THE PLUMMER FIELD, GREENE COUNTY, INDIANA

Special Report 17

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The Plummer Field Greene County Indiana

By JAMES A. NOEL

DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY SPECIAL REPORT 17

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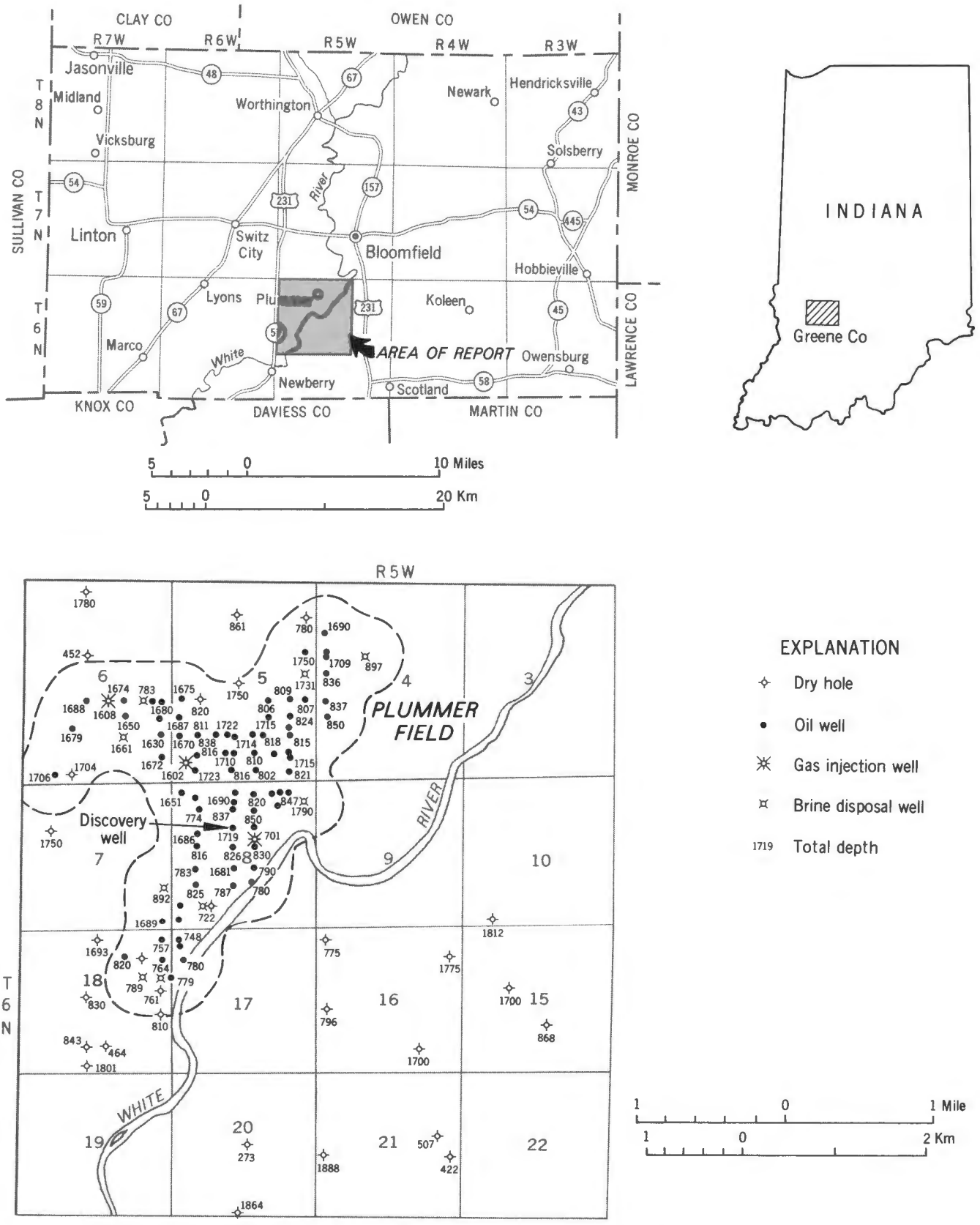


Figure 1. Sketch map showing location of the Plummer Field.

The Plummer Field, Greene County, Indiana

By JAMES A. NOEL

Abstract

The Plummer Field in Greene County, Ind., was discovered by Citizens Gas and Coke Utility during the summer of 1969 on completion of Citizens No. 1 Fred & Lucille Rollison. The initial production of this well was 120 barrels of oil per day through perforations in the Salem Limestone at 688 to 698 feet and 705 to 710 feet. The well also tested 20 barrels of oil and 120 barrels of water per day from perforations at 1606 to 1611 feet and 1616 to 1621 feet in middle Devonian limestone (Muscatatuck Group). Subsequent to the discovery well, 87 wells have been drilled (1975) in the field. Of the 88 wells, 50 produce from the Salem Limestone, 20 produce from middle Devonian limestone, one produces from the Ste. Genevieve Limestone, three are gas injection wells into middle Devonian limestone, nine are salt water injection wells into the Salem Limestone, and five are dry holes. By the end of 1974, 2,217,268 barrels of oil had been produced from the Salem Limestone and 129,585 barrels from the Devonian. Full-scale production from the Devonian was delayed until early 1973 when gas recycling equipment was completely installed.

Stratigraphic units drilled in the Plummer Field range in age from Silurian through Pennsylvanian. The stratigraphy and lithologies of the formations are typical for this part of the Illinois Basin. The field is arcuate; the open part of the arc faces west and has a strong northeast projection.

Structure contour maps on top of the Renault Formation, the Salem Limestone, and middle Devonian limestone all depict this arcuate form. Isopach maps of intervals between the Renault and the Ste. Genevieve and between the Salem and the Devonian also depict the form and position of the Plummer Field. An isopach map of the New Albany Shale does not show the outline of the field as precisely as the isopachs of the other two intervals. The structure is believed to be due to draping and compaction of beds over a Silurian reef.

There are three porous zones that are productive in the Salem Limestone. These zones are not present everywhere in the field and are unproductive in the northwestern lobe. All zones are believed to be connected by fractures. Two productive zones are also present in middle Devonian limestone.

Blowout preventers were used during drilling operations. Tank batteries and salt water collecting pits have embankments to prevent spills from spreading and to contain salt water until it is reinjected into the Salem Limestone.

Introduction

The Plummer Field in Greene County, Ind. (fig. 1), was discovered during the summer of 1969 by Citizens Gas and Coke Utility. The discovery well was the Citizens No. 1 Fred & Lucille Rollison in sec. 8, T. 6 N., R. 5 W. During development of the field, Citizens conducted a comprehensive logging and coring program that accumulated valuable data on which this report is based.

As currently developed (1975), the Plummer Field occupies parts of secs. 4, 5, 6, 7, 8, 17, and 18, T. 6 N., R. 5 W. (fig. 1). The field lies between State Route 57 on the west and the West Fork of White River on the east. Newberry is about 1.75 miles from the south end of the field, and Plummer is on the northeast edge.

Discovery of an oilfield in Greene County was not entirely unexpected by the geologists of Citizens Gas and Coke Utility. They had noted shows of oil and gas in Mississippian and Devonian rocks during exploration for underground storage sites for natural gas. Prior to discovery of the Plummer Field, Citizens had established five underground storage sites in Greene County.

The extensive documentation of the geology of the area from logging, coring, and testing and the successful completion and production practices of Citizens resulted in a storehouse of valuable information. This study was undertaken in the hope of stimulating similar work elsewhere in the state.

Acknowledgments

I am indebted to Citizens Gas and Coke Utility for permission to study data from their files and especially for the rewarding and informative discussions with Ward J. Collins, Lowell E. Gladish, and Howard Smith. Also, without the assistance, encouragement, and advice of the personnel of the Petroleum Section of the Indiana Geological Survey, this report could not have been completed. I am especially indebted to Paul Dubois, who assisted in the preparation of all illustrations.

General Geology

The Plummer Field lies in the eastern part of the Illinois Basin. The regional dip of the beds is to the southwest and ranges from 35 to 60 feet per mile. The area is partly covered by glacial deposits, and the shallow bedrock consists of strata of Pennsylvanian age. The total sedimentary section consists of rocks ranging in age from Precambrian through Pennsylvanian, and the deepest well terminated in rocks of Silurian age.

Geologic descriptions of the area and regional stratigraphic relationships appear in many publications. Geologic concepts and stratigraphic nomenclature (table 1) used in this paper were taken from Esarey, Malott, and Galloway (1947), Esarey, Bieberman, and Bieberman (1950), Lineback (1970), Murray (1955), Perry and Smith (1958), Pinsak (1957), Shaver and others (1970), Sullivan (1972), and Swann (1963).

The Plummer Field

The Plummer Field is one of the major oil and gas discoveries in Indiana in recent years. Since the field was discovered, 88 wells have been drilled (1975); five are dry holes, nine are salt water disposal wells, 20 produce from middle Devonian limestone, three are gas injection wells, 50 produce from the Salem Limestone, and one produces from the Ste. Genevieve Limestone.

Citizens Gas and Coke Utility successfully conducted exploration for underground gas storage sites elsewhere in Greene County. This exploration program had the discovery of oil and gas as a secondary goal. Shows of gas were consistently found in middle Devonian limestone and shows of oil in upper Mississippian rocks. Thus there was really little surprise, except in the magnitude of the find, when drill stem tests in the Citizens No. 1 Fred & Lucille Rollison well showed good production potential as illustrated below:

DST 1 654 - 675 ft, St. Louis, 2.5 hrs: recovered 5 ft mud.

DST 2 680 - 695 ft, Salem, 2.5 hrs: recovered 350 ft oil, 30 ft oil cut mud.

DST 3 728 - 755 ft, Salem, 2.5 hrs: recovered 60 ft oil, 210 ft oil cut mud, 375 ft oil cut water.

DST 4 1498 - 1548 ft, Devonian limestone, 2.5 hrs: recovered 20 ft mud.

DST 5 1550 - 1559 ft, Devonian limestone, 2.5 hrs: recovered 120 ft mud.

DST 6 1585 - 1609 ft, Devonian limestone, 2.5 Hrs: 70 ft mud, slight show of oil.

DST 7 1596 - 1609 ft, Devonian limestone (Geneva?), 2.5 hrs: recovered 150 ft gas cut mud, 380 ft gas cut water.

Swabbing tests through perforations at 1606 to 1611 feet and 1616 to 1621 feet resulted in 20 barrels of oil and 120 barrels of water per day. Initial production of the well completed on August 12, 1969, was 120 barrels of oil per day through performations in the Salem Limestone at 688 to 698 feet and 705 to 710 feet.

Development of the Salem pool progressed systematically during the next 4 years. But development of the Devonian pool was delayed 3 years until gas recycling equipment could be installed at the field. Lea Oil Co. (also identified as Barkley or Arthalony) operates two producing wells in sec. 8 and all producing wells in secs. 17 and 18 (1975). Citizens Gas and Coke Utility either owns or operates the rest (table 2).

Early analyses by Oilfield Research, Inc., showed that the Salem oil has an API gravity of 35° at 60°F and a viscosity of 7.5 CPS at 75°F. Initial production from the Salem Limestone ranged from 7 to 250 barrels of oil per day and averaged 67 BOPD. Initial production from Devonian limestone ranged from 5 to 100 BOPD and from 5 to 750 thousand cubic feet of gas per day and averaged 33 BOPD and 163 MCFPD.

STRATIGRAPHY

Rocks penetrated during drilling range in age from Silurian through Pennsylvanian. Plate 1 is a north-south cross section showing correlations across Greene County and relating wells in the Plummer Field to those outside it. This cross section includes one well in Owen County, one well north of the field, two wells in the field, one well south of the field, and one well in Daviess County. Logs in the cross section are representative types of electric logs that have been

Table 1. Generalized stratigraphic classification for part of the geologic column in the Greene County area

System	Series	Stratigraphic unit	
Pennsylvanian	Undifferentiated	Undifferentiated	
Mississippian	Chesterian	Glen Dean Ls.	
		Hardinsburg Fm.	
		Haney Ls. (Golconda)	
		Big Clifty Fm. (Jackson)	
		Beech Creek Ls. (Barlow)	
		Cypress Fm.	
		Reelsville Ls.	
		Sample Fm.	
		Beaver Bend Ls.	
		Bethel Fm.	
	Valmeyeran	Renault Fm. and Aux Vases Fm.	
		Ste. Genevieve Ls.	Levias Mbr. Spar Mountain Mbr. Fredonia Mbr.
		St. Louis Ls.	
		Salem Ls.	
		Harrodsburg Ls.	
		Borden Gr.	
	Kinderhookian	Rockford Ls.	
		New Albany Sh.	
Devonian	Undifferentiated	North Vernon Ls.	Muscatatuck Gr. (middle Devonian limestone)
		Jeffersonville Ls. including Geneva Dol. Mbr.	
Silurian	Undifferentiated	Undifferentiated	

