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Bedrock Geology of Western Story County, Iowa

L. Zimmerman
Iowa State College

L. A. Thomas
Iowa State College

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By H. L. Zimmerman and L. A. Thomas

Story county is located in the geographic center of Iowa. It contains the usual sixteen congressional townships common to interior Iowa counties and covers an area of about 576 square miles.

Previous Geological Investigations

The occurrence of bedrock about 3 miles northwest of Ames was noted, and the rock referred to the St. Louis formation by White (1870).

McGee (1891), although mapping surficial deposits, established the presence of a structural flexure within the county and called it the "Skunk River" anticline. He considered it to be one of a series of northwest-southwest trending flexures in the strata of Iowa.

Beyer (1898), in the only other previous study of the indurated rocks of the area, recognized the occurrence of the Pennsylvanian and Mississippian systems in the area. He verified the existence of the "Skunk River" anticline, and also considered the general trend of the flexure to be northwest-southeast.

The present report considerably expands the number of known exposures, the exposed stratigraphic section, and reinterprets the structural trend of the county.

Stratigraph

Introduction

In Story county the glacial drift rests directly upon both Pennsylvanian and Mississippian rocks. The Pennsylvanian, as now known from outcrops and well borings, is limited to the Cherokee group. The Mississippian rocks known to directly underlie the drift are assigned to the following formations, in descending order, the St. Louis, Warsaw, Keokuk, Gilmore City, and the Hampton. Although it is highly probably that the Burlington formation, stratigraphically between the Keokuk and the Gilmore City, also underlies the drift, no evidence of it has as yet been recognized. The St. Louis and the Warsaw are the only exposed Mississippian formations.

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Pennsylvanian

The rocks of the Pennsylvanian system are here assigned to the Cherokee group. The maximum known thickness of the group in this area occurs near Nevada, in the central part of the country. The log of the Howard Richardson well in the NW¼, NW¼, SE¼, sec. 36, T. 84N., R. 23 W., shows a thickness of 235 feet. The Cherokee group is of approximately the same thickness in three other wells in this vicinity.

The most complete exposed section of the Pennsylvanian which shows the contact with the St. Louis formation is exposed along Bear Creek. The following composite section, exposed from the southeast corner of section 29 to the southwest corner of section 22, T. 85N., R. 23W. illustrates this contact. Bed number one is the top of the St. Louis formation.

6. Drift.
5. Limestone, gray, fine-grained, porous, massive; containing abundant pyrite crystals; bottom contact irregular and gradational with shale below ..... 2.0′
4. Shale, gray-green, blocky; very calcareous, calcite nodules becoming abundant near top; containing Pennsylvanian conodonts; upper contact irregular and gradational ..... 2.24′
3. Limestone, gray, dense, glauconitic; upper layer dense with a 3 inch band of dense, gray chert in center; lower layer sandy, grading laterally into calcareous sandstone ..... 0.75′
2. Sandstone, white to buff, fine-grained, friable, well-sorted; grains rounded to subangular; cross-bedding locally prominent; locally containing lenses of "conglomeratic" chert near top ..... 18.0′
1. Dolomite, buff to light gray, fine-grained with occasional calcite rhombs ..... 1.5′

The boundary between the Mississippian (St. Louis formation) and the Pennsylvanian (Cherokee group) cannot be accurately determined due to the lack of fossils. Pennsylvanian conodonts do occur, however, in the shale of bed number four. Lithologically the sandstone appears to be closely related to other Pennsylvanian sandstone known in this region. A "conglomeratic" chert zone occurs between the underlying dolomite and this sandstone unit in the section exposed about one mile downstream in the NW¼, SE¼, sec. 32, T. 85N., R. 23W. The massive sandstone unit fills an old solution cavity in the underlying St. Louis formation in an old quarry located on the right bank of the Skunk River in the SW¼, SW¼ sec. 13, T. 84N., R. 24W. For these reasons this sandstone is placed in the Pennsylvanian system.

