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STRUCTURE AND OIL POSSIBILITIES OF THE WARSAW  
 AREA, HANCOCK COUNTY, ILLINOIS

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SUMMARY

Prospecting for oil and gas in the vicinity of Warsaw, Illinois, has included the leasing of much acreage and the drilling of three test wells southeast of Warsaw between the fall of 1930 and the spring of 1932. Showings of oil were found in two of these wells. In view of the increased interest aroused by these prospects, the Illinois State Geological Survey undertook in September and October, 1932, a detailed study to determine oil possibilities in an area of approximately 50 square miles extending from Warsaw and Hamilton on the north to the Hancock-Adams county-line on the south and from the east bluff of Mississippi River on the west to the east line of the west tier of sections of R. 8 W. on the east (Fig. 1).

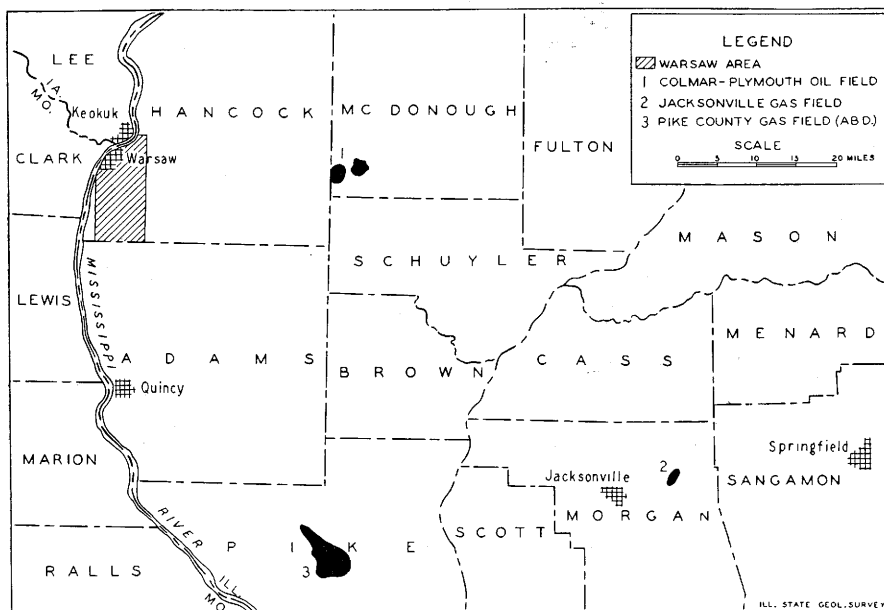


FIG. 1.—Index map showing location of Warsaw area and the nearest oil and gas fields.

## Possible oil producing horizons in the Warsaw area

System	Series	Group	Formation		Thickness	Character of rocks
Mississippian	Iowa	Merramec	St. Louis		0-25	Limestone conglomerate and limestone, light gray, compact, sublithographic to finely granular, basal bed (1½ to 2½ ft.) crinulated.
			Salem		20-90	Limestone, argillaceous, and shale, gray; contains numerous geodes
		Warsaw				
		Osage	Keokuk		135-155	Limestone, gray to white, crystalline, crinoidal; much chert in beds and nodules
			Burlington			
			Hannibal			
			Saverton			
		Kinderhook	Grassy Creek		285-330	Shale, bluish-gray, with thin sandstones and limestone near top; grading down to brown shale
Devonian	Senecan		Cedar Valley	90-125	Limestone, sandy, light gray; sand horizon near base gave shows of oil in Warsaw area (log No. 1)	
			Wapsipinicon			
Ordovician	Mohawkian		Kimmswick	230	Limestone ("Trenton"), dolomitic, light brown, crystalline, coarse-grained near top, finer grained below; thin shales near base; producing horizon of Dupo field; gave shows of oil in Warsaw area (log Nos. 1 and 3)	
			Plattin			
	Chazyan		Joachim			
			St. Peter			Sandstone, white, porous, contains salt water

FIG. 2.—Generalized geologic column for the Warsaw area.

One prominent structural feature, the Warsaw anticline (Fig. 3 and Table 1) which seems to have possibilities of commercial oil and/or gas production was revealed by the detailed study. This anticline has a known closure of approximately 30 feet, and possibly more, on the base of the Warsaw formation. All other structures in the area surveyed are slight in comparison (Fig. 4 and Table 1). Possible producing horizons include the Devonian limestone, the Hoing sand, and the Kimmswick-Plattin ("Trenton") limestone (Fig. 2).

#### STRUCTURE

As shown by figure 3 the Warsaw anticline occupies a total area of about 20 square miles in the north part of T. 4 N., R. 9 W., and extends east into T. 4 N., R. 8 W., and north across the Mississippi River valley. The crest of the anticline is in sec. 1, T. 4 N., R. 9 W., from which anticlinal axes extend west-southwest into sec. 16, T. 4 N., R. 9 W. and east-southeast into sec. 7, T. 4 N., R. 8 W. The Warsaw-Keokuk contact has a dip of 126 feet in less than 2 miles from datum point 8 to datum point 13. To the north this horizon dips 83 feet from datum point 4 to datum point 2, a distance of  $1\frac{1}{2}$  miles. To the south it dips 61 feet from datum point 22 to datum point 25, a distance of a little less than 2 miles. To the east there is a dip of 34 feet from datum point 4 to datum point 31. The elevation of the key horizon could not be determined in the area to the east of the contoured area because of the lack of outcrops and well records.

From these data it is determined that the Warsaw anticline has a known closure of approximately 30 feet. If the eastward dip continues east from datum points 30, 31, and 32 (sec. 6, T. 4 N., R. 8 W.) the total closure may be somewhat greater than the known closure.

As will be seen from Table 1 the variations in elevation of the key horizon for datum points 34-56 in the area south of that shown in figure 3 are so slight that they are but little greater than the probable error for the elevations of individual datum points and so contours are not drawn in this part of the area.