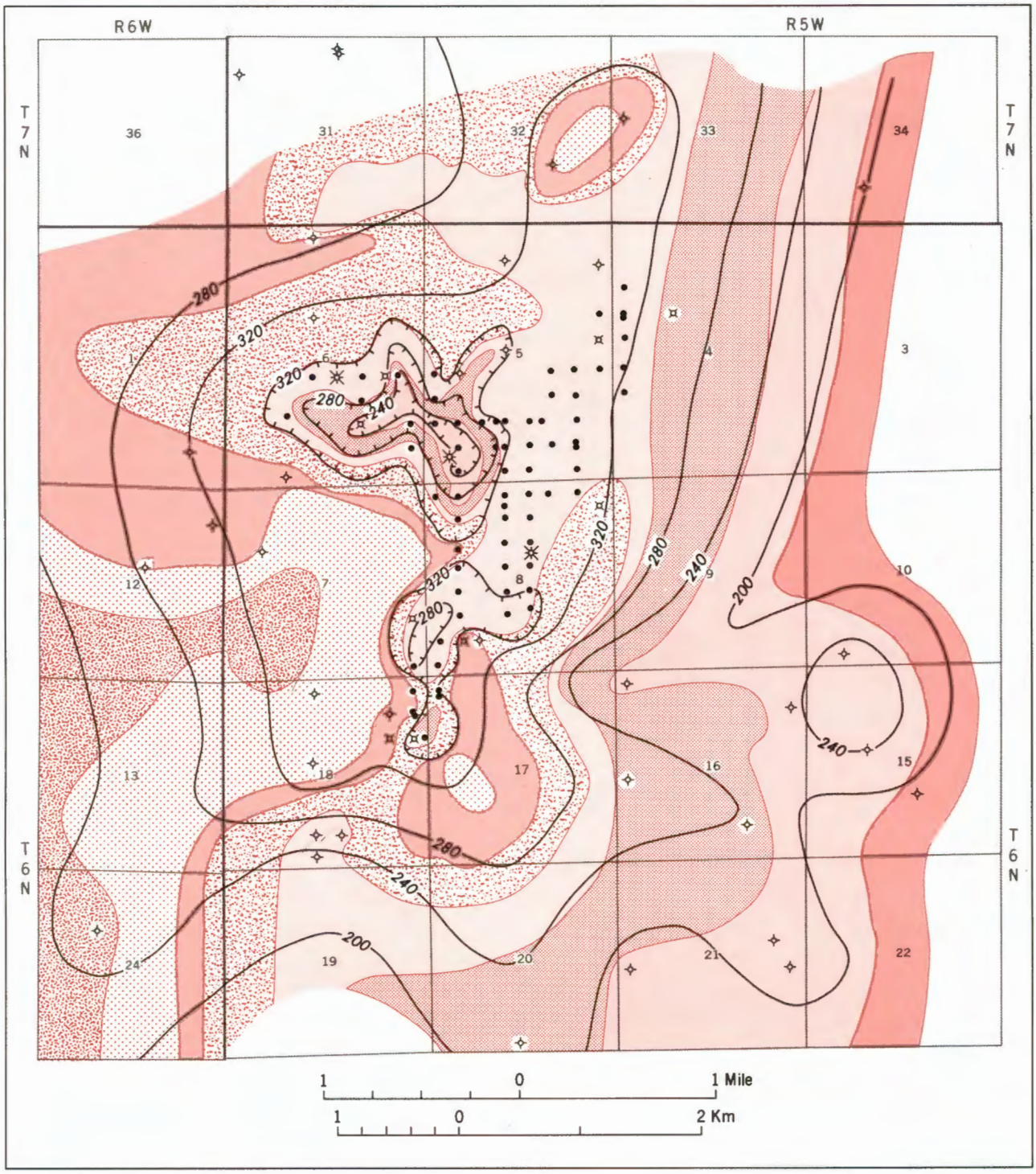
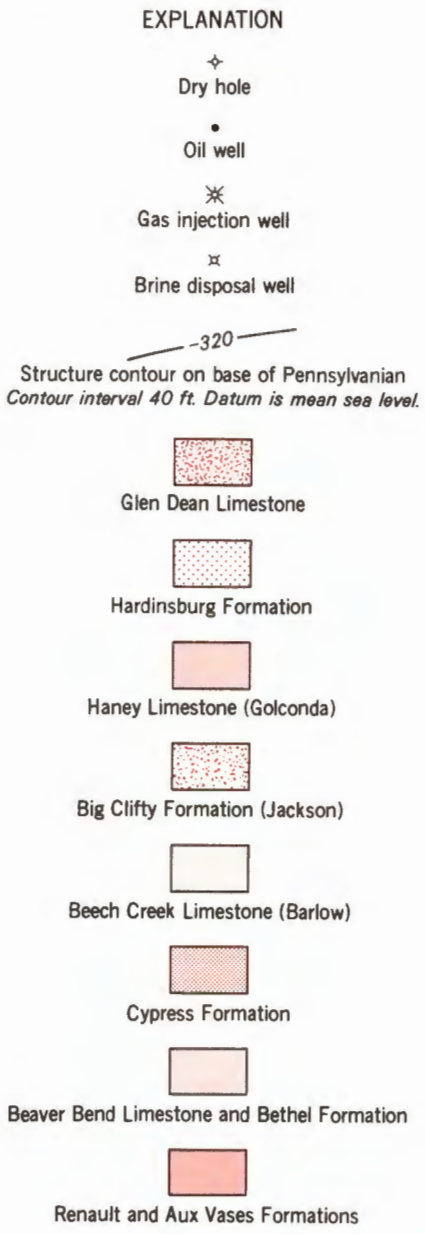


Figure 2. Paleogeologic map of the sub-Pennsylvanian Chesterian surface and the configuration of the Pennsylvanian-Chesterian surface in the Plummer Field.



used in recent years. They include conventional electric logs and dual induction logs of Schlumberger and Birdwell and show the graphic variability that may exist for a given formation from one log type to another. In addition to showing correlations and facies and thickness changes, the cross section is a guide to correlation among the different log types. The top of the Renault Formation is the datum plane for the section. In the Plummer Field area, casing is usually set on top of the Beaver Bend Limestone or the Renault Formation, thus preventing younger formations from appearing on the electric logs. The Pennsylvanian rocks lie unconformably on successively younger Chesterian rocks from east (Renault Formation) to west (Glen Dean Limestone). The sequence is interrupted on the crest of the field by pre-Pennsylvanian erosion; the Beaver Bend Limestone and the Cypress Formation lie at the unconformity (fig. 2).

Chesterian rocks that I identified in the area are the Renault Formation, the Bethel Formation, the Beaver Bend Limestone, the Cypress Formation, the Beech Creek Limestone, the Big Clifty Formation, the Haney Limestone (Golconda), the Hardinsburg Formation, and the Glen Dean Limestone (table 1). The lithologies of these rock units are typical of those found in this part of the Illinois Basin and have been described in numerous publications.

The Renault and Aux Vases Formations are treated here as a single unit. Because the correlation problem associated with the Aux Vases Formation was not within the scope of this study, the correlation level used next below the top of the Renault in this report is the top of the Ste. Genevieve Limestone. The Renault and the Aux Vases appear together on the electric log as two resistive peaks that are separated and followed by low resistivity intervals.

The top of the St. Louis Limestone remains as much a matter of individual interpretation as ever. In the Plummer Field area there is no distinct characteristic, either lithologically or electrically, to differentiate the St. Louis Limestone from the overlying Ste. Genevieve Limestone. Throughout the area, there are three high resistivity zones on electric logs separated by two low resistivity zones in the lower part of the St. Louis Limestone. Comparison of electric logs with samples in the same well shows that these responses are caused by dense finely crystalline dark-brown limestone and by anhydrite and gypsum beds. As this is a consistent and recognizable interval, these beds have been labeled "evaporite zone" on the cross sections as a correlation indicator and not as a stratigraphic term.

The top of the Salem Limestone is marked on the electric log by a high resistivity zone about 30 feet thick. It is also distinctive on the sidewall neutron porosity log. In the beds immediately above the Salem Limestone, the neutron curve records an off-scale reading. The top of the Salem Limestone is generally picked at the inflection point of the curve where it is recording the changes from the alternating shale, dolomite, evaporite sequence of the overlying St. Louis to the more uniform limestone lithology of the Salem.

On the dual induction lateral log, the resistivity of the lower two-thirds of the Salem Limestone is generally at a lower level than the zone at the top of the unit. The underlying white to light-gray crystalline fossiliferous Harrodsburg Limestone is more resistive than the Salem Limestone on most logs and contrasts sharply with the lower part of the Salem Limestone.

In the immediate area of the Plummer Field, the curves on the logs through the Borden Group depict lower resistivity and more uniform lithology. An exception is in the Citizens No. 1 Osburn (pl. 1). In this well it is difficult to determine if the Harrodsburg Limestone has thickened in places or if the upper part of the Borden Group contains 35 feet of limestone rather than siltstone and shale. Wells on plate 1 outside the Plummer Field that show development of thick limestone in the upper part of the Borden Group are Citizens No. 3 Vehslage, Poe No. 1 Baker, and Refuge No. 1-Comm. Wikle & Asdell.

The Rockford Limestone ranges from 2 to 6 feet in thickness and is represented only by a small peak on the resistivity curve. Its peak is sometimes obscured by the large response from the New Albany Shale.

The New Albany Shale in Indiana generally has excessively high resistivity for a shale unit. Its resistivity is nearly equivalent to that of a limestone. The gamma ray and neutron curves exhibit anomalous conditions as well. In many wells, measurements of 400 API units have been recorded on the gamma ray curve.

Distinction between the New Albany Shale and middle Devonian limestone is exceptional on radioactivity logs. The contact is marked by a sharp decrease in radioactivity on both the gamma ray and neutron curves. These changes give the Devonian limestone a broad shoulder effect, and the upper 80 feet appears blocky on the logs. On electric logs, the contact is shown by a relatively strong shift of the self-potential curve to the left. But on most logs there is only a gradual increase in the resistivity curves between the two units.

Although the North Vernon Limestone is present in the area, time and resources did not permit sufficient study to distinguish this formation from the Jeffersonville Limestone. Therefore, all middle Devonian rocks (Muscatatuck Group of Shaver, 1974) down to the top of the typical Geneva Dolomite Member of the Jeffersonville Limestone are treated as a single unit on some maps and in other references in this report. As much as 80 feet of the upper part of the North Vernon-Jeffersonville sequence is highly resistive and appears very square on radioactivity logs. Beneath this is a zone ranging from 10 to 40 feet in thickness that is less resistive and of higher porosity. This, in turn, is underlain by a section 10 to 30 feet thick of higher resistivity and lower porosity. These latter two zones are referred to on the cross sections as the Devonian porous zones. They are believed to be part of the Jeffersonville Limestone, but actual stratigraphic position is not certain. These porous zones in the Devonian are productive in the Plummer Field.

The Geneva Dolomite Member of the Jeffersonville Limestone is a unit of relatively low resistivity and high porosity. Sample descriptions agree with those given in Shaver and others (1970, p. 63): "Typically a dolomite that is buff to chocolate brown, rather soft, sparingly unfossiliferous, granular, and calcareous. . . ."

Few wells in the area penetrate Silurian rocks, and those that do are not deep enough to provide data for definitive electric log characteristics. On some electric logs, the Silurian is represented by a higher peak on the resistivity curve than that for the Geneva. On other logs there is little difference. Samples show that the Silurian rocks are white to light-gray medium-grained limy dolomites.

STRUCTURE

In addition to the correlation cross section (pl. 1), other cross sections were prepared to demonstrate structure across the field. But because no wells were drilled far down the flanks of the field, little structure was evident, and thus these cross sections are not shown. Lack of dry holes off the crest indicates the preciseness of the exploration and development program. In addition to the paleogeologic map (fig. 2), structure contour maps were drawn on the top of the Renault Formation (fig. 3), the top of the Salem Limestone (fig. 4), and the top of middle Devonian limestone (fig. 5). All the structure maps show the general form of the field, which is arcuate; the open part of the arc faces west and has a strong northeast projection. The paleogeologic map of the sub-Pennsylvanian (fig. 2) departs from this general description. It shows the highest area shifted off to the west and the western rim breached by erosion. Of the four maps, the paleogeologic map is the least reliable as an exploration tool. It does indicate structure, but because of post-Mississippian erosion and uneven distribution of sedimentation during early Pennsylvanian time, the true form and location of the structural feature are obscured. Relying solely on drilling to the base of the Pennsylvanian as an exploration technique would be of little value.

