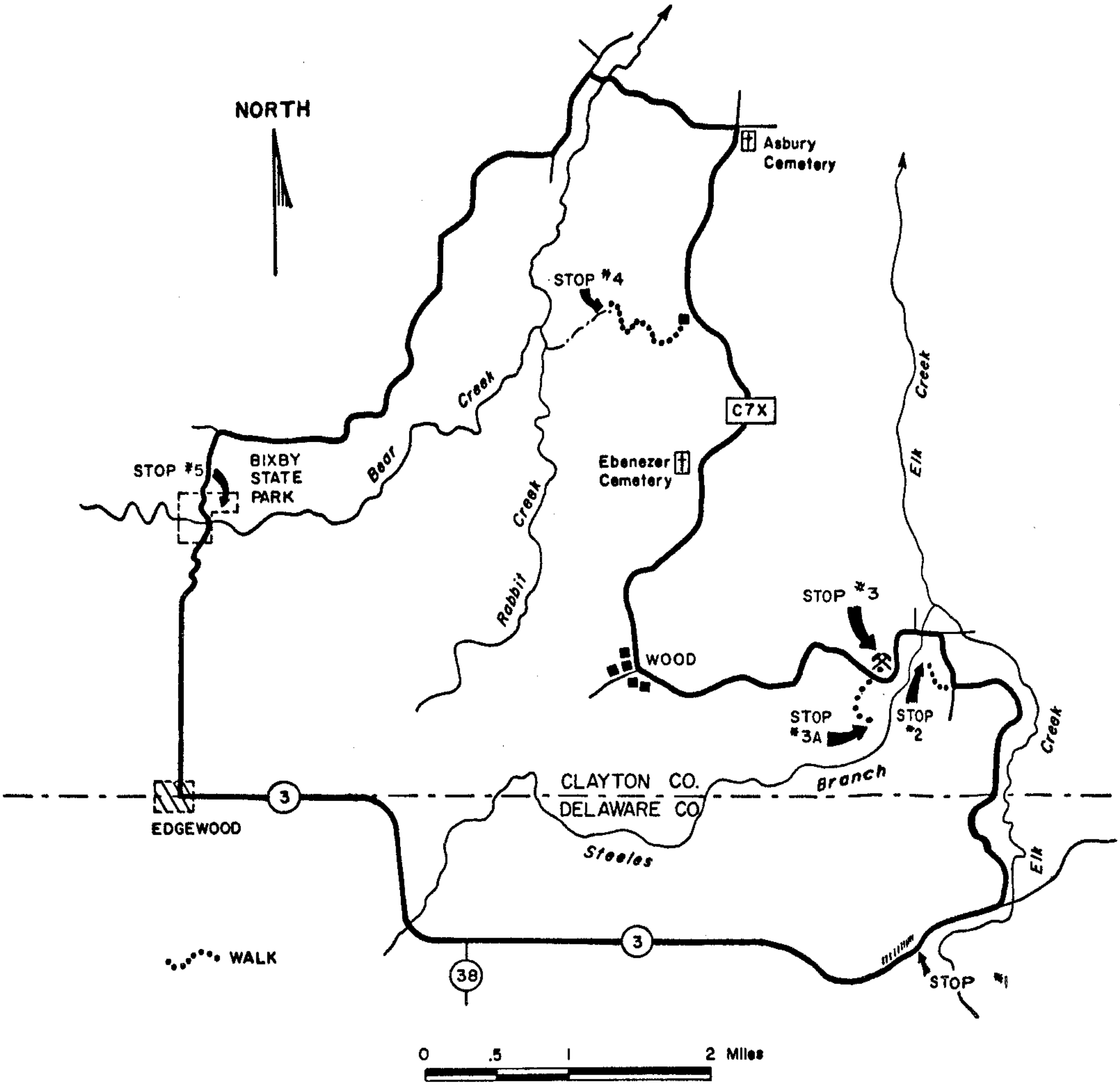
There are a number of karst features to be seen in this area, particularly sinkholes. (A sinkhole is a basin or funnel-shaped closed depression at the land surface, having no external drainage, and formed by direct solution of underlying carbonate rock or by collapse of the land surface over a subterranean void.) In addition to the existence of the sinks themselves, points of interest concern their unusual distribution and topographic position. In contrast to their normal development on broad plains which favor the collection of surface waters, these sinkholes are found along the margins of narrow, upland divides, and frequently with pronounced directional orientations. We will consider the hypothesis that at least some of the sinkhole development was initiated by joints mechanically expanded by movement of large blocks of the Silurian dolomite, rather than by traditional solutional activity.