In the western half of Story county there are also two isolated exposures of the Cherokee group whose relationships to the other

Cherokee exposures has not been accurately determined. The first, located in the big bend of the Skunk River southeast of Story City in the NE¼, NE¼, SE¼, sec. 13, T. 85N, R. 24W., exposes approximately 4 feet of gray to black shale. The other, along Indian Creek in the pit of the brick and tile plant just west of Nevada in the SW¼, SE¼, sec. 1, T 83N., R. 23W., exposes about 39 feet of variegated and gray shales.

Mississippian

The Mississippian rocks are exposed where stream erosion has cut into the northeast-southwest trending anticline. A correlation of selected exposures (Plate 1) gives the total thickness of the exposed Mississippian rocks as 76.5 feet. The exposed Mississippian rocks are here assigned to two formations, in descending order, the St. Louis and the Warsaw. The oldest formation directly underlying the till is the Hampton, found in the Joe Taylor well in the SW¼, NE¼, NE¼, sec. 33, T. 84N., R. 24W., and in the Iowa State College deep well in the NE¼, NE¼, SW¼, sec. 4, T 83N., R. 24W. As there is no continuous exposure of the complete Mississippian section a composite section was compiled from selected exposures (see Plate 1).

Composite section of the St. Louis Formation.
Total Thickness Exposed—28.0 to 29.0 Feet.

6. Dolomite, buff, fine-grained, heavy bedded, concretions common; a 1-foot bed 1.5 feet below top is resistant and locally cherty; upper surface irregular and weathered ..... 7.5′
5. Dolomite, light gray to buff, fine-grained, dense, conchoidal fracture, fossiliferous ..... 0.75′
4. Dolomite, buff to brown, fine-grained, massive, locally glauconitic; containing a few chert concentrations ..... 2.0′
3. Dolomite and shale (interbedded); dolomite, gray-brown, medium-grained, containing calcite veinlets; shale brown, calcareous, fissile ..... 1.0′
2. Dolomite, brown, fine to medium-grained, massive; containing a few chert concretions. Recrystallization along joints forms veins of dense, gray dolomite. These veins form dike-like ridges on weathered surface. Lower contact irregular ..... 10.75′
1. Sandstone, light-green, fine-grained, friable, with dolomitic lenses becoming more prominent near top ..... 6.0 to 7.0′

Composite Section of the Warsaw Formation.
Total Thickness Exposed—48.8 to 50.8 Feet.

22. Shale, blue-gray to green, silty, blocky, dolomitic; containing large irregular, granular, nodular masses of chert intermixed with calcite. In places it contains lenses of dolomite and locally the lower portion grades laterally into argillaceous dolomite. The shale is locally separated from

overlying sandstone by a lens of brown to buff, medium-grained dolomite..... 5.0′

21. Dolomite, buff to brown, fine to medium-grained, heavy-bedded; lens of gray shale 1.1 feet above base; upper 3 feet siliceous with nodular, irregular, granular masses of chert and calcite..... 5.5′

20. Shale, blue-gray, blocky, silty, finely disseminated pyrite present. The bottom 1 foot grades laterally into gray to buff, earthy, pyritic dolomite. Dolomite lenses locally present in rest of shale..... 3.25′

19. Dolomite, buff to gray, fine to medium-grained; argillaceous, locally cherty..... 2.0′

18. Dolomite, brown, fine-grained; with masses of dark brown chert and calcite nodules; locally argillaceous; two beds of dark brown, brecciated-appearing, siliceous dolomite, one at base and the other 2.5 feet above base; dolomite grades laterally into shale..... 4.0′

17. Shale, brown to dark gray, blocky, with siliceous dolomite concretions throughout; two 3-inch beds of brown, siliceous, dense dolomite, one near middle and the other near top..... 2.0′

16. Dolomite, dark gray, fine to medium-grained; upper half firm and locally siliceous..... 2.15′

15. Shale, blue-gray, blocky, pyritic; top 4 inches dolomite and locally siliceous..... 1.75′

14. Dolomite, buff to brown, medium to fine-grained; lower 2 feet argillaceous; top 1 foot resistant, saccharoidal dolomite containing crinoid stems, fish teeth, and brachiopods; locally capped with lens of buff dolomitic chert.....3.0 to 3.5′