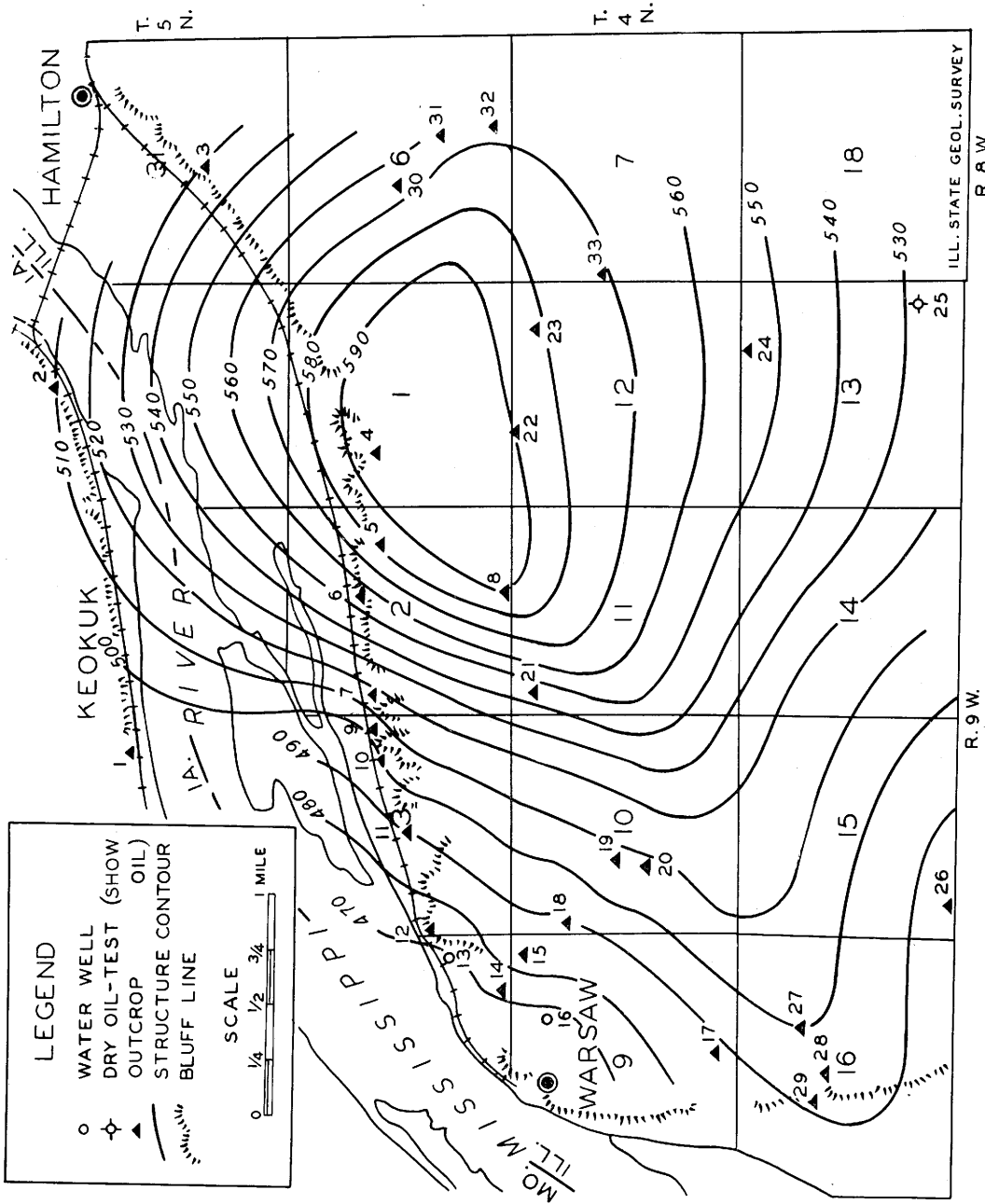


FIG. 3.—Structure map of the Warsaw anticline. Key horizon, Keokuk-Warsaw contact. Datum, sea-level. For description of the datum points, see Table 1.

TABLE 1.—*Structural data on Warsaw Area*

(Locations of datum points 1-33 are shown in Figures 3 and 4, 34-56 in Figure 4)