Ms. Ardith Hansel, Ph.D. candidate in physical geography at the University of Illinois, completed her Masters Degree in Geography at the University of Northern Iowa. It is her field area we are visiting and her geomorphic model which we will examine for an explanation of the physiographic and stratigraphic relationships.

Briefly stated, Hansel's model is this: Sinkhole development is present along the narrow upland ridges of the Niagara Escarpment, areas which receive limited amounts of surface drainage. These sinkholes occur most often adjacent to valleys whose streams are entrenched into the Maquoketa Shale. They are less common away from the Escarpment, or near valleys whose streams are not eroded into the shale. Where valley erosion progressed into the Maquoketa, mechanical slippage of massive blocks of Silurian dolomite occurred on the shale, probably aided by the movement of groundwater along the impermeable shale contact. The result of this movement was to open crevices along joint or fracture traces in the carbonate rock. This expansion resulted in deformation, slumping and collapse of overlying materials as well as diversion of surface drainage underground. Intersecting fracture traces, in combination with weathering and percolation of surface water into the formation, enlarged the upper portions of the crevices and resulted in characteristic sinkhole depressions on the land surface. This mechanically induced karst is the explanation proposed for the origin of at least some of the sinkhole features observed in this particular portion of northeast Iowa.

At our first stop we will orient ourselves with respect to where we are in the geologic section and observe the characteristic features of the rock units in this area. We will then look in detail at karst development on top of the Niagara Escarpment--sinkhole abundance, characteristics, relationship to linear joint patterns, and relationship to adjacent valley development. Interesting vegetation and landuse patterns can be observed throughout this area where bedrock stratigraphy is clearly reflected in the surface terrain--an uncommon situation in a state whose landscapes usually are dominated by glacial deposits. We will examine another portion of the Silurian section on foot through a steep, narrow valley down to a particularly scenic and interesting contact with the underlying Ordovician Maquoketa Shale. Finally, we will stop at Bixby State Park to examine cave and spring development associated with open fracture systems in the Silurian.

The entire field trip is covered on the Edgewood and Garber 7.5' U. S. Geological Survey topographic quadrangles. Field trip leaders will have sets of these maps available so that topographic and drainage characteristics of the region can be examined. Figure 1 diagrams the trip route and stops.



ROUTE and LOCATION MAP

FIGURE 1.

ROAD LOG

ORIENTATION: Edgewood City Park, 9:30 a.m., Saturday, September 13, 1975

The town of Edgewood is located near the boundary between two distinct topographic regions of Iowa. The terrain to the south and west of Edgewood is gently rolling, with little local relief or abrupt change in slope. This appearance is characteristic of the "Iowan Surface," described by Ruhe (1968) as an erosional surface developed on Kansan till, and having a thin, discontinuous Wisconsin loess cover. This terrain contrasts sharply with the steeply dissected angular topography to the north and east of Edgewood. Here the landscape resembles that of Iowa's "Driftless Area," whose boundary as drawn by Trowbridge (1966) is a few miles further east. Bedrock controls the topography, though in this area thin Kansan till remains on the upland divides and a Wisconsin loess cover of approximately 15 feet exists in the area. The Edgewood 7.5' topographic map clearly illustrates this distinction between the topographic regions.