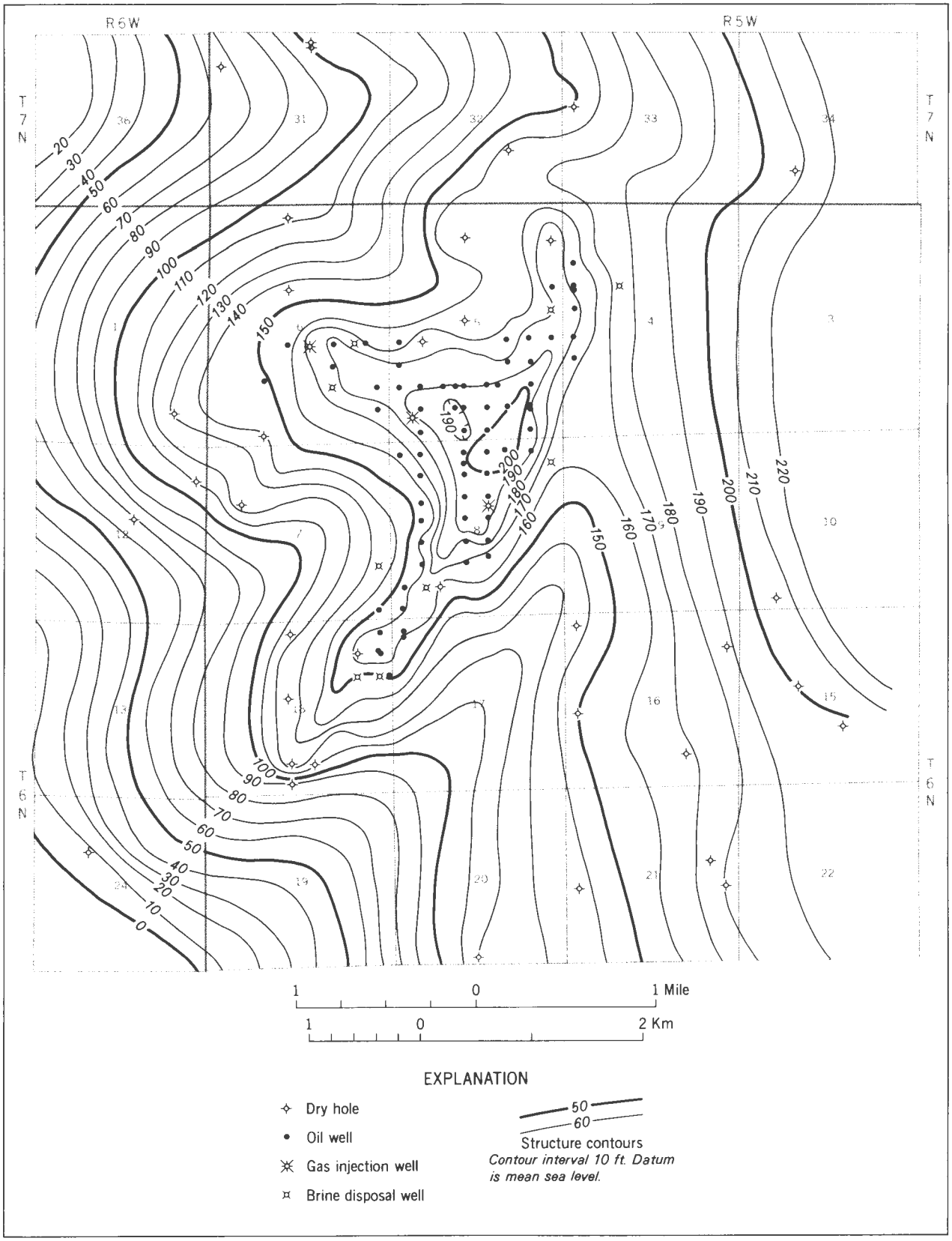


Figure 3. Map showing structure on top of the Renault Formation.

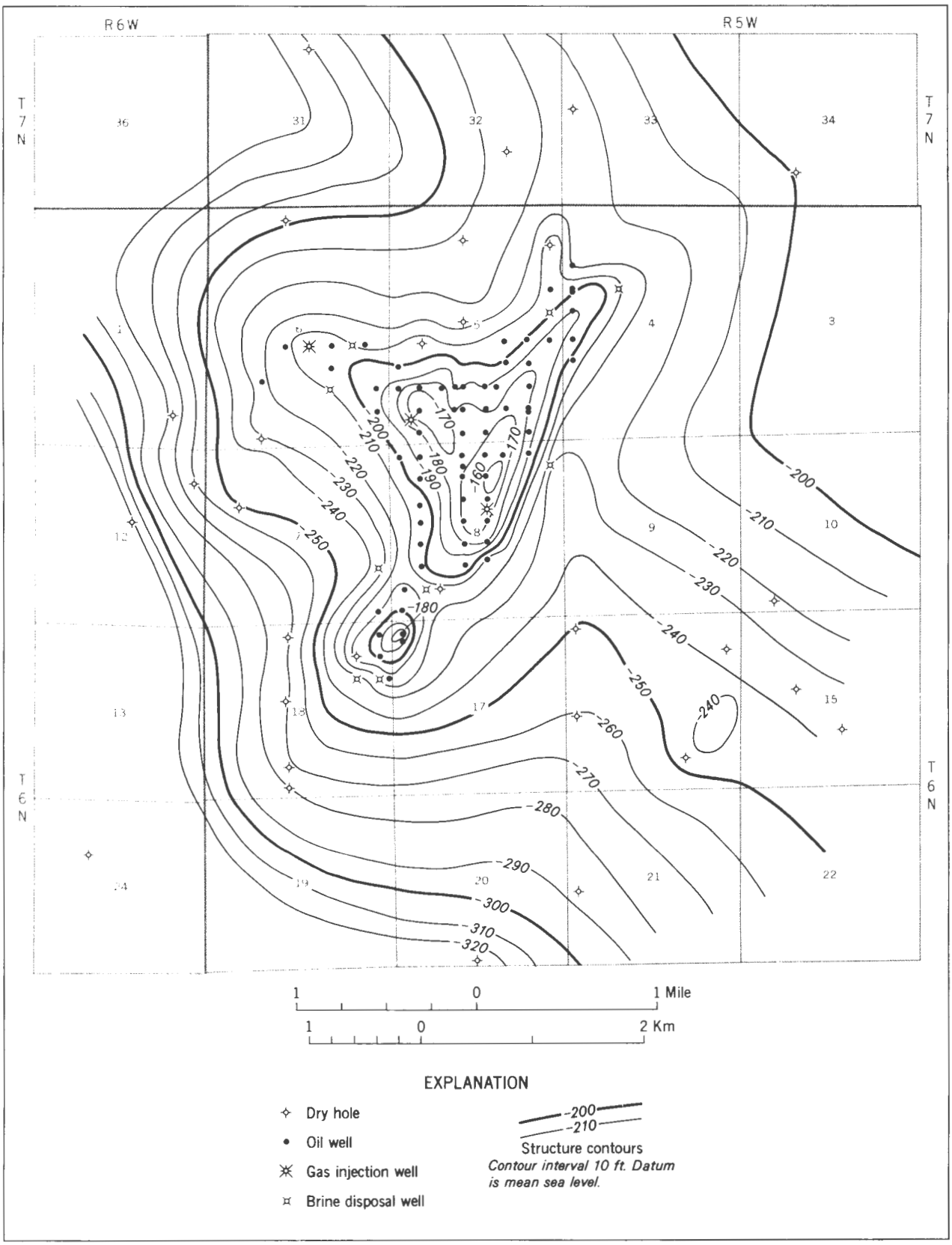


Figure 4. Map showing structure on top of the Salem Limestone.

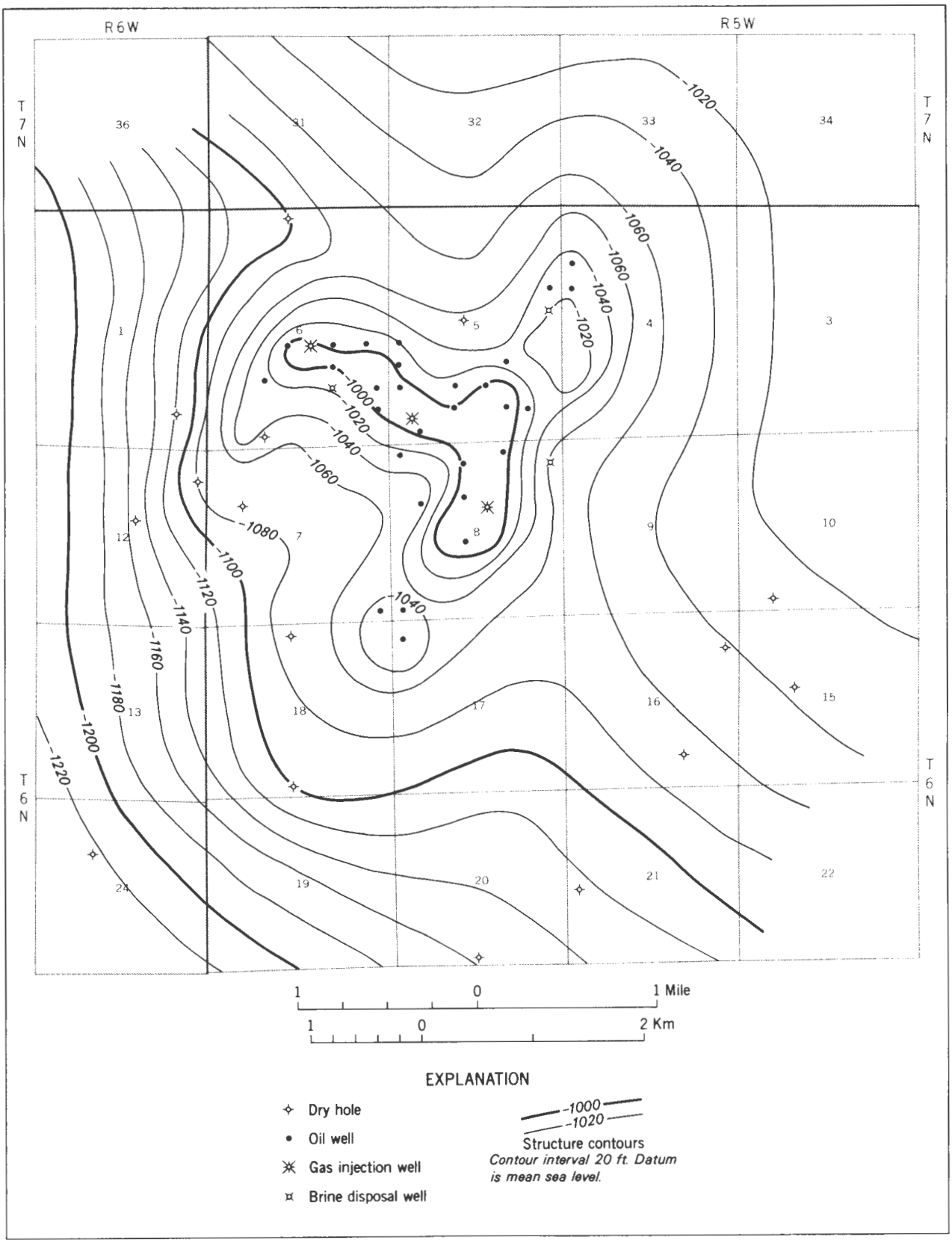


Figure 5. Map showing structure on top of middle Devonian limestone.

The structure map illustrating the top of the Renault Formation (fig. 3) closely defines the position and form of the field. The map shows 30 feet of closure, and the northeast-southwest trend of the eastern part of the field is well defined. The northwest-southeast arm of the arc is less sharply depicted but nevertheless is reasonably represented. The Renault Formation was eroded from the extreme eastern part of the study area, but where it is present, drilling to the Renault Formation can be used as both an exploration tool to define structure and as an indication of structure at depth. (Compare fig. 3 with figs. 4 and 5.) The shallowest depth to the Renault Formation found in the Plummer Field was 305 feet in sec. 5, T. 6 N., R. 5 W. The deepest that the Renault was encountered was 529 feet in the area adjoining the field in sec. 24, T. 6 N., R. 6 W.

Structure on top of the Salem Limestone is generally arcuate in shape but with three well-defined prongs and lobes (fig. 4). The main lobe in sec. 8, T. 6 N., R. 5 W., is the highest part of the feature and contains the best oil production. A low saddle separates this lobe from a smaller one in the southwestern part of sec. 8, the northwestern part of sec. 17, and the northeastern part of sec. 18, T. 6 N., R. 5 W. The field is asymmetrical west to east, and the steepest flank is on the east side. The end of the southwestern prong slopes steeply from a high of more than -180 feet to -250 feet in a horizontal distance of less than half a mile. The slope of the northwestern prong is much more gradual, -170 feet to -220 feet in a horizontal distance of 1 mile. Closure on the Salem Limestone is about 60 feet.

The structural shape depicted on the Salem (fig. 4) is maintained on the top of Devonian limestone (fig. 5) except that the reef-induced structure is generally broader and smoother and not as steep flanked. Closure on the Devonian limestone is about 70 feet.

Isopach maps constructed for three intervals reflect the shape and trends of the field. Although not as precise as the structure maps in locating the field and defining its boundaries, the isopach maps conform to the shape and trend of the structure. The intervals mapped are the thickness from the top of the Renault Formation to the top of the Ste. Genevieve Limestone (fig. 6); the thickness of the New Albany Shale (fig. 7); and the thickness from the top of the Salem Limestone to the top of middle Devonian limestone (fig. 8).

The isopach map for the section between the tops of the Renault and the Ste. Genevieve (fig. 6) shows 15 feet of thinning across the crest of the field from east to west. The overall shape of the contours closely resembles the structure contour maps except for the southwestern lobe. This lobe on the isopach map continues on to the south-central boundary of sec. 18, T. 6 N., R. 5 W. The northwestern prong is less pronounced, and the change in thickness in the northern half of sec. 5, T. 6 N., R. 5 W., is not marked enough to reveal the true shape. There is sufficient conformity in the shape of the field represented by the Renault to Ste. Genevieve isopach map and the structure maps to warrant the use of this type of map as an exploratory tool.

The isopach map of the New Albany Shale shows little change in the thickness of the formation within the area. The maximum change in thickness is 8 feet over part of the field. Some wells on the crest show the same thickness for the New Albany as do wells off the crest. Only by using a small contour interval (2 feet) can any sort of alignment be shown. The contouring is a matter of interpretation and may not depict any structure at all. The isopach map of the New Albany Shale is included to demonstrate that while it does indicate the shape and trend of the field, it does not reflect the structure for the Plummer Field.

The isopach map of the interval between the tops of the Salem and Devonian limestones (fig. 8) shows thinning of 30 to 40 feet over the field. It conforms to the structural configuration, maintaining the arcuate shape, steep eastern slope, and the three-lobed appearance.