Map No.	Location			Formation or well	Surface Elevation	Key horizon, Warsaw-Keokuk contact	
	Sec.	T. N.	R. W.			Interval	Elevation
<b>Lee County, Iowa</b>							
1	35	65	5	Warsaw shale <sup>a</sup>	<i>Feet</i> 525	<i>Feet</i> —29	<i>Feet</i> 496
2	36	65	5	Warsaw-Keokuk	510	0	510
<b>Hancock County, Illinois</b>							
3	31	5	8	Warsaw	540	—11	529
4	1	4	9	Warsaw-Keokuk	593	0	593
5	2	4	9	Warsaw-Keokuk	581	0	581
6	2	4	9	Warsaw-Keokuk	553	0	553
7	2	4	9	Warsaw-Keokuk	517	0	517
8	2	4	9	Lower Warsaw	597	—7	590
9	3	4	9	Warsaw-Keokuk	500	0	500
10	3	4	9	Warsaw shale <sup>a</sup>	528	—29	499
11	3	4	9	Lower Warsaw	492	?	492
12	3	4	9	Base of St. Louis	551	—75	476
13	4	4	9	Popel-Giller Brewery well <sup>b</sup>	523	—55	468
14	4	4	9	Warsaw shale <sup>a</sup>	503	—29	474
15	9	4	9	Warsaw shale <sup>a</sup>	515	—29	486
16	9	4	9	Warsaw city well	575	—111	464
17	9	4	9	Base of St. Louis	560	—75	485
18	10	4	9	Base of St. Louis	563	—75	488
19	10	4	9	Base of St. Louis	581	—75	506
20	10	4	9	Base of St. Louis	579	—75	504
21	11	4	9	Salem <sup>c</sup>	614	—70	544
22	12	4	9	Warsaw-Keokuk	589	0	589
23	12	4	9	Warsaw-Keokuk	582	0	582
24	13	4	9	Base of St. Louis	630	—75	555
25	13	4	9	Mitze well (log No. 1)	691	—163	528
26	15	4	9	Base of St. Louis	562	—75	487
27	16	4	9	Base of St. Louis	575	—75	500
28	16	4	9	Warsaw-Keokuk	495	0	495
29	16	4	9	Warsaw-Keokuk	491	0	491
30	6	4	8	Warsaw-Keokuk	565	0	565
31	6	4	8	Warsaw shale <sup>a</sup>	588	—29	559
32	6	4	8	Warsaw shale	603	—36	567
33	7	4	8	Warsaw shale <sup>a</sup>	600	—29	571
34	21	4	9	Warsaw shale <sup>a</sup>	518	—29	489
35	22	4	9	Base of St. Louis	574	—80	494
36	27	4	9	Base of St. Louis	581	—80	501
37	27	4	9	Base of St. Louis	584	—80	504
38	28	4	9	Warsaw shale <sup>a</sup>	511	—22	489
39	34	4	9	Base of St. Louis	583	—83	500
40	34	4	9	Base of St. Louis	583	—85	498
41	35	4	9	Base of St. Louis	594	—87	507
42	36	4	9	Dodge well (log No. 2)	732	—235	497
43	1	3	9	Base of St. Louis	594	—90	504
44	2	3	9	Base of St. Louis	601	—90	511
45	10	3	9	Warsaw-Keokuk	504	0	504
46	12	3	9	Base of St. Louis	602	—90	512
47	12	3	9	Base of St. Louis	588	—90	498
48	13	3	9	Base of St. Louis	598	—90	508

TABLE 1.—*Structural data on Warsaw Area—Concluded*

(Locations of datum points 1-33 are shown on Figure 3 and 4, 34-56 on Figure 4)

Map No.	Location			Formation or well	Surface Elevation	Key horizon, Warsaw-Keokuk contact	
	Sec.	T. N.	R. W.			Interval	Elevation
<b>Hancock County, Illinois—Concluded</b>					<i>Feet</i>	<i>Feet</i>	<i>Feet</i>
49	14	3	9	Lower Warsaw	518	—8	510
50	15	3	9	Lower Warsaw	510	?	510—
51	24	3	9	Salem <sup>c</sup>	601	—90	511
52	25	3	9	Base of St. Louis	591	—90	501
53	26	3	9	Base of St. Louis	593	—90	503
54	27	3	9	Lower Warsaw	505	?	505—
55	27	3	9	Lower Warsaw	505	?	505—
56	35	3	9	Warsaw-Keokuk	533	0	533
57	8	3	8	Miller well (log No. 3)	733	—230	503

<sup>a</sup> Base of principal shale member of Warsaw formation.<sup>b</sup> See Reference 4, p. 76, for published well log.<sup>c</sup> Probably close to base of St. Louis formation.

## OIL POSSIBILITIES

The Warsaw anticline seems to be of adequate dimensions to form a structural trap in which commercial quantities of oil or gas may have accumulated underground. It is comparable in size with the anticline on which the Colmar-Plymouth oilfield is situated, about 25 miles to the east. Whether or not oil or gas has actually accumulated in commercial quantities in the Warsaw anticline depends upon whether or not certain other conditions are fulfilled. Among these are (a) an adequate supply of source material from which oil and gas may be generated, (b) pervious rock which may hold fluids in its pore spaces, and (c) an impervious cover which would prevent the escape of fluids. The underground conditions and the presence or absence of oil or gas in commercial quantities can be determined only by drilling. If further test-drilling for oil is done in the Warsaw area it is recommended that a well be located on the crest of the Warsaw anticline somewhere within the 590-foot structural contour in sec. 1 or adjacent parts of secs. 2, 11, and 12, T. 4 N., R. 9 W., and sec. 6, T. 4 N., R. 8 W.

## POSSIBLE PRODUCING FORMATIONS

Possible producing formations for oil and gas in the Warsaw area include (a) the Devonian limestone, (b) the Hoing sand, which may or may not be present in any given locality, and (c) the Kimmswick-Plattin or "Trenton" limestone. No commercial production of oil or gas has been obtained in Illinois or the immediately adjacent states from any formation lower than the "Trenton." The depth at which a given formation will be

found at any point will depend on two factors: (a) the surface elevation, and (b) the position of the point with respect to structure. Estimated depths for various horizons for a point along the road near the center of the E.  $\frac{1}{2}$  SW.  $\frac{1}{4}$  sec. 1, T. 4 N., R. 9 W., on top of the Warsaw anticline, are as follows:

Horizon	Estimated depth <i>Feet</i>
Top Devonian limestone .....	525
Hoing sand .....	600
Top Kimmswick .....	615
Top St. Peter .....	840

For a complete test of the known possible producing formations, including the "Trenton," drilling should continue to the top of the St. Peter formation.

Logs of the three oil-tests previously made in the Warsaw area and of a "Trenton" test in the Colmar oilfield are given below (pp. 13-17). Shows of oil were found in two of the three wells in the Warsaw area.

## GEOLOGY

### PREVIOUS WORK

The area described in this report is part of the area along the Mississippi River valley in which the Mississippian formations were originally classified and described by D. D. Owen, James Hall, and others. The following list of references includes the more important of the previous publications on the geology of this area and the surrounding region.