13. Chert, dark brown, very dense, upper surface irregular..... 0.5′

12. Dolomite, brown, fine-grained, firm, with dark brown, nodular chert..... 1.0′

11. Chert, clear, granular nodules and irregular masses mixed with calcite; pyritic; bed-like but probably masses in brown, fine-grained dolomite. It pinches and swells.....1.0 to 1.75′

10. Dolomite, brown, fine-grained, firm; containing irregular nodules of granular, chalcedonic chert..... 0.75′

9. Chert, dark brown, mottled, appearing brecciated in places. It has a 1-inch layer of brown, fine-grained dolomite on top and bottom.....0.5 to 0.75′

8. Dolomite, gray to brown, fine-grained, pyritic; with a few chert nodules..... 0.75′

7. Shale, blue-gray to buff, blocky, silty, pyritic; dolomite lens 1 foot above base; a band of granular chert nodules 2 feet above base locally underlain by a lens of dolomite.....3.0 to 3.5′

6. Dolomite, gray-brown, medium-grained; lower 5 inches resistant, upper 5 inches nodular, argillaceous; containing fish teeth and algae..... 0.82′

5. Dolomite, buff, fine-grained, earthy; containing lenses of coarser-grained, more resistant dolomite; discontinuous chert

	bed 2 feet above base. The bottom 8 inches grades into shale laterally	3.0′
4.	Dolomite, brown, fine-grained, very shaly. On weathering it gives the appearance of shale. Upper and lower contacts irregular	1.0′
3.	Dolomite, buff, fine-grained, argillaceous, massive; discontinuous band of dense, chalcedonic chert 1.5 feet above base. Mases of calcite appear in and around chert zone	2.35′
2.	Shale, blue-gray, blocky, pyritic; with selenite along with the partings; containing brachiopods and algae (?)	5.0′
1.	Dolomite, blue-gray, medium-grained, pyritic	0.5′

Areal Distribution

The areal distribution of the Pennsylvanian and Mississippian rocks can be seen on Plate 2 (see also bed rock contour map Pl. 3). The map is very generalized due to the lack of sufficient detailed information; however, enough information has been gained to necessitate a revision of Beyer's interpretation (1898, p. 238).

Comparison of Beyer's map with the map of this study shows the following modifications. Beyer's map shows the St. Louis as the oldest formation exposed across the anticline. Present information indicates that the St. Louis is not continuous across the structure, but has been breached by erosion so that older Mississippian formations are exposed along the crest. In addition, isolated exposures of Pennsylvanian sediments along the crest and margins of the structure somewhat modify the configuration of the Mississippian-Pennsylvanian contact near the anticline.

The older Mississippian formations are known from several wells and exposures. The Iowa State College deep well, located on the campus, and the Joe Taylor well, located in SW¼, NE¼, NE¼, sec. 33, T. 84N., R. 24W., penetrate the Hampton formation directly under the drift. Wells at Story City and at Roland show the drift overlying the Keokuk formation. At "Soper's Mill", in the S. ½ SE¼ sec. 6, T. 84N, R. 23W., the Warsaw formation is exposed directly beneath the drift.

Structure

Introduction

The existence of a structural flexure in Story County was first established by McGee (1891, p. 341) to explain the inlier of Mississippian rocks exposed in the Skunk River near Ames. He considered it to be one of a series of northwest-southeast trending anticlinal flexures in the strata of Iowa and named it the "Skunk River" anticline.

Beyer (1898, pp. 215-216) verified the existence of this flexure by studying the strata penetrated by the deep wells at Nevada, Iowa State College, and Boone. He likewise interpreted the anticline to have a northwest-southeast trend with a dip of about 35 feet and 21 feet per mile for the southwest and northeast limbs, respectively.

Although McGee and Beyer recognized the existence of the anticlinal fold, more detailed information gained in studying additional bedrock exposures and well logs during this investigation necessitates a revision of their ideas.