Intersecting this regional topographic boundary just east of Edgewood is the significant geologic boundary between the Silurian and Ordovician bedrock systems. The surface expression of this contact, the Niagara Escarpment, contributes to the rugged appearance of the landscape to the northeast of Edgewood. The Niagara Escarpment also serves to divide the terrain of the northern portion of the Kansan till, which has little influence on the topography, from the remainder of the Kansan surface, where the glacial till strongly influences the terrain and constitutes a third major topographic region in Iowa. (See figure 2 and figure 3.)

> Leave Edgewood on Iowa Hwy. 3; travel east for 5 miles to Stop #1.

STOP #1: Roadcut Exposure on Hwy. 3, NE 1/4, Sec. 10, T. 90 N., R. 4 W. The Hopkinton and Kankakee Formationsof the Silurian are exposed in this recent roadcut which presents a good view of the rock units comprising the Silurian Escarpment. Note particularly the bedding characteristics of the rocks and the occurrence and distribution of chert. This locality is not particularly fossiliferous. A more detailed stratigraphic column of the area is shown in figure 4.

The Edgewood Formation is covered here and its less resistant, argillaceous character has necessitated repeated repair of the road bed on the lower portion of the hill. The Brainard Member of the Ordovician-age Maquoketa Shale is reached toward the bottom of the hill, and seepage of groundwater along the Silurian-Maquoketa contact has contributed to the slumping and road deterioration problem.

Joint crevices reveal thin rinds of calcium-carbonate flowstone. Expansion along these joint or fracture systems is believed to be induced by mechanical slippage of the massive Silurian dolomite blocks on the underlying Maquoketa Shale. The rind of flowstone provides evidence of water movement through the crevice system, and of some solutional activity.

> Continue east for 1 mile. Note exposure of Maquoketa Shale along left roadside just before turning left. Turn left (north) on county road through Elk Creek valley for 2 1/4 miles. As we climb out of creek valley note landuse patterns (cropland, pasture and forest) associated with changes in slope. Continue uphill to "T" intersection. Parking area will be indicated.

STOP #2: Sinkhole development in the Silurian along upland margin of Niagara Escarpment, SW 1/4, Sec. 26, T. 91 N., R. 4 W. The sinkholes at this stop are located on an upland of Silurian dolomite which is surrounded on three sides by streams entrenched into the Maquoketa Shale. Note the abundance and characteristics of sinkholes present, including basin-shaped and funnel-shaped varieties. Some of the sinks show signs of being excavated, whereas others are filling with sediment. One of the basin-shaped sinkholes is plugged with sediment and contains ponded water. Do you observe any lineations in the arrangement of the sinkholes? Finally, note the effect of these geomorphic features on land use. Trees and shrubs are concentrated around and within the topographic depressions, in contrast to the surrounding tillable land.

> Return to county road. Continue north for 1/2 mile to "T" intersection in Elk Creek valley. Turn left (west) for 1/2 mile and follow bend in road south to quarry.

STOP #3: Johnson Quarry in the Silurian (Kankakee), SE 1/4, Sec. 27, T. 91 N.,

R. 4 W. The Hopkinton and Kankakee Formations are exposed at this location, with the Kankakee best observed in the west wall of the quarry. Note particularly the thin beds of dolomite and chert that characterize this formation. The Hopkinton lies above the quarry face, and in turn is mantled by Pleistocene overburden.

Again, vertical joints are well exposed in this quarry, particularly along the north wall opposite the quarry entrance. The joint expansion is believed to be caused by movement of large blocks of Silurian dolomite on the underlying Maquoketa Shale. Solutional activity is minimal and slumped material from above is present within the crevices.

STOP #3a: Surface expression of sinkhole development along linear joint traces, NE 1/4, Sec. 34, T. 91 N., R. 4 W. We will leave the quarry on foot, cross the county road, and hike along the field lane to the upland. Once there, observe the karst development, and the variation that exists in the depth and diameter of the sinkholes. Note especially the distinct alignment of sinkholes with known directional trends of the regional joint systems. A prominent east-west orientation is clearly seen. This upland topographic position is not favorable to the capture of the quantity of surface drainage needed for solutional karst development. This fact plus the obvious structural alignment and known stratigraphic sequence in the adjacent valley, indicates a mechanical origin for the sinkholes. Do you think sinkhole development along the margins of such sinuous upland areas could occur under any other conditions, if the Maquoketa Shale was not present?