- (1) <sup>1</sup>HALL, JAMES, Report on the geological survey of the State of Iowa, Vol. I, 1858.
- (2) HINDS, HENRY, Description of the Colchester and Macomb quadrangles, United States Geological Survey Geologic Atlas, Folio No. 208, 1919.
- (3) KEYES, CHARLES ROLLIN, Geology of Lee County, Iowa Geological Survey Vol. III, Second Annual Report, pages 305-407, 1893.
- (4) KREY, FRANK, Structural reconnaissance of the Mississippi Valley area from Old Monroe, Missouri, to Nauvoo, Illinois, Illinois State Geological Survey Bulletin 45, 1924.
- (5) <sup>1</sup>MORSE, WILLIAM C., and Kay, Fred H., The Colmar oil field—a restudy, Illinois State Geological Survey Bulletin 31, pages 37-55, 1914.
- (6) VAN TUYL, FRANCIS M., The stratigraphy of the Mississippian formations of Iowa, Iowa Geological Survey Vol. XXX, Annual Reports 1921 and 1922, pages 33-374.
- (7) <sup>1</sup>WORTHEN, A. H., Geology of Hancock County, Geological Survey of Illinois Vol. I, pages 327-348, 1866.

<sup>1</sup> Out of print; may be consulted in public, technical, or university libraries.

## GENERAL

The Warsaw area lies west of the Eastern Interior Coal Basin and is on a northward extension of the Ozark uplift that has been called the Mississippi River anticline.<sup>2</sup> The surface topography is considerably more broken than in most parts of Illinois. Although glacial drift was deposited over the whole area, many streams have cut through the drift and exposed the underlying bedrock.

The exposed bedrock in the Warsaw area is all of Mississippian age (with the possible exception of small outliers of Pennsylvanian) and comprises the Keokuk, Warsaw, Salem, and St. Louis formations (geologic column, Fig. 2). These formations and selected geologic sections illustrating their typical characters are described below.

## ST. LOUIS FORMATION

The St. Louis formation is present in most of the Warsaw area but is absent on top of the Warsaw anticline and in the Mississippi River valley. It is exposed along the north bluff of this valley in the city of Keokuk, in creek valleys in the eastern part of the city of Warsaw, and in numerous valleys in the area south of Warsaw. Much of it consists of limestone conglomerate or breccia, from a few to 25 feet in total thickness. A persistent bed of dense gray limestone, 1½ to 2½ feet thick, which shows distinctive crenulations on vertical weathered surfaces, is assumed to be the basal bed of the St. Louis formation. Owing to the resistant character of this bed as compared with the less resistant character of the underlying Salem-Warsaw beds, waterfalls are formed in many streams. Such falls occur at datum points 17, 19, 20, 26, 27, 36, 39, and 47.

Geologic Section No. 1—*Falls in gully 200 feet west of bridge, SW. ¼ NE. ¼ sec. 16, T. 4 N., R. 9 W. (Datum point 27)*

	Thickness Feet
St. Louis formation	
3. Limestone, light gray, hard, fine-grained, crenulated. ( <i>Elevation of base used as structural datum</i> ).....	2
Salem formation	
2. Limestone, brown, crystalline, medium-grained, well-bedded, but bedding planes somewhat irregular, beds 2 to 6 inches thick, some shaly lenses .....	5
1. Talus .....	5

Geologic Section No. 2—*Gully 300 feet northeast of stream junction NW. ¼ NW. ¼ NE. ¼ sec. 34, T. 4 N., R. 9 W. (Datum point 39)*

St. Louis formation	
4. Limestone, light gray, finely granular, hard, crenulated. ( <i>Elevation of base used as structural datum</i> ).....	2
Salem-Warsaw formations	
3. Limestone, argillaceous, yellowish-gray, well-bedded, contains abundant fossils .....	3
2. Shale, calcareous, yellow-brown .....	2
1. Limestone, magnesian, brown.....	3

<sup>2</sup>Howell, J. V., Tectonic map of Central United States, Kansas Geological Society, 1931.



Geologic Section No. 3—*Gully west of abandoned bridge, SE. ¼ NE. ¼ SE. ¼ sec. 2, T. 3 N., R. 9 W. (200 feet west of datum point 43)*

St. Louis formation	
3. Limestone, light gray, compact, crenulated. ( <i>Elevation of base used as structural datum</i> ).....	2
Salem-Warsaw formations	
2. Sandstone, argillaceous, silty, dolomitic, slightly calcareous, greenish-gray, very fine, compact, micaceous.....	2
1. Limestone, brownish-gray, coarsely granular; contains abundant fragmentary fossils, including crinoid segments, bryozoa, and brachiopods in matrix of clear crystalline calcite.....	3

SALEM FORMATION

The Salem (Spergen) formation has been recognized in the Warsaw area and surrounding region. (See reference 6, pp. 223-226.) It is overlain unconformably by the St. Louis formation but appears to grade into the underlying Warsaw formation. In places it seems to be absent, so that the St. Louis rests directly on the Warsaw formation, but where present it ranges in thickness to 5 or 6 feet. It varies from coarsely crystalline cross-bedded crinoidal limestone to fine-grained sandstone and shale (Geologic Sections Nos. 1, 2, and 3). For the purpose of the present structural study the Salem and Warsaw formations have been grouped together.