Trend and type of Folding

A structure contour map drawn on the base of the St. Louis formation (Plate 4, see also Pl. 5) shows a northeast-southwest trending anticline. The eastern limb of the anticline has the steeper dip, in contrast to Beyer's interpretation, which shows the southwestern limb to have the steeper dip. The axis of this fold extends from the northwest corner of T. 83N., R. 24W., trending about N. 59 degrees E., to the southeast corner of T. 84N., R. 24 W., thence N. 31 degrees east to the Hamilton County line near the northeast corner of T. 85N., R. 23W. Thus it extends a distance of approximately 20 miles across the northwestern part of the county. Ames and Roland are located on its crest.

The crest of the anticline is marked by three domal highs with intervening saddles. For convenience these will be referred to, in this report, as Ames high, the Soper's Mill high, and the Roland high, named from southwest to northeast.

On the Ames high, the Hampton formation underlies the drift at an elevation of 835 feet in the Iowa State College well. The base of the St. Louis, (restored) would have an elevation of 1,055 feet. The Ames high has a maximum structural closure of 200 feet. Dimensions of this closure are about 4½ miles by 2 miles. One limb of this high has a north-northwest dip of about 75 feet per mile and the other has a south-southeast dip of approximately 220 feet per mile.

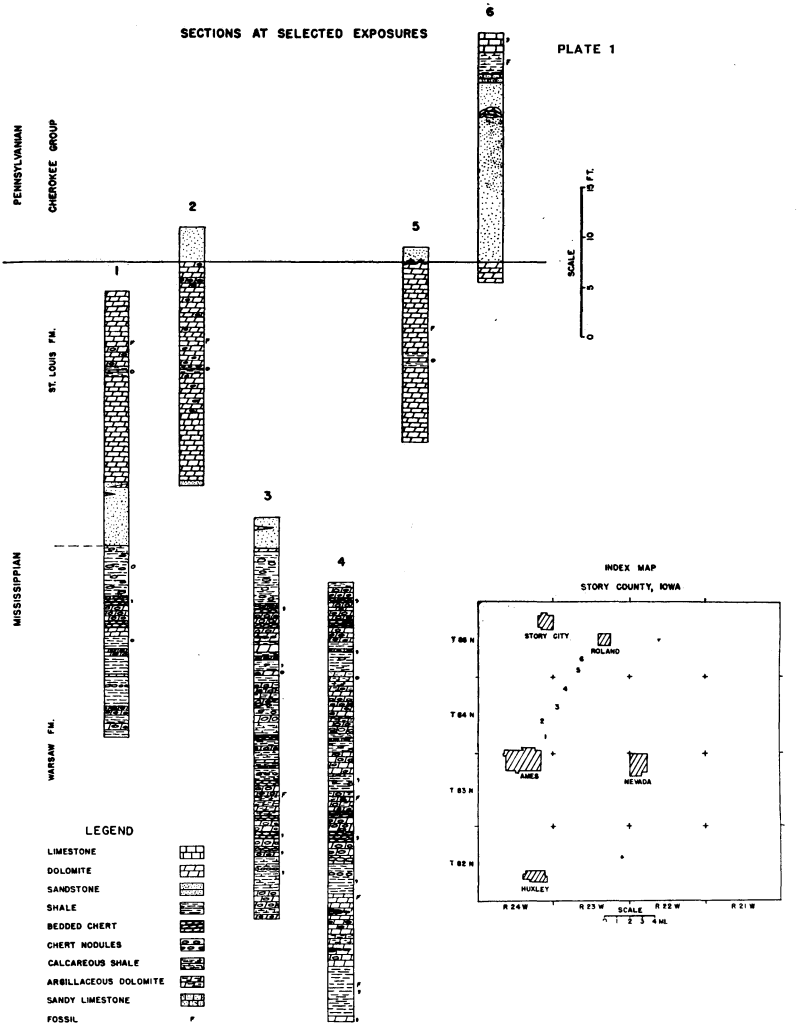
The middle, or Soper's Mill, high is elongated N. 31 E. It has a maximum structural closure of 150 feet and has dimensions of about 5 miles by 1½ miles. The northwest and southeast limbs of this high have, respectively, dips of approximately 55 feet and 100 feet per mile.