The prevailing opinion has been that the structural features of Greene County are the result of differential sedimentation rates and compaction of younger sediments over Silurian reefs (Dawson and Carpenter, 1963, and Droste and Shaver, 1975). No evidence was found to contradict this view. Conversely, no wells have been drilled deep enough in the Plummer Field (1975) to determine the presence of a reef. But until conclusive data are found to the contrary, there is no reason to refute the theory that reefs form the basis for the structural features in Greene County. Otherwise, it would be difficult to explain the configuration of the persistent anomalies in strata above Silurian reefs that exist in other known reef fields in Indiana.

Various interpretations can account for the changes in thicknesses shown by isopachs, although not all are applicable to the Plummer Field. Some interpretations are: (1) Thinning is due to less deposition over high spots on the depositional surface; (2) gradual local uplift of the depositional surface results in thinning over the uplift; and (3) local changes in energy at the depositional site may result in facies changes.

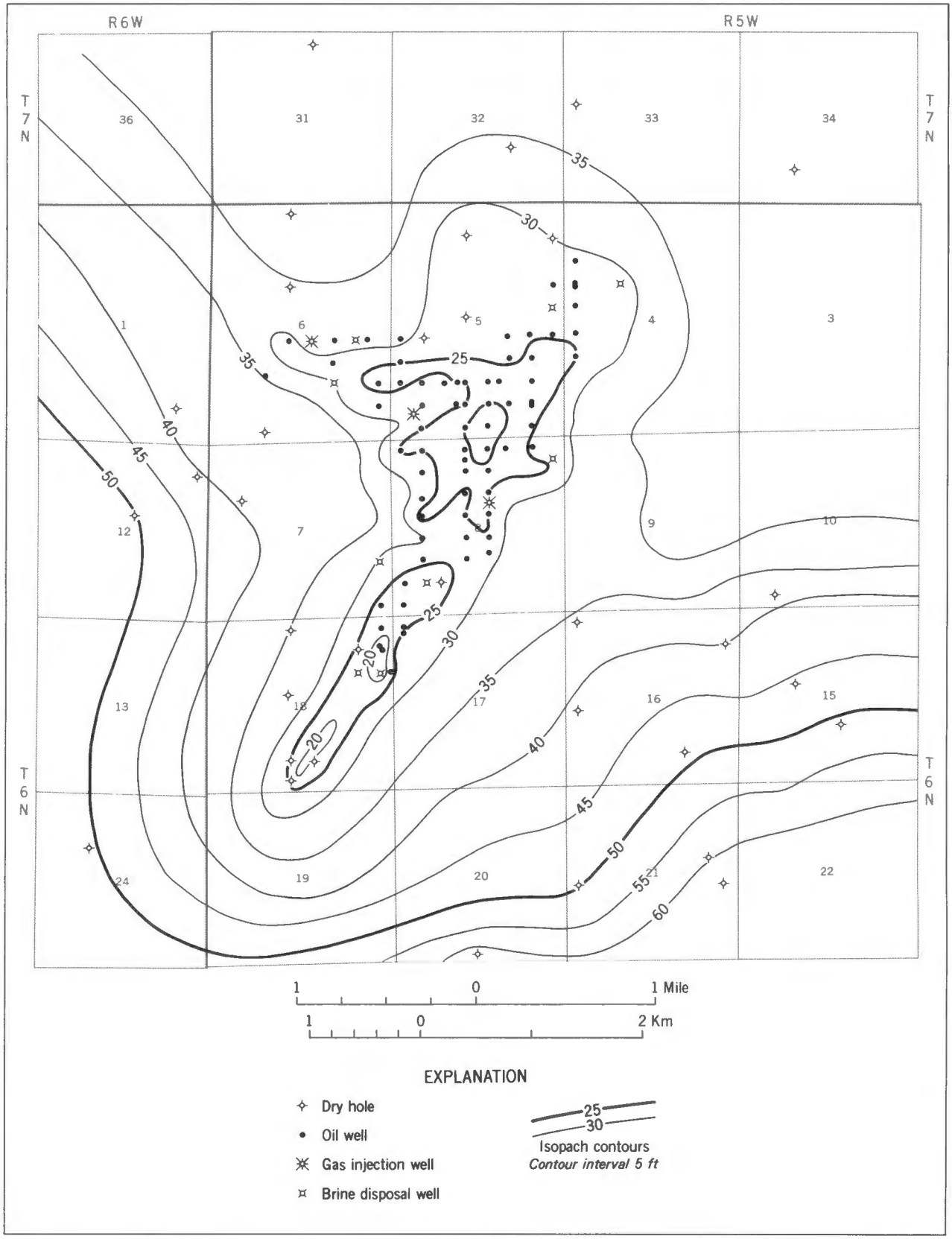


Figure 6. Map showing thickness of interval from top of the Renault Formation to top of the Ste. Genevieve Limestone.

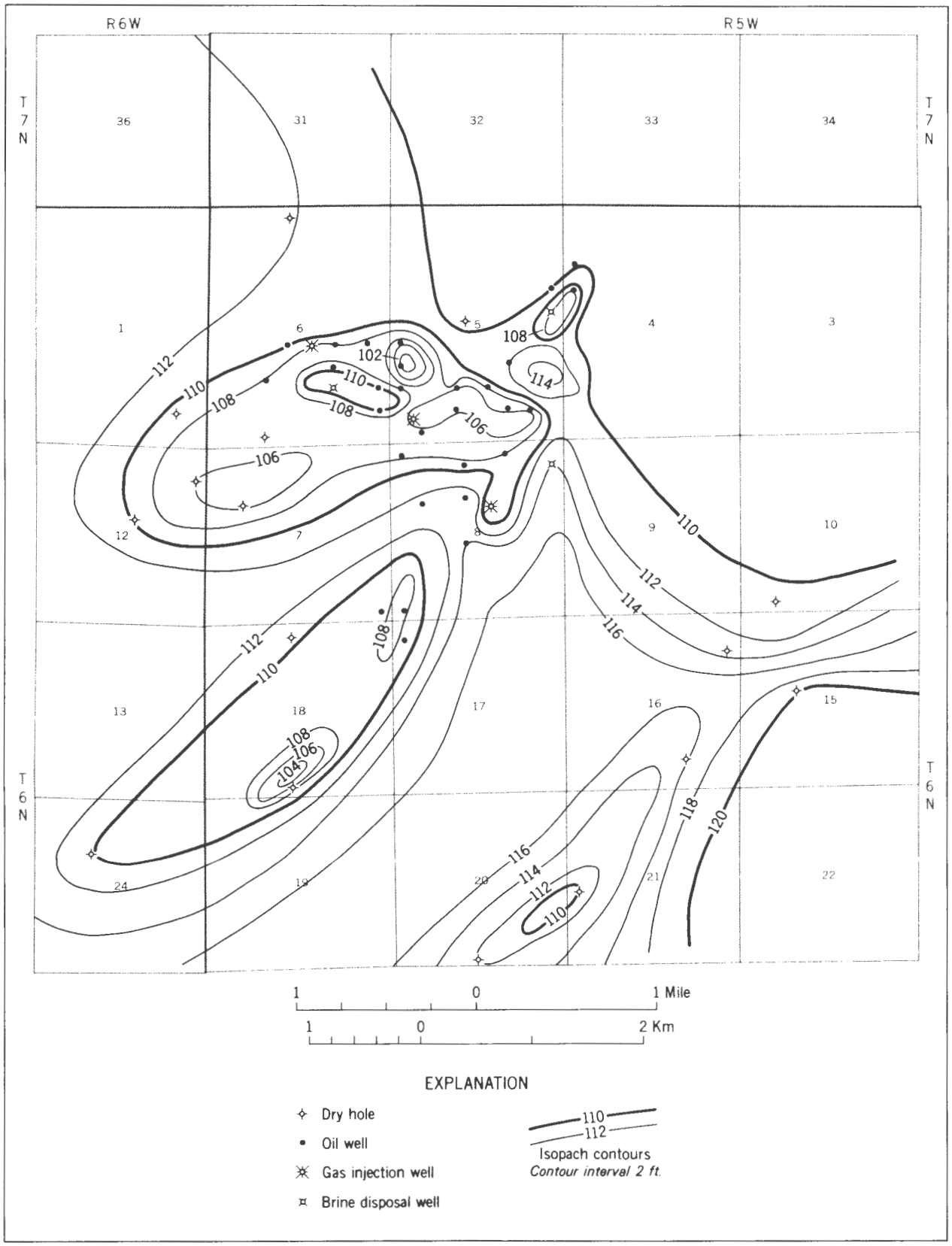


Figure 7. Map showing thickness of the New Albany Shale.

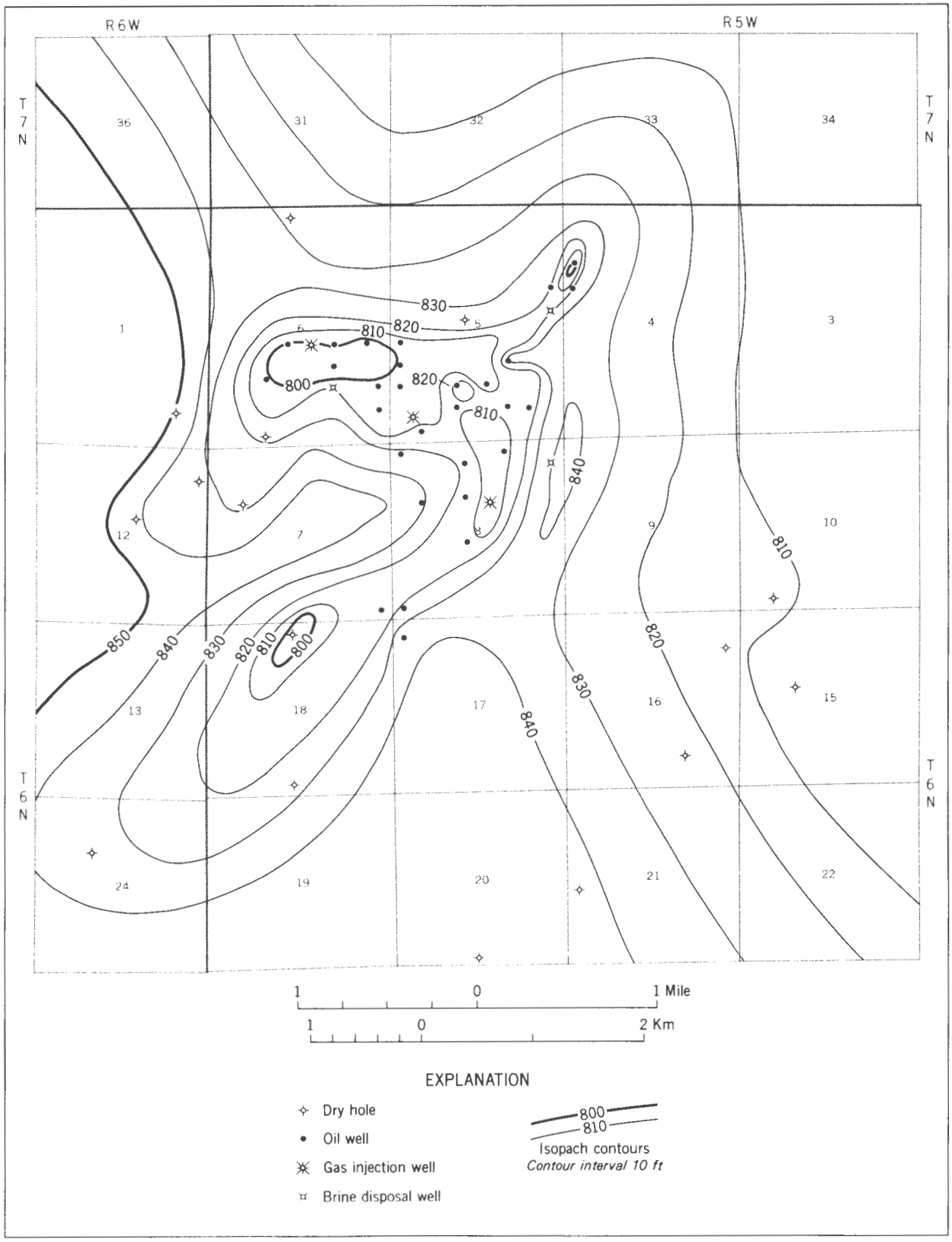


Figure 8. Map showing thickness of interval from top of the Salem Limestone to top of middle Devonian limestone.