WARSAW FORMATION

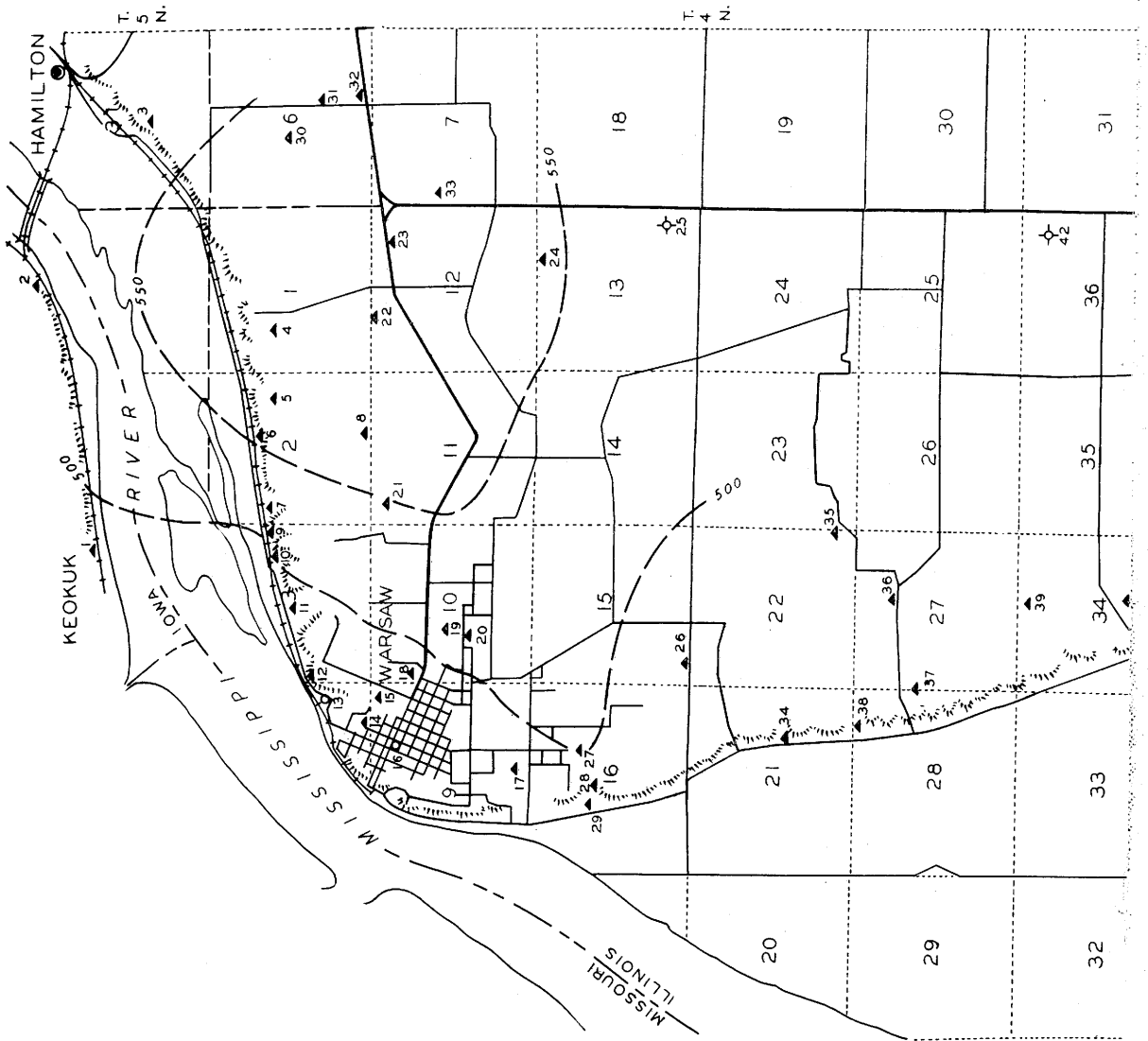
The Warsaw formation is present in most of the Warsaw area and crops out in many places. It consists largely of shale and argillaceous limestone and is well known for the abundant geodes that it contains. It grades downward into the underlying Keokuk formation. The combined thickness of the Salem and Warsaw formations in the area varies from approximately 75 to 90 feet.

Geologic Section No. 4—*North bank of west-flowing creek, 100 feet west of stone bridge approximately 300 feet south and 100 feet west of NE. cor. sec. 9, T. 4 N., R. 9 W., in the city of Warsaw (Datum point 15)*

	Thickness
Salem-Warsaw formations	<i>Feet</i>
8. Limestone, brown .....	3
7. Shale, bluish-gray, and some interbedded limestone.....	11
6. Limestone, magnesian, yellowish-brown, vesicular.....	5
5. Limestone, argillaceous, bluish .....	3
4. Shale, gray .....	1½
3. Limestone, argillaceous, bluish.....	1½
2. Shale, calcareous, light gray; contains geodes.....	21
1. Limestone, argillaceous, bluish-gray, massive; contains some chert in beds and nodules and some imperfect geodes.....	7

The geologic section in Soap Factory Hollow, south of Warsaw (datum point 28), in which the lower part of the Warsaw formation is exposed, has been described by Van Tuyl. (See reference 6, pp. 187-188.)

The lower part of the Warsaw formation and its transition into the underlying Keokuk is exemplified in the following geologic section.