The Roland high trends N. 31 degrees E. from about 1½ miles southwest of Roland to the northern boundary of the county, a dis-

tance of about 5 miles. The beds have a northwest dip of 35 feet per mile and a southeast dip of 90 feet per mile.

Most of the anticline is probably limited to Story county. The folding appears to be dying out northward and probably only a minor part is located in Hamilton county. The fact that the Ames high shows the greatest amount of folding and that there appears to have been a small disturbance in the vicinity of Madrid (Boone county) toward which the Ames high extends, suggests the extension of the anticline southwestward into Boone county.

Other than the anticlinal flexure, four lesser structural features

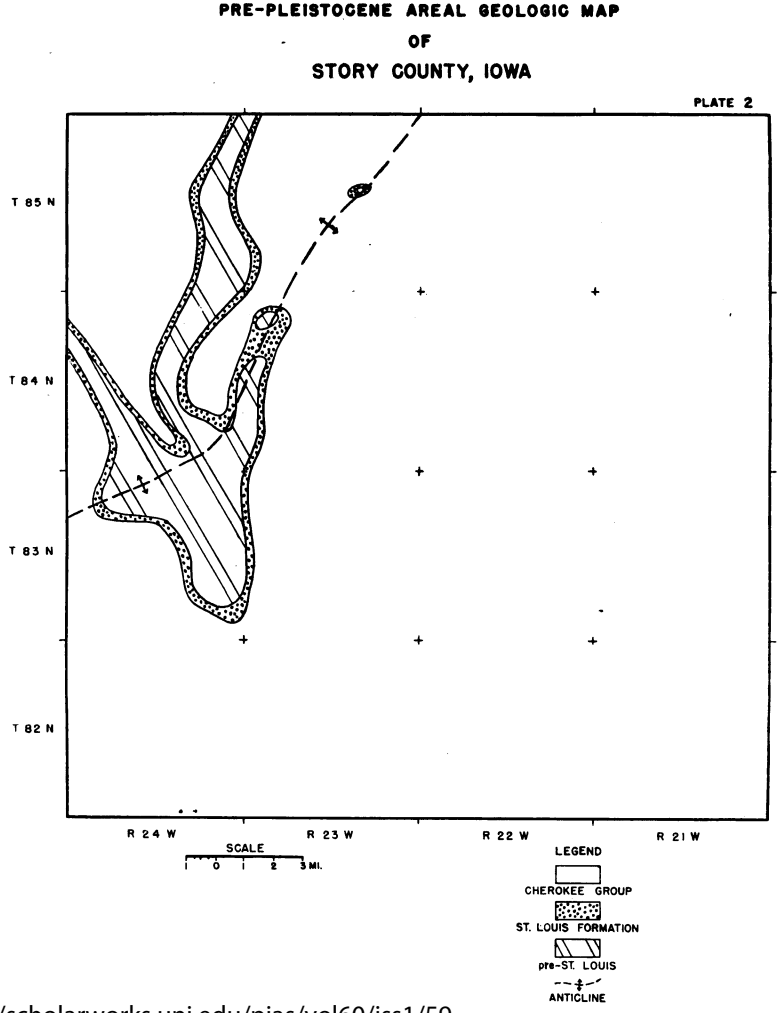


are shown on Plate 2. A broad, gentle high extends from the eastern edge of the county toward the center. In the southern portion of the area there is a gentle, south-plunging synclinal flexure. A small basin and a local high are indicated in T. 83 N., R. 24W. They trend N. 45E.

Time of Deformation

There are insufficient data, at present, to establish definitely the time of deformation in Story county. The evidence, however, appears to indicate two periods of movement.