Year	Salem reservoir (bbl)	Devonian reservoir (bbl)
1969	135,322	----------
1970	599,676	----------
1971	475,420	----------
1972	398,071	7,881
1973	335,442	61,172
1974	273,337	60,532
Total bbl	2,217,268	129,585

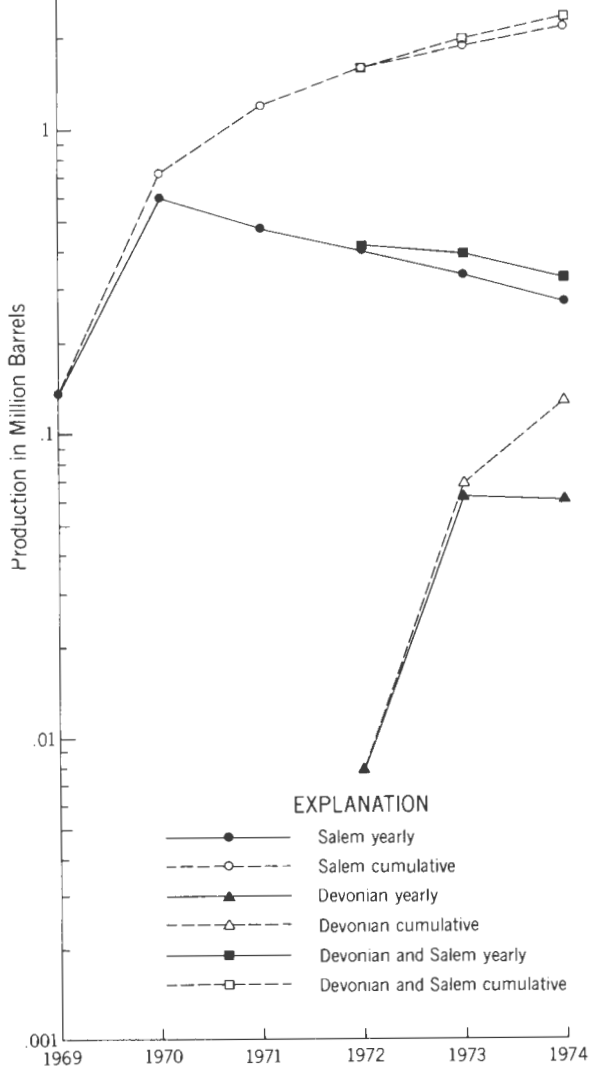


Figure 9. Graph showing production of oil from the Plummer Field, 1969-74. Production figures were supplied by Citizens Gas and Coke Utility.

Continuity of the formations illustrated in the cross section indicates that there is no rapid lateral facies change of sufficient magnitude to cause the changes in thickness shown on the isopach maps. Also, there is no evidence of local differential uplift in the Plummer Field area, although the highly fractured nature of the rocks cored, the steep eastern slope of the field, and the anomalous course of the West Fork of White River along the east side of the field may be indicators of movement. The isopach maps indicate successive depositional surfaces from Silurian time through Pennsylvanian which contained local highs over reefs; these highs received less sediment than surrounding areas. Thus, the maps are able to reflect the shape and form of these highs. The overall shape of the field resembles a fringing atoll. Because fringing atolls grow on submerged high points, irregularity of the depositional surface may have existed before reef buildup. If this is true, a structural target possibly exists below the Silurian rocks.

PRODUCING FORMATIONS

Except for production from Ste. Genevieve limestone in the Lea No. 3-A Holmes, in the northeastern part of sec. 18, T. 6 N., R. 5 W., production comes from Salem and Devonian limestones (table 2). The Salem produces only oil, but the Devonian produces both oil and gas. The gas from Devonian limestone is recycled into the reservoir to conserve gas and enhance oil recovery.

Figure 9 is a plot of the yearly production from each pool, combined yearly production for both pools, cumulative production for each pool, and combined cumulative production. Drawdown for the Salem pool is evident on the yearly Salem production curve. Because production from the Devonian pool was curtailed until the surface equipment for recycling the gas could be installed, not enough time has elapsed (1975) since the start of production to indicate the Devonian drawdown rate. Large quantities of water are produced along with the oil from both pools. A test conducted by Oilfield Research, Inc., indicated that as much as 59 percent of the total fluid produced is water.

Plate 2 is a west-east cross section showing the producing zones. It is made from sidewall neutron porosity logs, and porosity measurements from core analyses are plotted on a few of these logs. The close correlation between these porosity determinations and those indicated by the log is remarkable. The sidewall neutron porosity log is a reliable indicator of porosity in both Salem and Devonian limestones. Tables 3, 4, 5, and 6 consist of analyses of cores from Salem and Devonian limestones, including lithologic description, porosity, permeability, and oil and water saturations.

Table 3. Core analysis of the Salem Limestone
[Citizens No. 2 Cooper et al, sec. 4, T. 6 N., R. 5 W., Permit No. 32738]
[Compiled by Oilfield Research, Inc., Evansville, Ind.]

Sample No.	Depth (ft)	Permeability (md)		Porosity (pct)	Oil (pct)	Total water (pct)
		Horizontal	Vertical			
1	743.5	< 0.10	< 0.10			
2	744.5	< 0.10	< 0.10			
3	745.5	< 0.10	< 0.10			
4	746.5	0.30	0.37			
5	747.5	0.74	0.40			
6	748.5	< 0.10	0.13			
7	749.5	< 0.10	< 0.10			
8	750.5	< 0.10	< 0.10			
9	751.5	< 0.10	< 0.10			
10	752.5	< 0.10	< 0.10			
11	753.5	< 0.10	< 0.10			
12	754.5	3.0	1.5	10.8	12.3	62.8
13	755.5	8.8	13.	12.8	33.9	56.0
14	756.5	1.2	6.2	11.9	39.8	55.2
15	757.5	1.7	0.10	11.8	25.6	61.7
16	758.5	11.	7.0	15.7	40.0	59.5
17	759.5	158.	3.0	16.9	48.3	51.3
18	760.5	46.	1.1	16.6	43.5	51.5
19	761.5	41.	39.	12.0	43.1	41.6
20	762.5	5.6	29.	15.1	47.3	46.8
21	763.5	178.	175.	19.8	53.2	45.9
22	764.5	12.	7.5	16.9	37.6	59.1
23	765.5	< 0.10	0.44	10.0	35.9	39.8
24	766.5	226.	115.	14.8	48.0	44.3
25	767.5	50.	29.	11.8	42.5	53.2
26	768.5	146.	45.	13.1	35.3	49.1
27	769.5	7.6	0.78	10.9	24.9	65.1
28	770.5	1.6	< 0.10	11.3	32.6	48.9
29	771.5	8.4	2.8	13.8	28.6	64.3
30	772.5	3.6	2.7	14.6	33.3	61.6

Table 4. Description of a core of the Salem Limestone
[Citizens No. 2 Cooper et al, sec. 4, T. 6 N., R. 5 W., Permit No. 32738]
[Compiled by Oilfield Research, Inc., Evansville, Ind.]

Depth interval (ft)	Description
Salem	
743.0 - 746.0	Limestone, light-gray, crystalline; occasional carbonaceous partings and stringers; dense; no show of oil.
746.0 - 748.0	Limestone, brown, crystalline, dense; fair show of oil.
748.0 - 754.0	Limestone, light-gray, crystalline; occasional carbonaceous partings and stringers; dense; no show of oil.
754.0 - 757.0	Limestone, light-brown, oolitic; fossils and fragments; good show of oil.
757.0 - 758.0	Limestone, light-brown; chiefly crystalline; some oolitic development and fossils; good show of oil.
758.0 - 760.0	Limestone, brown; chiefly fossils and fragments; some oolitic development; good show of oil.
760.0 - 761.0	Limestone, brown, crystalline; fossils and fragments; occasional solution porosity; fair show of oil.
761.0 - 764.0	Limestone, brown; fossils and fragments; crystalline; good show of oil.
764.0 - 765.0	Limestone, brown; chiefly crystalline; good show of oil.
765.0 - 765.5	Limestone, gray, crystalline; fossils; dense; no show of oil.
765.5 - 770.0	Limestone, brown, crystalline; fossils and fragments; good show of oil.
770.0 - 773.0	Limestone, gray to light-brown; chiefly crystalline; some fossils; fair show of oil.

Table 5. Core analysis of middle Devonian limestone

[Citizens No. 1 Lowry, sec. 5, T. 6 N., R. 5 W., Permit No. 33785]

[Compiled by Oilfield Research, Inc., Evansville, Ind.]

Sample No.	Depth (ft)	Permeability (millidarcys)			Porosity (pct)	Percentage of saturation	
		Horizontal		Vertical		Oil	Water
		Maximum	90°				
		Core No. 1 1582.0 - 1612.0					
1	1582.0-82.9	1.8	1.2	< 0.10	6.3		
2	1582.9-84.0	< 0.10	< 0.10	0.12	10.4		
3	1584.0-84.8	< 0.10	< 0.10	< 0.10	3.9		
4	1584.8-85.8	0.69	0.61	0.13	6.7		
5	1585.8-86.8	11.	8.2	0.16	9.9		
6	1586.8-87.7	0.98	0.86	2.6	18.8		
7	1587.7-88.9	0.51	0.37	< 0.10	8.2		
8	1588.9-89.8	1.0	0.18	< 0.10	2.9		
9	1589.8-90.8	0.63	0.63	0.19	6.6		
10	1590.8-91.6	0.61	0.51	0.13	3.6		
11	1591.6-92.4	*1.0		0.19	6.0		
12	1592.4-93.3	1.6	0.43	0.78	7.2		
13	1593.3-94.0	*0.91		0.68	7.2		
14	1594.0-94.7	0.22	0.18	< 0.10	5.5		
15	1594.7-95.6	0.63	0.49	0.67	7.2		
16	1595.6-96.8	*6.2		3.7	19.3		
17	1596.8-97.8	4.5	2.4	1.0	8.6		
18	1597.8-98.8	2.9	2.1	2.9	12.5		
19	1598.8-99.8	10.	4.1	3.0	12.1		
20	1599.8-00.5	5.3	4.5	3.4	12.2		
21	1600.5-01.3	4.9	4.9	3.4	12.3		
22	1601.3-02.2	1.8	1.6	1.8	11.7		
23	1602.2-03.3	1.8	1.2	1.2	9.4		
24	1603.3-04.6	0.57	0.53	0.39	7.5		
25	1604.6-05.6	0.43	0.26	0.19	5.4		
26	1605.6-06.5	< 0.10	< 0.10	< 0.10	< 3.0		
27	1606.5-07.1	0.49	.43	0.19	7.5		
28	1607.1-08.3	4.5	4.5	2.8	11.2		
29	1608.3-09.1	1.6	1.2	1.9	9.5		
30	1609.1-10.2	1.2	0.69	0.17	8.4		
31	1610.2-11.3	2.1	2.1	1.8	13.5		
32	1611.3-12.0	2.4	1.6	1.1	11.9		

Table 5. Core analysis of middle Devonian limestone—Continued

Sample No.	Depth (ft)	Permeability (millidarcys)			Porosity (pct)	Percentage of saturation	
		Horizontal		Vertical		Oil	Water
		Maximum	90°				
		Core No. 2 1612.0 - 1642.0					
33	1612.0-13.1	1.8	1.6	1.6	13.0		
34	1613.1-13.9	0.63	0.63	0.25	10.0		
35	1613.9-14.9	0.69	0.67	0.14	9.9		
36	1614.9-15.9	8.8	1.2	2.2	11.8		
37	1615.9-16.7	0.57	0.47	2.2	8.5		
38	1616.7-18.0	< 0.10	< 0.10	< 0.10	< 3.0		
39	1618.0-19.0	< 0.10	<.10	< 0.10	< 3.0		
40	1619.0-20.0	*< 0.10		< 0.10	< 3.0		
41	1620.0-21.1	< 0.10	< 0.10	< 0.10	< 3.0		
42	1621.1-22.0	< 0.10	< 0.10	< 0.10	< 3.0		
43	1622.0-22.8	0.78	0.18	< 0.10	< 3.0		
44	1622.8-23.8	4.5	0.49	< 0.10	< 3.0		
45	1623.8-24.7	< 0.10	< 0.10	< 0.10	< 3.0		
46	1624.7-25.5	*< 0.10		*< 0.10	6.1		
47	1625.5-26.7	*< 0.10		*< 0.10	7.1		
48	1626.7-27.8	< 0.10	< 0.10	< 0.10	< 3.0		
49	1627.8-28.7	< 0.10	< 0.10	< 0.10	< 3.0		
50	1628.7-29.9	< 0.10	< 0.10	< 0.10	< 3.0		
51	1629.9-31.1	0.63	0.35	< 0.10	5.3		
52	1631.1-32.0	9.4	8.0	1.4	10.8		
53	1632.0-32.8	1.8	1.6	0.27	8.7		
54	1632.8-33.6	1.6	0.69	0.28	8.0		
55	1633.6-34.3	0.69	0.63	0.24	7.5		
56	1634.3-35.3	1.6	0.69	0.61	6.1		
57	1635.3-36.3	< 0.10	< 0.10	< 0.10	< 3.0		
58	1636.3-37.3	0.22	0.18	< 0.10	5.1		
59	1637.3-38.1	2.1	1.8	0.14	8.2		
60	1638.1-38.8	7.3	7.3	2.1	10.3		
61	1638.8-39.6	11.	11.	2.7	10.9		
62	1639.6-40.4	8.8	8.4	1.6	10.3		
63	1640.4-41.2	7.3	4.1	1.2	8.2		
64	1641.2-42.0	2.0	1.6	0.99	8.9		

Table 5. Core analysis of middle Devonian limestone—Continued

Sample No.	Depth (ft)	Permeability (millidarcys)			Porosity (pct)	Percentage of saturation	
		Horizontal		Vertical		Oil	Water
		Maximum	90°				
		Core No. 3	1642.0 - 1672.0				
65	1642.0-43.0	9.4	6.1	1.9	8.6	31.0	26.7
66	1643.0-44.0	5.3	4.1	1.2	8.5	53.8	45.2
67	1644.0-44.7	2.4	1.1	1.2	9.7	37.7	50.0
68	1644.7-45.5	9.8	6.5	3.4	10.6	43.5	53.8
69	1645.5-46.4	16.	5.7	3.0	10.5	46.7	46.7
70	1646.4-47.1	8.2	3.7	1.6	10.0	38.7	53.2
71	1647.1-48.1	9.8	9.0	2.5	10.0	0.0	93.8
72	1648.1-48.8	1.3	0.94	1.9	10.3	0.0	92.9
73	1648.8-49.4	4.3	3.3	2.4	10.3	13.8	85.4
74	1649.4-50.3	7.3	6.5	3.7	12.3	17.8	74.4
75	1650.3-51.3	9.4	8.4	3.5	11.2	6.6	85.4
76	1651.3-52.5	31.	16.	7.5	11.8	17.4	74.1
77	1652.5-53.5	20.	18.	5.0	11.5	18.1	73.0
78	1653.5-54.4	37.	36.	4.3	12.2	13.0	32.1
79	1654.4-55.5	10.	6.9	3.6	11.6	14.6	56.5
80	1655.5-56.4	2.5	2.5	6.4	11.2	10.0	61.7
81	1656.4-57.2	57.	45.	13.	16.7	14.3	64.3
82	1657.2-58.0	355.	196.	15.	17.5	12.6	65.5
83	1658.0-59.1	45.	41.	8.6	13.3	2.8	64.8
84	1659.1-60.1	20.	18.	9.9	15.6	8.7	54.1
85	1660.1-61.0	36.	16.	63.	14.2	18.9	50.9
86	1661.0-61.9	175.	155.	85.	18.3	4.9	54.9
87	1661.9-62.8	18.	14.	16.	15.1	13.7	55.1
88	1662.8-63.8	78.	45.	46.	25.8	3.6	63.0
89	1663.8-64.8	41.	27.	31.	14.6	17.5	66.0
90	1664.8-65.5	27.	19.	9.7	17.2	10.6	64.0
91	1665.5-66.6	11.	2.4	5.7	12.1	15.2	50.0
92	1666.6-67.6	28.	21.	18.	12.8	26.5	72.5
93	1667.6-68.2	2.4	1.6	3.4	9.4	15.4	66.7
94	1668.2-69.3	2.4	2.3	1.8	9.5	7.6	82.4
95	1669.3-70.3	17.	6.9	7.3	7.5	13.0	60.0
96	1670.3-71.1	*< 0.10		*< 0.10	4.4	33.0	55.0
97	1671.1-72.0	< 0.10	< 0.10	< 0.10	< 3.0	23.6	71.4

*Conventional analysis.