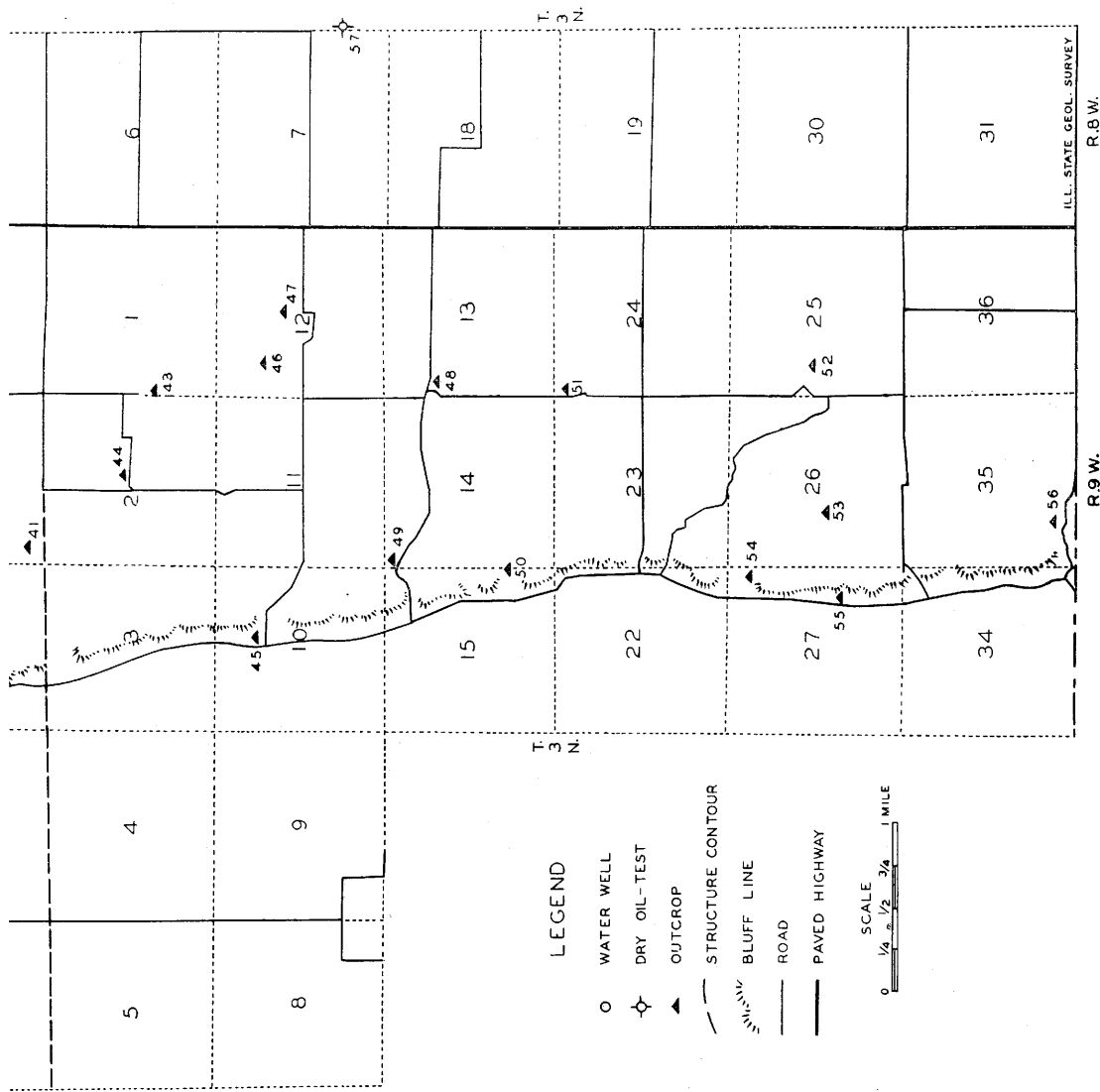


FIG. 4.—Map showing location of structural datum points in Warsaw area. (See Table 1.)  
The Warsaw anticline (Fig. 3) is here shown by 50-foot contours.

Geologic Section No. 5—*Quarry on the west bank and bed of gully, south side of T. P. and W. Railroad, SE. ¼ SE. ¼ NE. ¼ sec. 3, T. 4 N., R. 9 W. (Datum point 9)*

	Thickness
	Feet
Warsaw formation	
3. Shale, brownish-gray, with some interbedded limestone.....	8
2. Limestone, gray and crystalline or argillaceous and bluish-gray, in alternating beds, the latter in greater amount but the former standing out because of greater resistance to erosion; some chert beds, especially in lower part; fossils very abundant in shaly layers .....	28
Keokuk formation	
1. Limestone, gray, crystalline, with chert in beds and nodules....	5

#### KEOKUK FORMATION

The Keokuk formation is exposed in numerous gullies which traverse the structurally high area northeast of Warsaw. Elsewhere in the area this formation is wholly or largely below the surface.

Near the mouth of Cedar Glen Creek, in the NE. ¼ NE. ¼ sec. 2, T. 4 N., R. 9 W. (north of datum point 5) a nearly complete section of the Keokuk formation is exposed. It consists of gray, crinoidal limestone with much chert in beds and nodules and is approximately 70 feet thick. This section has been described in detail by Van Tuyl. (See reference 6, pp. 155-156.)

#### BURLINGTON FORMATION

The Burlington formation is present below the surface in the Warsaw area and is not exposed at the surface unless some of the lowermost beds in the Cedar Glen section represent the uppermost beds of the Burlington formation. This formation is lithologically similar to the Keokuk. For descriptions of the Burlington and underlying formations down to the St. Peter sandstone, see geologic column (Fig. 2).

As shown in Table 1, the key horizon crops out at some places and its elevation could be measured directly. At other places, however, the elevation of the key horizon was calculated by subtracting an assumed interval from the elevation of some higher horizon. Of these the ones most commonly used were the base of the St. Louis formation and the base of the principal shale member of the Warsaw formation. The interval from the base of the St. Louis to the top of the Keokuk, as determined from datum points 27 and 28 in the Soap Factory Hollow area and allowing for a west dip of 5 feet in ¼ mile, is 75 feet. This was assumed to be the St. Louis-Keokuk interval for the area of figure 3. This interval is somewhat greater in the area to the south. Thus at datum point 42 (Dodge well), it is probably 93 feet; at datum point 57 (Miller well), it is 87+ feet—the full interval is not known here because the St. Louis formation is cut out by glacial drift; in the vicinity of datum points 52, 53, 54, and 55 it is probably

close to 90 feet. For all of the datum points determined on the base of the St. Louis in T. 3 N., R. 9 W., the St. Louis-Keokuk interval was assumed to be 90 feet. For the datum points in the intermediate area between the south line of T. 4 N., R. 9 W., and the south line of figure 3, the interval was assumed to increase regularly to the south, as may be noted in Table I.