Again, this is a good location from which to see the relationship of landuse patterns to topographic conditions. Off to the north and east is a good view of the wooded Silurian Escarpment rising above the valley of Elk Creek.

Return to quarry for lunch. Time also will be available to examine exhibits illustrating the significant karst development in Floyd County, being studied by Dr. Stan Grant and students from the University of Northern Iowa.

LUNCH

Continue west on county road 2 1/4 miles to Wood, elevation: 1,176 feet, highest point of land on the trip. Turn right (north) on county road C7X for 3 miles to farm of V.C. Culberson.

STOP #4: The "Blue Basin," SE 1/4, Sec. 17, T. 91 N., R. 4 W. Valleys which are dry or intermittent in their upper reaches and with springs near their mouths are common along this section of the Escarpment. This particularly scenic valley and spring combination was named by Hansel as the "Blue Basin" for reasons which will become clear when we reach our destination. It offers a detailed look at the Silurian section and the contact with the underlying Brainard Member of the Maquoketa Shale. Note rock unit characteristics and see if you can pick the contacts between formations. This is a particularly good locality for observing joint patterns in the Silurian dolomites exposed in the stream bed. There are also good examples in this stream bed, and in a small tributary valley, of headward erosion by knickpoint advance.

Near the main escarpment, the valley becomes deeply entrenched and contains massive blocks of Silurian dolomite that have fallen from the steep valley sides. Springs emerge from bedding planes near the base of the Escarpment, marking the zone of contact of the permeable dolomites with the more shaley beds of the Edgewood Formation and the underlying Maquoketa Shale. An excellent exposure of the clay shales of the Brainard Member of the Maquoketa is seen along the south wall of the valley and along the sides and bottom of the "Blue Basin" into which the spring water falls.

The hike into Blue Basin is along a steep, narrow valley and over large, irregular and slippery rock blocks. Geology and botany are very interesting, but do keep a careful eye on your footing. Return up slope, watching for sinkhole development and alignment near top.

> Continue north on county road C7X for 1 1/2 miles to Asbury Cemetery intersection. Turn left (west) on county road 1 1/4 miles to "T" Intersection in Bear Creek valley. Turn left (south) on county road approximately 3/4 miles along Bear Creek valley to county road intersecting from the right (west). Turn right leaving valley and climbing Silurian Escarpment to upland ridge. Continue for approximately 4 miles to turn-off for Bixby State Park.