Table 6. Description of a core of middle Devonian limestone
[Citizens No. 1 Lowry, sec. 5, T. 6 N., R. 5 W., Permit No. 33785]
[Compiled by Oilfield Research, Inc., Evansville, Ind.]

Depth interval (ft)	Description
	Core No. 1 1582.0 - 1612.0
1582.0 - 1609.0	Limestone and dolomitic limestone, gray to tan, finely crystalline interbedded with coarsely crystalline units, fossiliferous; irregular bedding; occasional to numerous chertlike inclusions.
1609.0 - 1616.5	Dolomitic limestone, grading to dolomite, tan to brown, finely crystalline; uniform texture; fossiliferous; brachiopods; show of oil.
	Core No. 2 1612.0 - 1642.0
1616.5 - 1622.0	Limestone, gray, finely crystalline; uniform texture; dense; occasional coralline units.
1622.0 - 1630.0	Limestone, dark-gray, finely crystalline, sucrosic; occasional thin units of dolomite; numerous coral fragments, argillaceous?; vertical fracture, 1624.6 to 1626.9 ft.
1630.0 - 1635.3	Dolomite, tan to brown, fine- to medium-crystalline; evidence of recrystallization; sucrosic; fossils obscure; show of oil.
1635.3 - 1636.5	Limestone, gray, finely crystalline; uniform recrystallized appearance; minute fractures; dense.
1636.5 - 1646.2	Dolomite, brown, finely crystalline, sucrosic, coralline; occasional coarsely crystalline units; occasional dense patches; show of oil.
	Core No. 3 1642.0 - 1672.0
1646.2 - 1656.0	Dolomite, tan, finely crystalline; uniform texture; sucrosic; scattered corals.
1656.0 - 1670.0	Dolomite, tan, finely crystalline, uniform; vuggy porosity; sugary; numerous coral fragments; patches of dense material; argillaceous partings.
1670.0 - 1672.2	Limestone, gray, finely crystalline, dense.

Oil saturation as determined from core analyses is plotted on the logs on the cross section for a few wells. The plots of high oil saturations indicate the productive intervals. The cross section shows correlations of three porous zones in the Salem Limestone that have been arbitrarily designated as S1, S2, and S3. Core analyses show that the S1 zone has an average porosity of 15.2 percent and an average permeability of 1,136 millidarcys (md). Average porosity and permeability are 17.5 percent and 616 md for the S2 zone and 16.8 percent and 263 md for the S3 zone.

Plate 2 shows that there is horizontal connection among the three porosity zones of the Salem Limestone. Geologists of both Citizens Gas and Coke Utility and Oilfield Research, Inc., reported that cores from the Salem Limestone and Devonian limestone contained large numbers of vertical fractures. The plate also shows that the S1 zone disappears from east to west and is not highly developed in the northeastern part of the field. The thickest porous zones are found in the central part of the field in adjoining parts of secs. 5 and 8, T. 6 N., R. 5 W.

Unsuccessful attempts were made to establish an oil-water contact for both pools by using drill stem tests, initial production (table 2), cores, and log interpretation data. An oil-water contact that appeared valid for one part of the field was not valid for another. No oil-water level similar to that found in uniform sandstone reservoirs can be established because of horizontal and vertical communication among the porous zones and the erratic distribution of porosity and permeability.

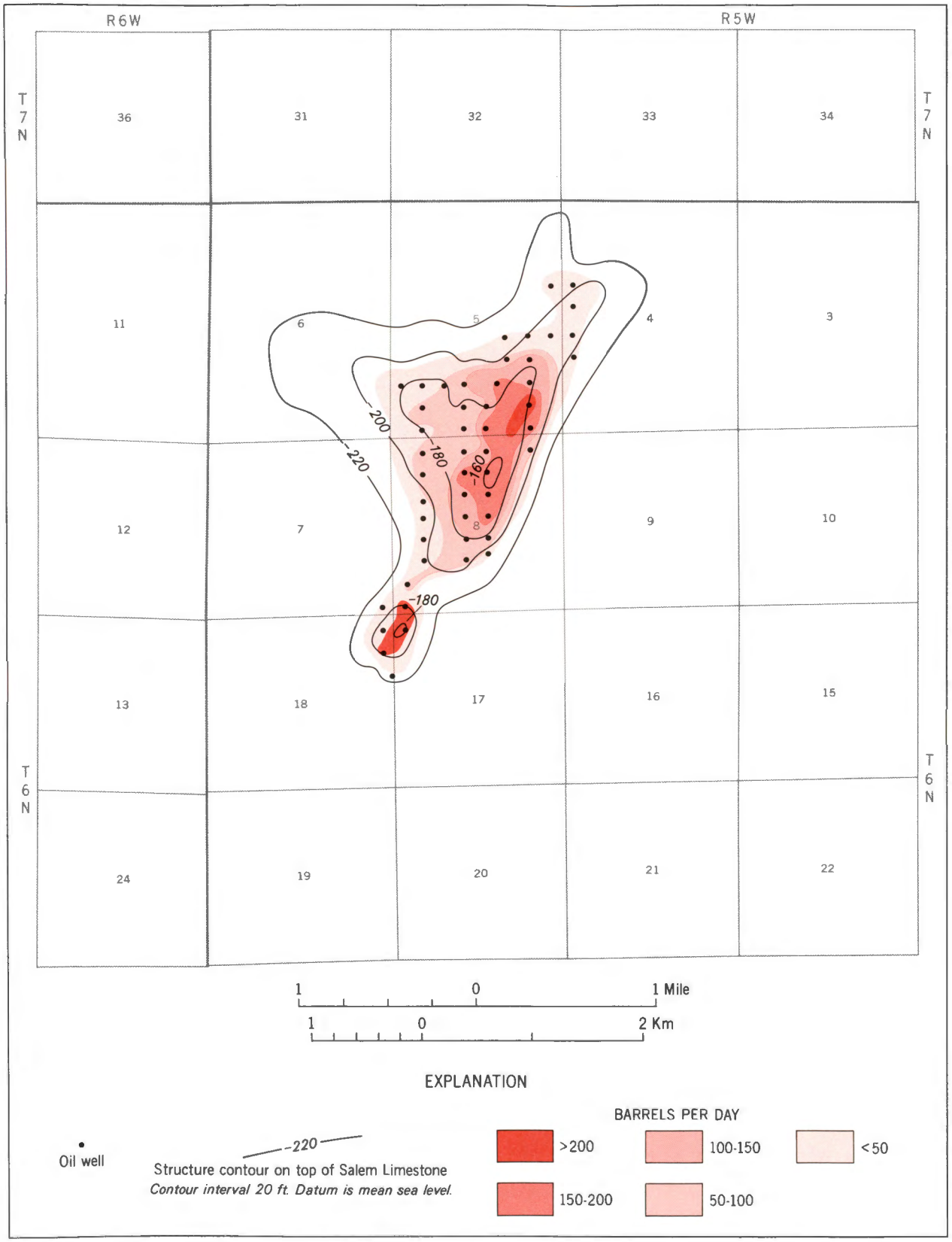


Figure 10. Map showing distribution of initial oil production from the Salem Limestone.

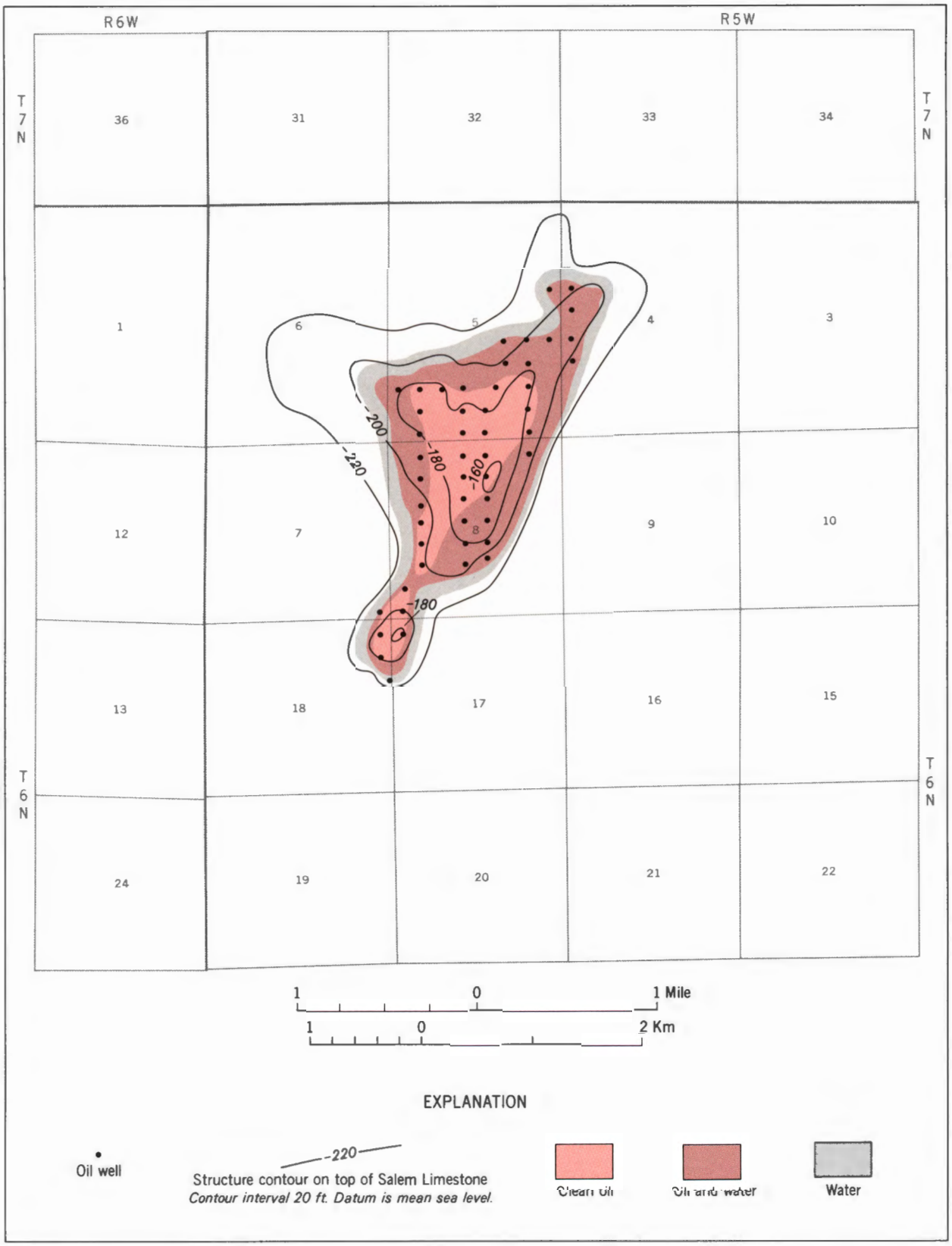


Figure 11. Map showing distribution of initial total fluid production from the Salem Limestone.

Distribution of initial oil production for the Salem Limestone (fig. 10) shows that maximum initial production was found along the structurally highest part of the field. The thickest porosity zones are in this area as well. Distribution of initial total fluid production showing clean oil, oil and water, and water from the Salem Limestone (fig. 11) indicates that the clean oil is generally produced where the structure is highest and where the porous zones are best developed.

Plate 2 shows that there are two porous zones, designated here D1 and D2, in Devonian limestone. Zone D1 is directly below the massive part of the North Vernon and Jeffersonville Limestones. Zone D2, which includes the Geneva Dolomite Member of the Jeffersonville Limestone, is separated from D1 by a less porous zone. It is believed that these two porous zones have vertical connection through fractures and horizontal connection through interfingering.