## ACKNOWLEDGMENTS

The base map used for the study is a topographic map of parts of the Keokuk and Mendon quadrangles specially prepared for this study by the United States Geological Survey in cooperation with the Illinois State Geological Survey. Mr. Louis C. McCabe of the Survey staff assisted the writer in the geological study of the area and in determining elevations of outcrops and wells.

## WELL LOGS

1. *Walmar Oil Company, Mitze well No. 1, NE. ¼ SE. ¼ SE. ¼ sec. 13, T. 4 N., R. 9 W., Hancock County (Datum point 25)*

Elevation 691 feet

	Thickness <i>Feet</i>	Depth <i>Feet</i>
Recent and Pleistocene systems		
Loess, silt, till, sand and gravel; show of gas 35-40 feet; water 60-65 feet .....	76	76
Mississippian system		
Iowa series		
Meramec group		
St. Louis formation		
Limestone, sandy, light gray, pink, and green, very fine-grained .....	14	90
Osage group		
Warsaw formation		
Shale, sandy, dark gray .....	2	92
Dolomite, silty, dark gray, very fine-grained .....	4	96
Shale, sandy, dolomitic, dark gray .....	15	111
Dolomite, argillaceous, dark gray, very fine-grained, grading to shale, dolomitic, dark gray; contains geodes .....	41	152
Dolomite, argillaceous, medium to light gray, very fine-grained; contains geodes .....	11	163
Keokuk formation		
Limestone, dolomitic, very cherty, light to dark gray, speckled, coarse-grained; "1 bailer water" at 202 to 209 feet .....	46	209
Burlington formation		
Limestone, partly dolomitic, cherty, light buff to white, coarse-grained; "water to drill" at 209 to 216 feet, "3 bailers water" at 216 to 221 feet .....	41	250
Dolomite, cherty, light yellow to white, very fine-grained; water at 250 to 260 feet .....	41	291
Limestone, dolomitic, cherty, white, coarse to very fine-grained .....	13	304
Sedalia (?) formation		
Limestone, dolomitic, buff, very fine- to medium-grained	6	310

<sup>a</sup> Drilled in 1931. Log derived from samples of well cuttings studied by L. E. Workman; notes regarding water and shows of oil and gas are from driller's log unless otherwise noted.

	Thickness Feet	Depth Feet
Kinderhook group		
Hannibal formation		
"Shale, blue, muddy" (no sample).....	5	315
Siltstone, dolomitic, gray .....	28	343
Limestone, oölitic, white, medium-grained.....	4	347
Dolomite, brownish-gray, very fine-grained, interlaminated with limestone, dolomitic, light gray, extra fine-grained .....	33	380
Dolomite, sandy, buff, and limestone, cherty, light buff	11	391
Siltstone, dolomitic, dark brownish-gray .....	21	412
Saverton formation		
Shale, silty, bluish-gray .....	60	472
Grassy Creek formation		
Shale, silty, bluish-gray to brown; contains <i>Sporangites</i>	41	513
Shale, silty brown; contains <i>Sporangites</i> .....	129	642
Devonian system		
Senecan series		
Cedar Valley formation		
Sandstone, calcareous, white, fine-grained, pyritic.....	...	642
Dolomitic, brownish-gray, very fine-grained.....	9	651
Limestone, sandy, cherty, dolomitic, brownish to light gray, very fine- to coarse-grained; hole full of water at 658 feet, <i>show of oil at 661 to 665 feet</i> .....	17	668
Limestone, dolomitic, light and dark gray, coarse-grained	31	699
Dolomite, cherty, light gray, very fine-grained.....	21	720
Limestone, sandy, cherty, dolomitic, light gray, coarse-grained; <i>oil show in sample</i> .....	14	734
Ordovician system		
Mohawkian series		
Kimmiswick and Plattin (and Joachim?) formations		
Dolomite, brownish-gray, fine-grained; <i>slight oil show in samples from 734 to 744 feet</i> .....	46	780
Dolomite, brownish-gray, fine-grained, cherty in upper part .....	125	905
Dolomite, slightly cherty, brownish-gray, with thin shale partings .....	30	935
2. <i>Kosana Oil Company, Dodge well No. 1,<sup>b</sup> NE. ¼ NE. ¼ sec. 36, T. 4 N., R. 9 W., Hancock County</i>		
Elevation 733 feet		
Recent and Pleistocene systems		
Soil, yellow clay, and "quicksand".....	25	25
Blue clay .....	15	40
"Quicksand;" gas at 60-70 and 80-85 feet.....	64	104
Sand .....	8	112
Mississippian system		
Iowa series		
Meramec group		
St. Louis formation		
Limestone, broken .....	7	119
Slate, dark blue, water.....	11	130
Limestone .....	12	142
Osage group		
Warsaw (and Salem?) formation		
Shale, white, sandy.....	4	146
Limestone, soft .....	7	153
Shale, light, sandy .....	4	157
Limestone, white, soft.....	5	162
Shale, green and blue.....	48	210
Limestone .....	25	235

<sup>b</sup> Drilled in 1930-31; driller's record.

	Thickness	Depth
	<i>Feet</i>	<i>Feet</i>
Keokuk and Burlington formations		
Limestone ("1 bailer water at 255 feet")	95	330
Shale, dark	3	333
Limestone	45	378
Kinderhook group		
Hannibal formation		
Shale, green	2	380
Limestone	6	386
Shale, green	6	392
Sand and sandy shale	8	400
Limestone, white, hard	53	453
Sand ("oil sand")	12	470
Saverton formation		
Shale, blue	83	553
Grassy Creek formation		
Shale, brown	30	583
Shale, light	89	672
Devonian system		
Senecan series		
Cedar Valley and Wapsipinicon (?) formation		
Limestone	18	690
"Sand", (probably sandy limestone), light	40	730
Limestone	57	787
Ordovician system		
Cincinnatian series		
Maquoketa group		
Shale	2	789
Mohawkian and Chazyan series		
Kimmswick and Plattin (Mohawkian series) and Joachim (Chazyan series) formations		
Limestone	27	816
Limestone, sandy (probably dolomitic limestone) water at 902 feet	102	918
"Sand" (probably dolomitic limestone), brown to light; water at 971 feet	105	1023
Chazyan series		
St. Peter formation		
Sandstone, white, water	55	1078