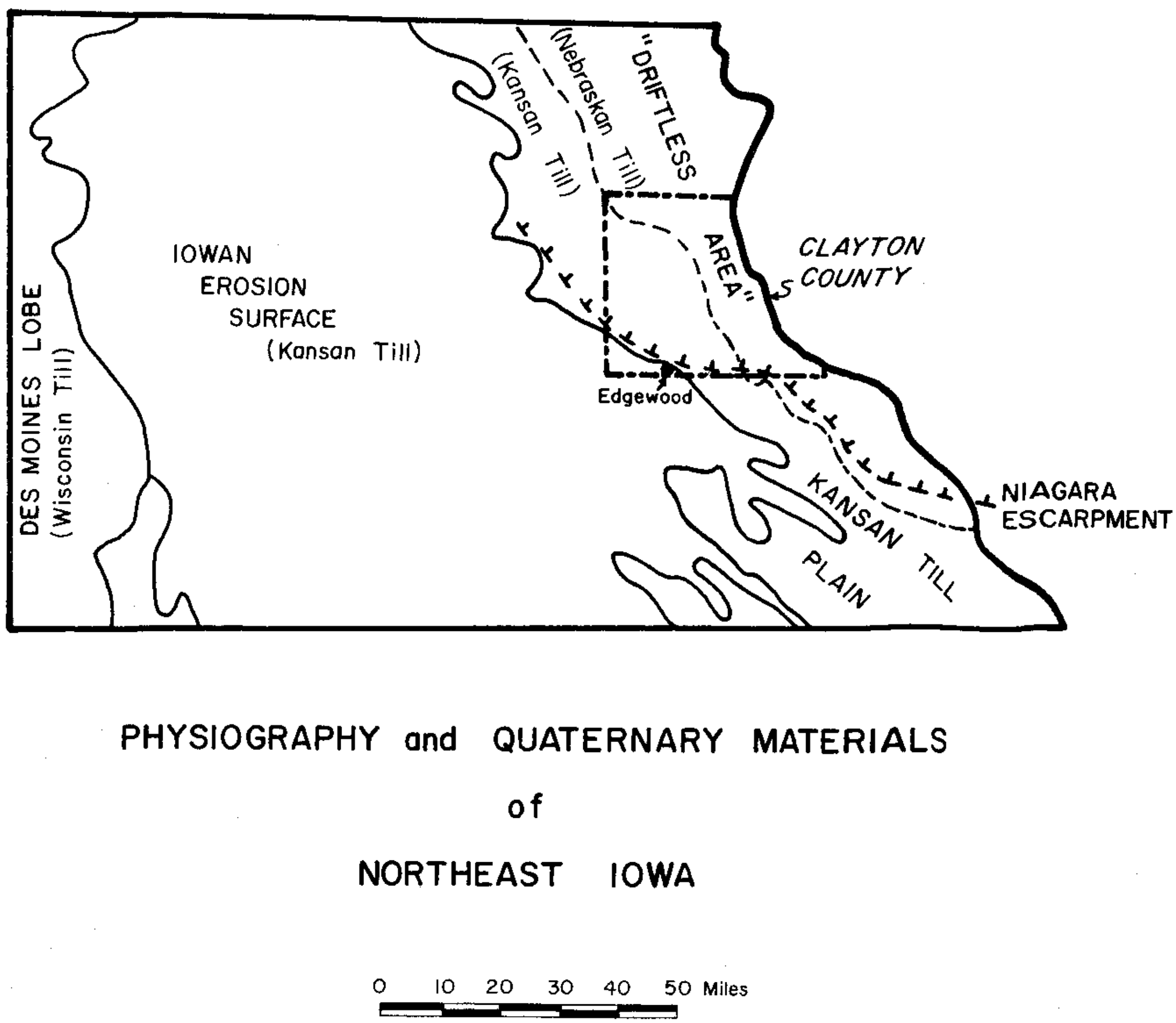
STOP #5: Bixby State Park, S 1/4, Sec. 23, T. 91 N., R. 5 W. The cliffs in the narrow valley of Bear Creek, eastward flowing tributary of the Volga River, again expose the Silurian strata we have seen earlier. Of particular interest is the ice-cave, and its natural air-conditioning system, developed along an open joint crevice in the

Silurian. Note the spring in the park; spring development is also associated with carbonate rock units and characteristic of karst landscapes.

There are other points of interest within this area. Mossy Glen Hollow, about three miles northwest of Bixby State Park is a very worthwhile trip. The geology of this area, and others, is described in the Guidebook for the 36th Annual Tri-State Geological Field Conference, General Geology in the Vicinity of Northern Iowa, published by the Department of Earth Science, University of Northern Iowa, Cedar Falls, Iowa, October 7-8, 1972. Also, those interested in seeing a good example of cave development associated with these open joint systems may get the location and property owner's name from the field trip leaders.