Trying to establish gas-oil and oil-water contacts in Devonian limestone for the entire field proved more complex than for the Salem Limestone. Some wells produced gas at lower elevations than did those producing oil and water.

Completion Practices

Citizens Gas and Coke Utility drilled through the S3 zone of the Salem Limestone, set casing, and perforated the most likely productive zones; then the formation was treated with mud-cleaning acid. The Lea Oil Co. drilled into the productive zone, stopped drilling when oil flowed into the well, cleaned out the well, continued drilling a few feet more, and finally completed the well as open hole. Citizens Gas and Coke Utility drilled through the D2 zone of Devonian limestone and completed the well by gun perforating the casing. The formation was treated with 1,000 gallons of acid, then with a buffering agent, and then with another 1,000 gallons of acid.

Environmental Aspects

During all phases of the exploration and developmental drilling and production of the Plummer Field, extensive precautions were taken by Citizens Gas and Coke Utility to ensure minimum infringement on the environment. Drilling rigs were equipped with double blowout preventers, and impoundment dikes were built around each drill site.

Each tank battery and water-collecting pit is now surrounded by an embankment to keep any unlikely spill or leakage from spreading and flowing away from the area. White River is patrolled periodically and inspected for evidence of any oil leaks or spills. All surface equipment at the wells and tank batteries are well maintained, clean, and freshly painted. The field is a model of what can and should be done to make all surface operations attractive.

Water injection was an early part of planning for development and production. Nine wells are currently being used (1975) to reinject produced salt water into the Salem Limestone.

Summary

After the Plummer Field was discovered in August 1969, development of the Salem Limestone reservoir progressed rapidly. Development of production in Devonian limestone moved at a slower rate while surface equipment for gas injection was being installed.

Oil is produced from 71 wells (1975); three porous zones in the Salem Limestone and two porous zones in Devonian limestone are productive. By the end of 1974, 2,217,268 barrels of oil had been produced from the Salem Limestone and 129,585 barrels from Devonian limestone. Minor production is obtained from one well in the Ste. Genevieve Limestone.

Oil and gas accumulated in the entrapment that resulted from draping and compaction of sediments over a Silurian reef. Isopach maps of the intervals between the tops of the Renault and the Ste. Genevieve and the Salem and the Devonian show the arcuate shape of the field. Structure contour maps on top of the Renault, Salem, and Devonian limestones also show that the field is arcuate and that the open part of the arc faces west. The best production is from the Salem on the northeastward-trending arm of the arc. The Renault structure map faithfully reveals the feature, so that mapping the Renault Formation can be used as an exploration tool. And plots of porosity from core analyses versus sidewall neutron porosity logs show that these logs are excellent tools for porosity determinations.

The management of the entire operation by Citizens Gas and Coke Utility has been exemplary and should serve as a model for other operations in the area.

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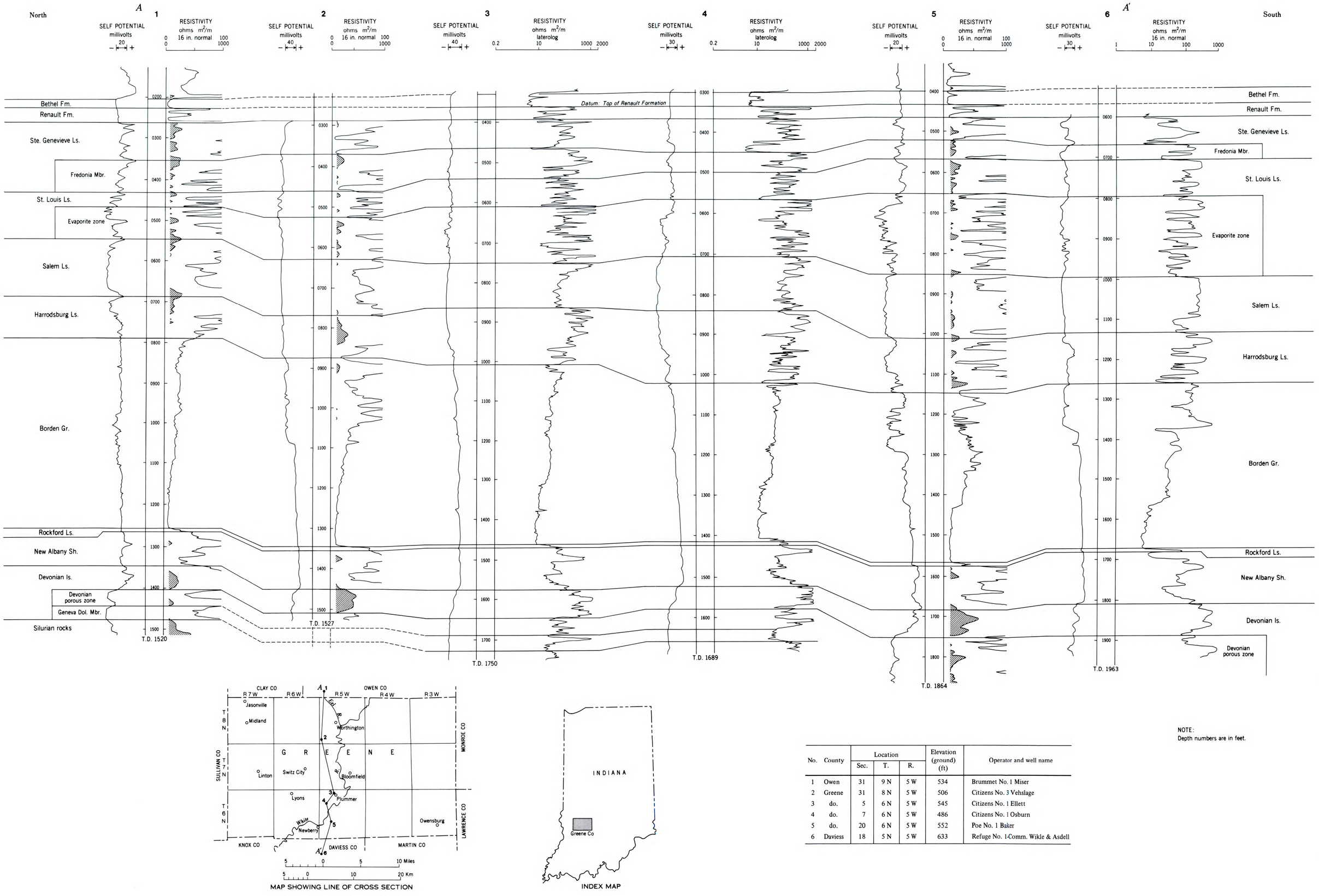

MAP SHOWING LINE OF CROSS SECTION

INDEX MAP

No.	County	Location Sec.	Location T.	Location R.	Elevation (ground) (ft)	Operator and well name
1	Owen	31	9 N	5 W	534	Brummet No. 1 Miser
2	Greene	31	8 N	5 W	506	Citizens No. 3 Vehslage
3	do.	5	6 N	5 W	545	Citizens No. 1 Ellett
4	do.	7	6 N	5 W	486	Citizens No. 1 Osburn
5	do.	20	6 N	5 W	552	Poe No. 1 Baker
6	Daviess	18	5 N	5 W	633	Refuge No. 1-Comm. Wikle & Asdell

NOTE:
Depth numbers are in feet.

Drafted by Richard T. Hill

CROSS SECTION SHOWING REGIONAL CORRELATION, OWEN, GREENE, AND DAVIESS COUNTIES, INDIANA

By James A. Noel

1979

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DEPARTMENT OF NATURAL RESOURCES
JOSEPH D. CLOUD, DIRECTOR

GEOLOGICAL SURVEY
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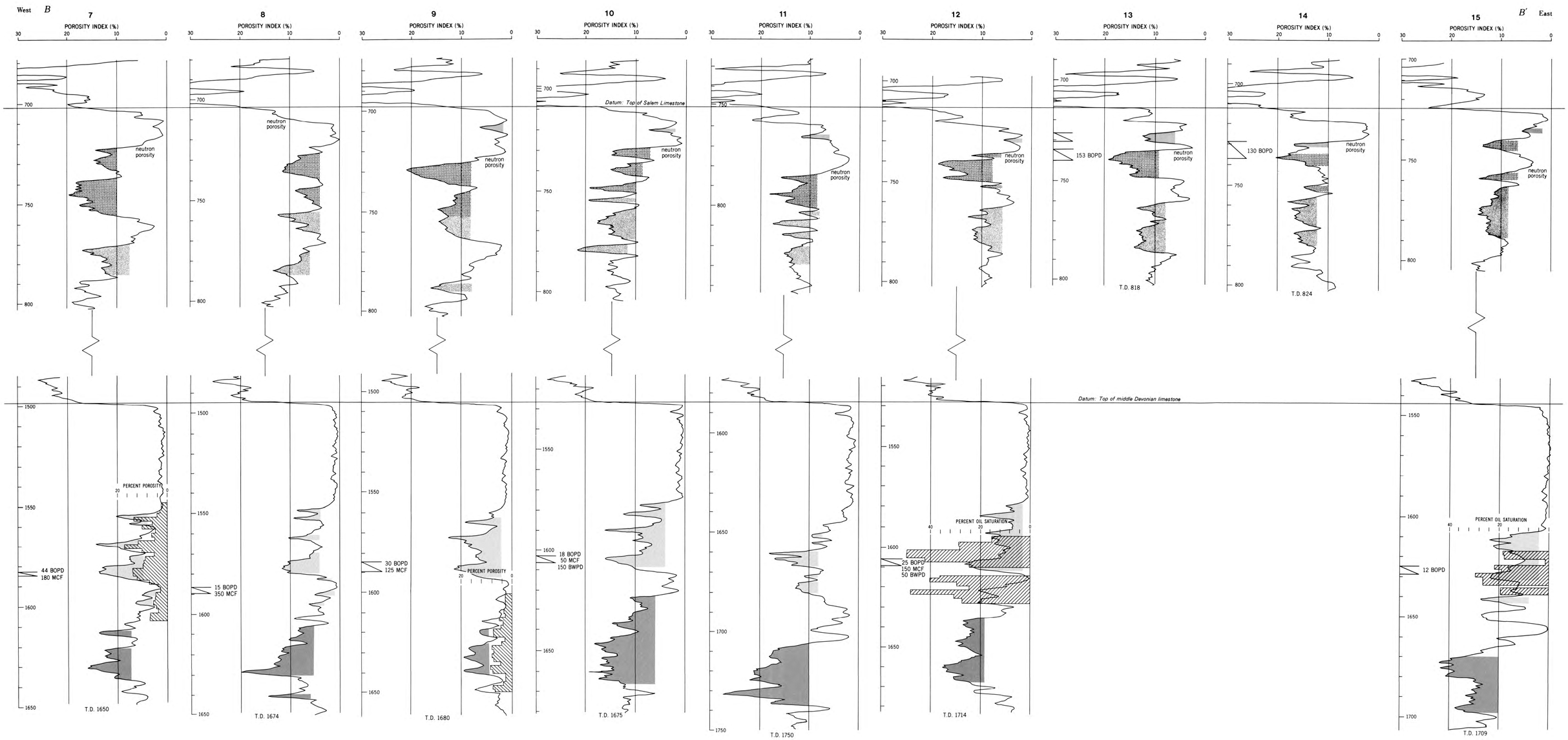
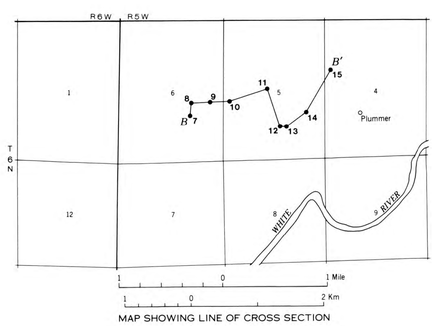
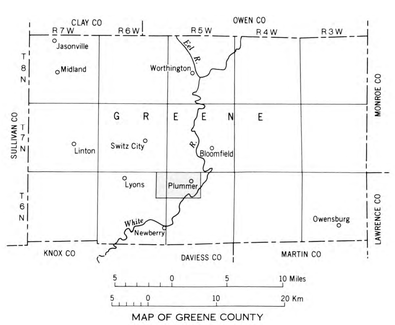




MAP SHOWING LINE OF CROSS SECTION



MAP OF GREENE COUNTY

INDEX MAP

EXPLANATION

POROSITY ZONES

Perforated interval and initial production

Oil saturation from core analysis

Porosity from core analysis

NOTE:
Depth numbers are in feet.