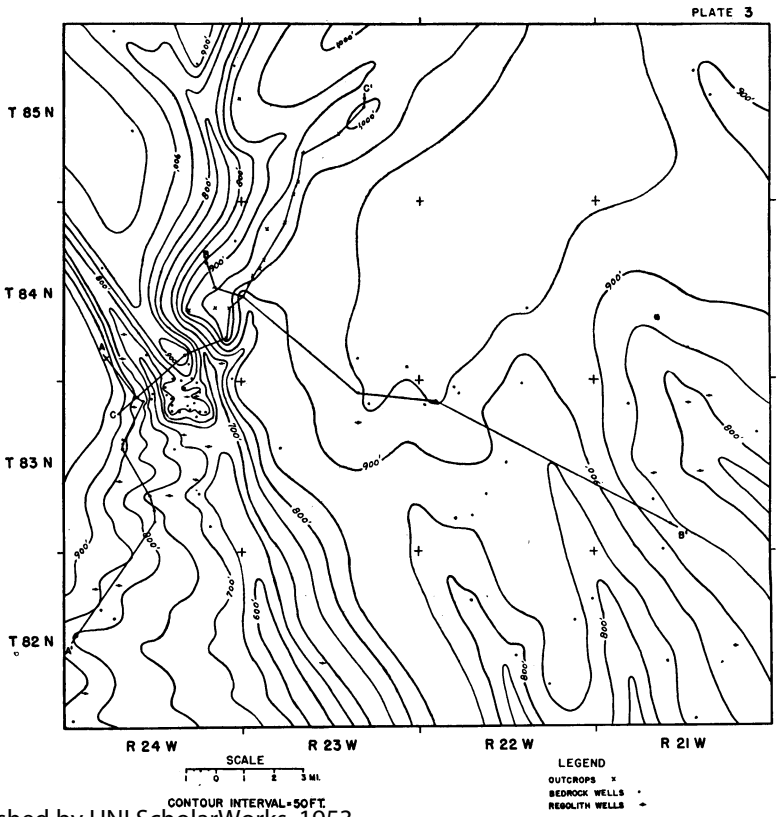
In the Roland City well, the SW¼, SW¼, sec. 14, T. 85N., R.



23W., Pennsylvanian shale rests directly on the Warsaw formation. This well, located on the crest of the anticline, is the only place in the county where the Pennsylvanian system is known to overlie a formation older than the St. Louis. The Pennsylvanian sandstone unit, in the NW¼, SE¼, sec. 32, T. 85N., R. 23W., is separated from the underlying St. Louis formation by a "conglomeratic" chert zone. A Pennsylvanian sandstone fills a solution cavity in the St. Louis formation in an old quarry on the right bank of the Skunk River in the SW¼, SW¼, sec. 13, T. 84N., R. 24W. These facts seem sufficient to establish an interval of erosion following Mississippian deposition but before Pennsylvanian deposition.

Whether this post-Mississippian erosion interval is the result of flexing of the anticline is difficult to establish; however, we are un-