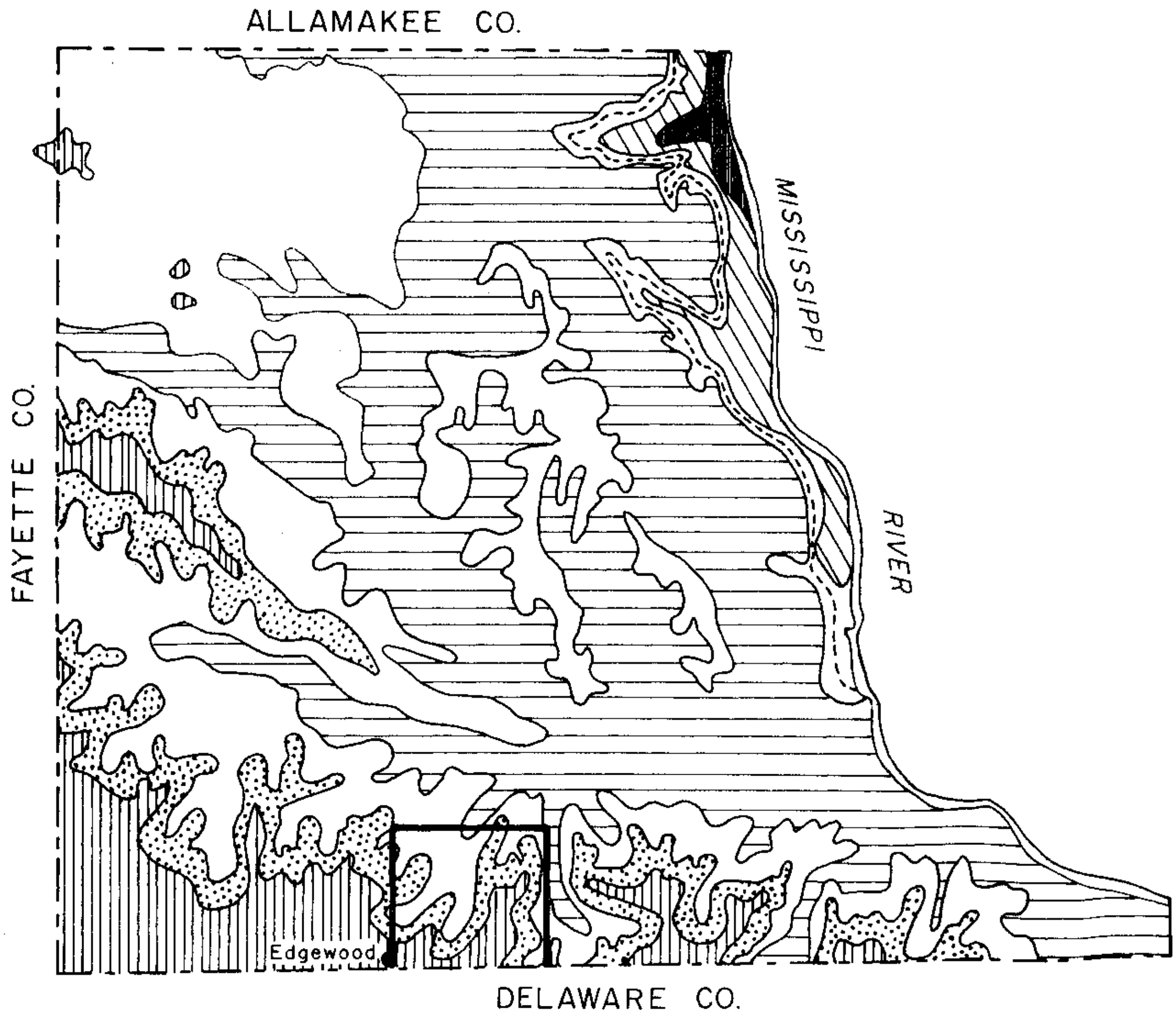
This stop concludes the field trip. Edgewood and Iowa Hwy. 3 are two miles south. For those terminating the day's activities here, we enjoyed your company and wish you a safe return trip.

NOTES



PHYSIOGRAPHY and QUATERNARY MATERIALS
of
NORTHEAST IOWA

FIGURE 2.



GEOLOGIC MAP OF CLAYTON COUNTY

0 5 10 Miles

SILURIAN
- Niagaran Series
- Kankakee-Edgewood

ORDOVICIAN
- Maquoketa
- Galena-Decorah-Platteville
- St. Peter
- Prairie du Chien

CAMBRIAN
- St. Croixan Series

Source: Geologic Map of Iowa
Iowa Geological Survey
1969

FIGURE 3.