3. *Walmar Oil Company, B. Miller well No. 1, SW. 1/4 NW. 1/4 SW. 1/4 sec. 8. T. 3 N., R. 8 W., Hancock County (Datum point 57)*

## Elevation 733 feet

Recent and Pleistocene systems		
Loam, silty, brown	5	5
Till, sandy, calcareous, yellow to bluish-gray	100	105
Sand, calcareous, yellow, coarse-grained; water at 110 feet	20	125
Till, sandy, calcareous, gray	10	135
Gravel, gray, sandy, calcareous	35	170
Mississippian system		
Iowa series		
Osage group		
Warsaw formation		
Shale, calcareous, dark gray, and limestone, sandy, dolomitic, gray, coarse-grained	38	208
Limestone, argillaceous, cherty, dolomitic, gray, very fine to very coarse-grained; some interbedded shale	22	230

<sup>c</sup> Drilled in 1931-32. Log derived from samples of well cuttings studied by L. E. Workman; notes regarding water and shows of oil and gas are from driller's log.

	Thickness <i>Feet</i>	Depth <i>Feet</i>
Keokuk formation		
Limestone, cherty, light and dark gray and buff, speckled, coarse-grained .....	51	281
Burlington formation		
Limestone, cherty, light buff to white, coarse-grained; water at 326-331 feet.....	60	341
Dolomite, cherty, light yellow to light gray, very fine-grained .....	29	370
Limestone, partly dolomitic, white, very coarse-grained	13	383
Kinderhook group		
Hannibal formation		
Shale, silty, gray.....	?	383
Siltstone, calcareous, gray.....	27	410
Limestone, oolitic, light buff, very fine to fine-grained	5	415
Dolomite, brownish-gray, very fine grained; interlaminated with limestone, dolomitic, light gray, sub-lithographic .....	37	452
Sandstone, dolomitic, brownish-gray to gray, very fine-grained .....	29	481
Saverton formation		
Shale, silty, bluish-gray .....	47	528
Grassy Creek formation		
Shale, silty to clayey, bluish-gray to brown; contains <i>Sporangites</i> .....	29	557
Shale, silty, brown; contains <i>Sporangites</i> .....	117	674
Devonian system		
Senecan series		
Cedar Valley formation		
Sandstone, calcareous, white, fine-grained, pyritic.....	?	674
Limestone, dolomitic, sandy, buff, very fine-grained....	15	689
Dolomite, cherty, buff, very fine-grained; thin sandstone, dolomitic, white, medium grained, at base.....	8	697
Limestone, dolomitic, sandy, buff and dark gray, coarse-grained .....	14	611
Limestone, argillaceous, dolomitic, cherty, brownish-gray, very fine-grained .....	30	741
Limestone, sandy, dolomitic, cherty, brownish-gray, very fine-grained .....	20	761
Wapsipinicon formation		
Limestone, lithographic, light gray; little clay, partly sandy, blue to gray; shale, sandy, red and blue, at base	36	797
Ordovician system		
Cincinnatian series		
Maquoketa group		
Limestone, gray, coarsely granular; contains diminutive gastropods, brachiopods, and crinoids .....	7	804
Mohawkian series		
Kimmswick and Plattin formations		
Limestone, dolomitic, light buff, very fine to medium-grained .....	66	870
Limestone, dolomitic, slightly cherty, buff, medium-grained .....	37	907
Limestone, dolomitic, buff, very fine to coarse-grained, slightly cherty in places; <i>show oil in sample 917 to 927 feet</i> .....	73	980
Chazy series		
Joachim formation		
Limestone, dolomitic, sandy, brown to buff; contains thin streaks of brown shale.....	47	1027
St. Peter formation		
Sandstone, white, very fine to medium-grained; blue shale streak at 1145 feet.....	126	1153



	Thickness	Depth
	<i>Feet</i>	<i>Feet</i>
Prairie du Chien series		
Shakopee formation		
Dolomite, more or less sandy with occasional thin streaks of sandstone, cherty, light gray to buff, very fine-grained .....	218	1371
4. <i>Snowden Brothers and Company, L. R. Grigsby well No. 1,<sup>d</sup> NW. ¼ SE. ¼ sec. 20, T. 4 N., R. 4 W., McDonough County</i>		
Elevation 576 feet		
Recent and Pleistocene systems		
Soil and clay .....	26	26
Mississippian system		
Iowa series		
Osage group		
Warsaw formation		
Limestone, gray .....	10	36
"Mud" (shale) .....	10	46
Keokuk and Burlington formations		
Limestone, sandy, white.....	44	90
Limestone, gray; water at 115 feet.....	55	145
Limestone, white .....	35	180
Kinderhook group		
"Mud" (shale), white.....	30	210
Shale, brown .....	10	220
"Slate" (hard shale) white, and "mud" (shale).....	40	260
Shale, brown .....	10	270
"Slate" (hard shale), white, and shale.....	20	290
"Mud" (shale) white.....	21	311
"Slate" (hard shale), sandy, white.....	67	378
Shale, brown .....	7	385
"Slate" (hard shale), sandy, white.....	15	400
Devonian and Silurian systems		
Limestone, gray; <i>show of oil at 425 to 432 feet</i> .....	34	434
Ordovician system		
Cincinnatian series		
Maquoketa group		
"Slate" (hard shale) and shale.....	187	621
Mohawkian series		
Kimmswick and Platin formations ("Trenton limestone")		
Limestone, white .....	29	650
Limestone, brown .....	155	805

<sup>d</sup> Drilled 1914. Driller's record.