BEDROCK CONTOUR MAP
OF
STORY COUNTY, IOWA

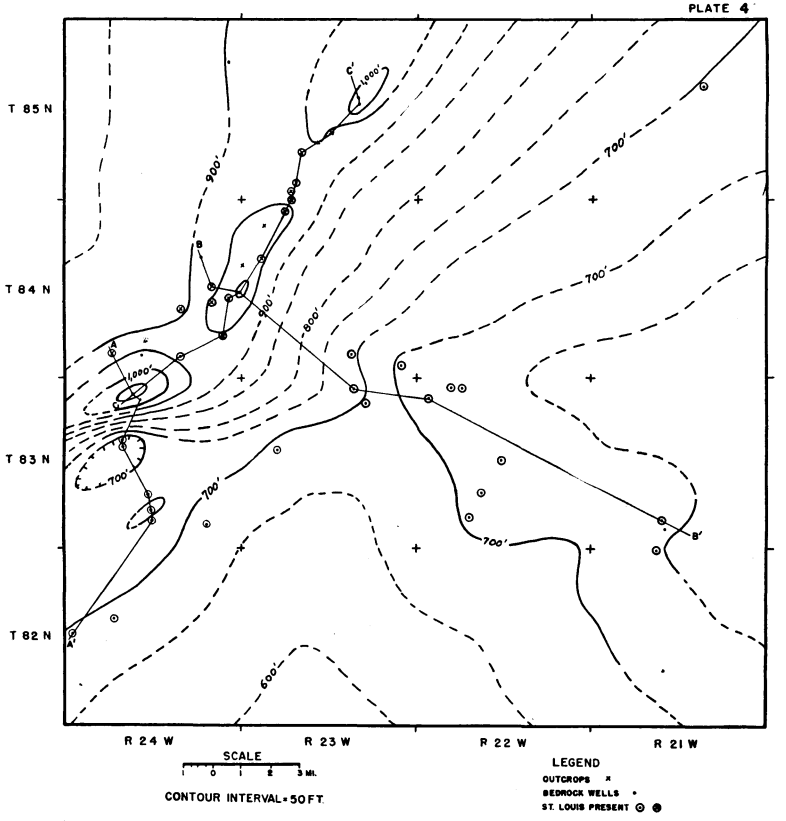


able to identify any Pennsylvanian unit of the Nevada well as extending over the flexure. The inability to trace a Pennsylvanian unit across the flexure suggests a local control of Pennsylvanian sedimentation. The disconformity separating Mississippian and Pennsylvanian as well as the character of the Pennsylvanian sediments suggests late Mississippian flexing which may have extended into the Pennsylvanian.

An earlier movement is indicated from a comparison of the Iowa State College and the Nevada deep wells. The elevation of the top of the St. Peter sandstone (Ordovician) is -490 feet in the College well and -867 feet in the Nevada well. Thus, in the College well this sandstone is 377 feet higher than in the Nevada well.

STRUCTURE CONTOUR MAP
OF
STORY COUNTY, IOWA

DATUM — BASE OF ST. LOUIS RESTORED

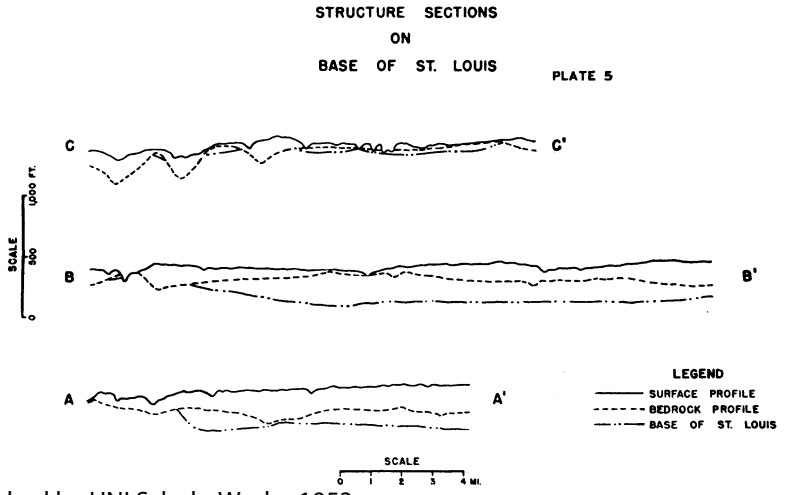


By comparison, the base of the St. Louis is only 332 feet higher than its equivalent in the Nevada well (723 feet elevation at Nevada, 1,055 feet elevation at the College). This difference in thickness of the interval between the top of the St. Peter and the base of the St. Louis suggests the absence or thinning of intervening units on the structure. Either of these would require structural movements between the Ordovician and the Mississippian periods. Available data do not indicate that any unit is missing nor do they permit analysis of thinning.

Summary

The exposed bedrock includes the Cherokee Group, the St. Louis and the Warsaw formations. Study of well logs indicate that in addition to the above units the Keokuk, Gilmore City, and the Hampton formations also directly underlie the drift. These Mississippian rocks are best exposed in the northwestern part of the county where the Skunk River and its tributaries have cut into the anticlinal flexure.

The major structure is a northeast-southwest trending, asymmetrical anticline, with the steeper dip to the east. Within Story county it extends from the Boone county line, in the northwest corner of T. 83N., R. 24W., to the Hamilton county line near the northeast corner of T. 85N., R. 23W. Its crest is marked by three highs with intervening saddles. Present evidence seems to indicate two periods of movement, one being post-Mississippian-pre-Pennsylvanian, and the other, at an earlier date.



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Department of Geology
Iowa State College
Ames, Iowa