STRATIGRAPHIC SECTION — SOUTHERN CLAYTON COUNTY

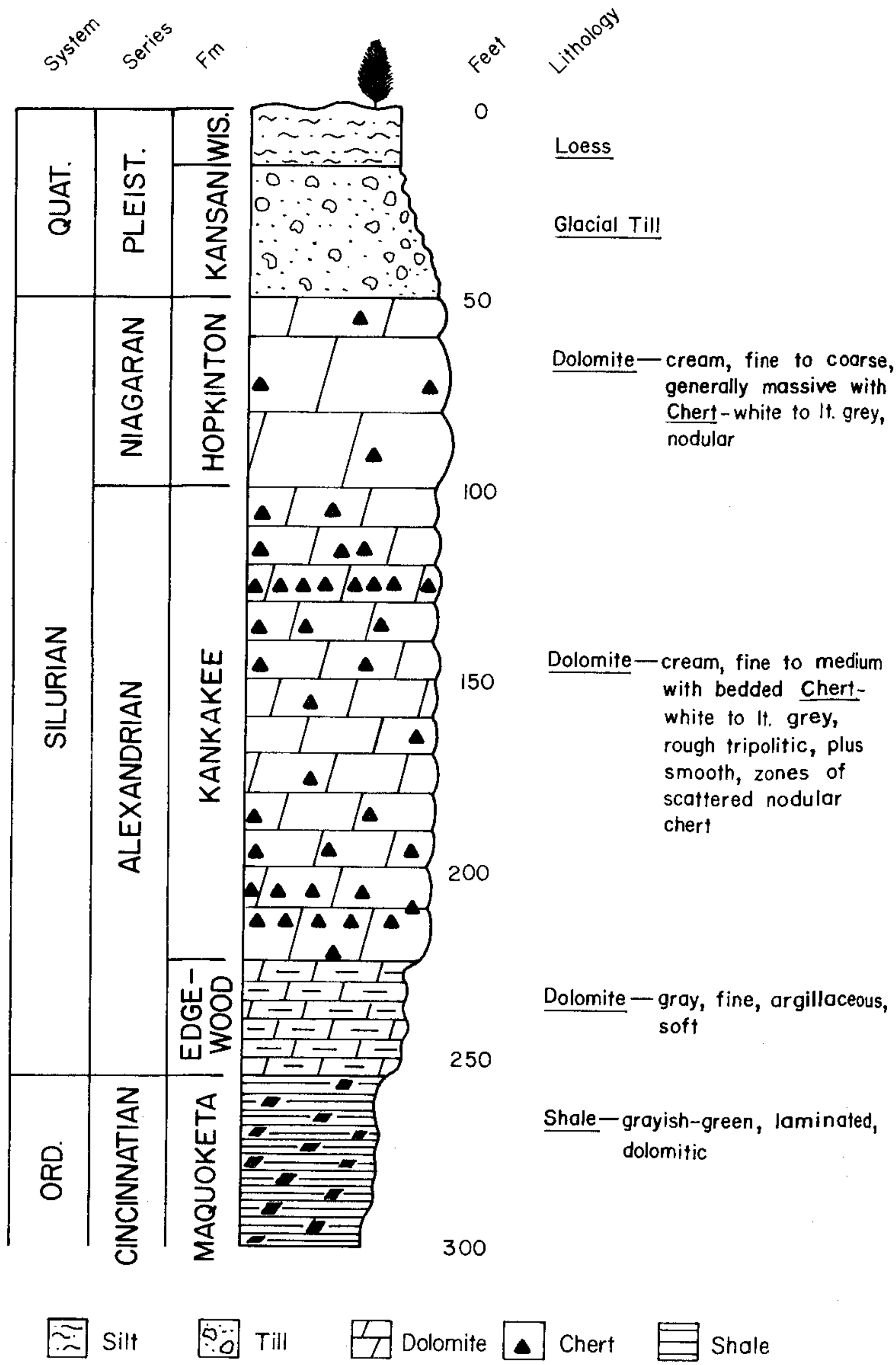


FIGURE 4.

REFERENCES

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