Salem: S1, S2, S3

Devonian: D1, D2

No.	County	Location Sec.	Location T.	Location R.	Elevation (ground) (ft)	Operator and well name
7	Greene	6	6 N	5 W	495	Citizens No. 1 Squires, Hemmerlein & Reagan
8	do.	6	6 N	5 W	496	Citizens No. 1 Patterson, Schaar & Hemmerlein
9	do.	6	6 N	5 W	498	Citizens No. 1 Schaar & Hemmerlein
10	do.	5	6 N	5 W	512	Citizens No. 2 Benham & McClellan
11	do.	5	6 N	5 W	532	Citizens No. 1 Scott
12	do.	5	6 N	5 W	531	Citizens No. 2 Warner & Rowe
13	do.	5	6 N	5 W	532	Citizens No. 1 Warner & Rowe
14	do.	5	6 N	5 W	528	Citizens No. 3 Ellett
15	do.	4	6 N	5 W	523	Citizens No. 2 Cooper & McIntosh

CROSS SECTION OF OIL-PRODUCING ZONES, PLUMMER FIELD, GREENE COUNTY, INDIANA

By James A. Noel

1979

Drafted by Richard T. Hill

WELLS IN THE PLUMMER FIELD AND INFORMATION ABOUT DRILL STEM TESTS AND INITIAL PRODUCTION

Permit No.	Location			Well designation		Elevation (ground) (ft)	Stratigraphic unit	Drill stem tests					Initial production			
	Sec.	T.	R.	Operator	Number and name			Subsurface elevation (ft)	Oil (ft)	Water (ft)	Gas	Mud (ft)	Subsurface elevation of perforated interval (ft)	Oil/Water (bbl)	Gas (Mcf)	Remarks
32737	4	6N	5W	Citizens	No. 1 Cooper et al	552	Salem	- 198 to - 222	105	25			- 200 to - 202	15/75		
							Salem						- 208 to - 212			
32738	4	6N	5W	Citizens	No. 2 Cooper et al	543	Salem	- 193 to - 224	120			25	- 207 to - 213	8/140		
32531	4	6N	5W	Citizens	No. 1 Comm. Cooper & McIntosh	524	Salem	- 204 to - 226	2			45	- 199 to - 201	8/140		
33874	4	6N	5W	Citizens	No. 2 Cooper & McIntosh	523	Devonian	-1077 to -1117			1400 ft	195	-1102 to -1106	12/0		
32701	4	6N	5W	Citizens	No. 1 Herold-Shryer-Plummer	558	Salem	- 207 to - 232	15			125	- 228 to - 230	7/140		
33863	4	6N	5W	Citizens	No. 1 Rollison & Benham	510	Salem	- 224 to - 238		20						
							Devonian	-1075 to -1116		120 (OC)		410 (OC)[1]	-1102 to -1105	15/150		
33700	5	6N	5W	Citizens	No. 2 Benham & McClellan	512	Devonian	-1056 to -1103	5		10 min	180 (OC)	-1091 to -1094	18/150		
							Devonian	-1103 to -1133				520				
34495	5	6N	5W	Citizens	No. 5 Davidson	532	Devonian	-1024 to -1058		285 (GC)	4 min		-1029 to -1034		500	
							Devonian						-1041 to -1044			
32501	5	6N	5W	Citizens	No. 1 Comm. Davidson & Bethany Christian Church	532	Salem	- 183 to - 226	110			60 (OC)	- 194 to - 196	35/3		
							Salem						- 202 to - 206			
							Devonian	- 989 to -1028				25				
							Devonian	-1032 to -1081			14 min	180				
							Devonian	-1103 to -1141		474	600 ft	130				
32664	5	6N	5W	Citizens	No. 1 Comm. Davidson & Carmichael et al	547	Salem	- 173 to - 207	300			70 (OC)	- 178 to - 186	55/0		
							Salem						- 188 to - 191			
32450	5	6N	5W	Citizens	No. 1 Ellett	545	Salem	- 213 to - 235	70	60 (OC)		110 (OC)	- 227 to - 230	24/78		
							Devonian	- 920 to -1017				18				
							Devonian	-1031 to -1081			1520 ft	30				
							Devonian	-1090 to -1122			510 ft	150 (GC)[2]				
32573	5	6N	5W	Citizens	No. 2 Ellett	544	Salem	- 214 to - 232	10			125 (OC)	- 222 to - 226	0/water		
							Devonian	-1019 to -1058			600 ft	20				
							Devonian	-1080 to -1137			1240 ft	380 (OC)				
							Devonian	-1140 to -1227		1560						
32618	5	6N	5W	Citizens	No. 3 Ellett	528	Salem	- 191 to - 219	412			40 (OC)	- 200 to - 208	130/20		
32693	5	6N	5W	Citizens	No. 4 Ellett	523	Salem	- 201 to - 227	100			25 (OC)	- 215 to - 219	15/15		
32726	5	6N	5W	Citizens	No. 5 Ellett	540	Salem	- 193 to - 205	155			55 (OC)	- 202 to - 210	20/80		
32616	5	6N	5W	Citizens	No. 1 Ellett & Duke	537	Salem	- 179 to - 212	468			150 (OC)	- 188 to - 203	140/15		
32692	5	6N	5W	Citizens	No. 1 Harris & Santee	539	Salem	- 202 to - 232	10			80				
33785	5	6N	5W	Citizens	No. 1 Lowry	538	Devonian	-1046 to -1074			9 min	135 (GC)	-1073 to -1077	10/0	250	
							Devonian	-1074 to -1114	6		525 ft	75 (GC)				
32651	5	6N	5W	Citizens	No. 1 Lyons, Davidson & Mitchell	546	Salem	- 176 to - 203	110			40 (OC)	- 178 to - 180	25/0		
							Salem						- 181 to - 188			
							Salem						- 195 to - 200			
32713	5	6N	5W	Citizens	No. 2 Lyons, Davidson & Mitchell	519	Salem	- 184 to - 211	240			70 (OC)	- 179 to - 181	30/10		
							Salem						- 184 to - 187			
							Devonian	-1033 to -1062			1463 ft	85				
							Devonian	-1063 to -1092			1500 ft	85				
							Devonian	-1106 to -1131		960 (GC)	480 ft	165 (GC)				
33755	5	6N	5W	Citizens	No. 3 Lyons, Davidson & Mitchell	515	Devonian	-1052 to -1088				310 (OC)	-1091 to -1095	34/100	100	
							Devonian	-1086 to -1118	30		642 ft	115 (OC)				
32516	5	6N	5W	Citizens	No. 1 Plummer Farm	547	Salem	- 180 to - 207	420			90 (OC)	- 186 to - 200	225/0		
32528	5	6N	5W	Citizens	No. 1 Comm. Plummer, Allen & Fry	536	Salem	- 179 to - 209	490			110 (OC)	- 191 to - 197	100/5		
34508	5	6N	5W	Citizens	No. 1 Comm. Plummer, Barge, Fry & Coleman	537	Devonian	-1070 to -1103	920	30	1.5 min		-1091 to -1097	100/20	50	
34532	5	6N	5W	Citizens	No. 2 Plummer & Barge	549	Devonian	-1056 to -1101	20		720 ft	120 (OC-GC)	-1086 to -1100	30/100	50	
32529	5	6N	5W	Citizens	No. 1 Comm. Plummer, Barge & Allen	533	Salem	- 171 to - 192	539			90 (OC)	- 183 to - 187	160/0		
							Salem						- 191 to - 195			
32547	5	6N	5W	Citizens	No. 1 Comm. Plummer & Crane	566	Salem	- 186 to - 212	422			120 (OC)	- 191 to - 194	150/24		
							Salem						- 196 to - 204			
32568	5	6N	5W	Citizens	No. 1 Comm. Reagan & Lee	546	Salem	- 181 to - 212	170			70 (OC)	- 201 to - 211	75/0		
33789	5	6N	5W	Citizens	No. 2 Reagan & Lee	536	Devonian	-1056 to -1096			23 min	165 (OC)	-1094 to -1097	30/50		
							Devonian	-1084 to -1124			300 ft	85 (OC)				
32630	5	6N	5W	Citizens	No. 1 Reagan	537	Salem						- 198 to - 205	100/10		
							Salem						- 209 to - 212			
32694	5	6N	5W	Citizens	No. 1 Rollison & Barkley	493	Salem	- 210 to - 248		120		20				
32553	5	6N	5W	Citizens	No. 1 Smith	529	Salem	- 173 to - 209	460			120 (OC)	- 194 to - 201	60/0		
32575	5	6N	5W	Citizens	No. 2 Smith	535	Salem	- 180 to - 205	390			95 (OC)	- 182 to - 185	90/0		
							Salem						- 190 to - 196			
32504	5	6N	5W	Citizens	No. 1 Warner	528	Ste. Genevieve	- 113 to - 122				30				
							Salem	- 193 to - 206	384			135 (OC)	- 204 to - 208	60/6		
							Devonian	-1026 to -1084			70 min	45				
							Devonian	-1080 to -1103			249 ft	124 (GC)				
							Devonian	-1080 to -1132			420 ft	429 (GC)				
32762	5	6N	5W	Citizens	No. 2 Warner	511	Salem	- 205 to - 238	200			110 (OC)	- 223 to - 225	25/50		
32578	5	6N	5W	Citizens	No. 1 Warner & Rowe	532	Salem	- 188 to - 213	555			126 (OC)	- 195 to - 199	153/0		
							Salem						- 203 to - 208			
33847	5	6N	5W	Citizens	No. 2 Warner & Rowe	531	Devonian	-1045 to -1077				195 (OC)	-1076 to -1079	25/50	150	
							Devonian	-1080 to -1127				240 (OC)				
32520	6	6N	5W	Citizens	No. 1 Davidson	501	Salem	- 196 to - 225				17				
							Devonian	-1051 to -1083		210	1370 ft		-1115 to -1117	25/5		
							Devonian	-1080 to -1119		10		500 (GC)				
33559	6	6N	5W	Citizens	No. 4 Davidson	497	Salem	- 195 to - 216		20						
							Devonian	-1045 to -1083			6 min	105	-1112 to -1115	25/50	150	
							Devonian	-1081 to -1113	60		5 min	430 (OC)				
							Devonian	-1112 to -1133		1540 (OC)						
33786	6	6N	5W	Citizens	No. 1 Patterson	503	Devonian	-1043 to -1083			11 min	195	-1084 to -1089	49/0	200	
							Devonian	-1083 to -1119				390 (GC)				
34588	6	6N	5W	Citizens	No. 2 Patterson et al	493	Devonian						-1043 to -1047		750	
33702	6	6N	5W	Citizens	No. 1 Patterson, Schaar & Hemmerlein	496	Devonian	-1049 to -1083			10 min	100	-1080 to -1083	15/0	350	
							Devonian	-1079 to -1108	25			170				
33787	6	6N	5W	Citizens	No. 1 Reagan	496	Devonian	-1073 to -1107	1		33 min	135 (OC)				
							Devonian	-1112 to -1137				20 (OC)	-1101 to -1105	70/0		
33558	6	6N	5W	Citizens	No. 1 Schaar & Hemmerlein	498	Devonian	-1056 to -1122			20 min	80				
							Devonian	-1118 to -1152					-1086 to -1091	30/0	125	
33701	6	6N	5W	Citizens	No. 1 Squires, Hemmerlein & Reagan	495	Salem	- 219 to - 237	10	15						
							Devonian	-1050 to -1082			15 min	64	-1087 to -1089	44/0	180	
							Devonian	-1090 to -1112			65 min	74				
32757	6	6N	5W	Citizens	No. 1 Squires	492	Salem	- 210 to - 235				25				
							Devonian	-1062 to -1088		125						
							Devonian	-1095 to -1198			390 ft	125				
33987	7	6N	5W	Citizens	No. 1 Osburn	486	Salem	- 224 to - 253	43			47	- 232 to - 237	11/0		
							Devonian	-1079 to -1117			180 ft	5				
32865	8	6N	5W	Citizens	No. 1 Comm. Antibus & Rollison	488	Salem	- 202 to - 230	330			215	- 222 to - 225	25/0		
32891	8	6N	5W	Citizens	No. 2 Antibus & Rollison	487	Salem	- 197 to - 223	370			15 (OC)	- 211 to - 215	15/0		
32668	8	6N	5W	Citizens	No. 2 Barge & Rollison	578	Salem						- 206 to - 223	20/140		
34694	8	6N	5W	Citizens	No. 3 Comm. Barge-Rollison	553	Devonian	-1074 to -1105			32 min	30 (GC)	-1088 to -1091	40/300	100	
							Devonian						-1103 to -1106			
32720	8	6N	5W	Citizens	No. 1 Brown	493	Salem	- 211 to - 245	15	120		15 (OC)	- 228 to - 235	8/80		
32908	8	6N	5W	Citizens	No. 2 Brown	488	Salem	- 205 to - 231	133			30 (OC)	- 222 to - 228	25/0		
32460	8	6N	5W	Citizens	No. 1 Comm. Chaney & Rollison	490	Salem	- 173 to - 206				120 (OC)	- 197 to - 206	50/20		
							Salem						- 210 to - 214			
							Devonian	- 993 to -1034			10 min	10 (GC)				
							Devonian	-1046 to -1076			3 min	60 (GC)				
							Devonian	-1095 to -1128			31 min	150 (GC)				
32615	8	6N	5W	Citizens	No. 2 Chaney & Rollison	489	Salem	- 196 to - 227	210	66		240 (OC)	- 203 to - 219	80/60		
32657	8	6N	5W	Citizens	No. 1 Chaney, Page, Martin & Indiana	526	Salem	- 178 to - 211	440			60 (OC)	- 204 to - 208	75/75		
							Salem						- 213 to - 219	20/100		
32734	8	6N	5W	Citizens	No. 2 Chaney, Indiana & Martin	489	Salem	- 145 to - 230	240			130 (OC)	- 201 to - 203	20/100		
							Salem						- 223 to - 226			
32700	8	6N	5W	Citizens	No. 2 Davidson	506	Salem	- 181 to - 13	180			120 (OC)	- 212 to - 216	75/60		
32712	8	6N	5W	Citizens	No. 3 Davidson	498	Salem	- 198 to - 241	285			70 (OC)	- 218 to - 222	60/5		
33751	8	6N	5W	Citizens	No. 6 Davidson	496	Devonian	-1076 to -1108	10			75				
							Devonian	-1104 to -1138				220 (OC)	-1094 to -1098	10/60	100	
33270	8	6N	5W	Lea	No. 1 Holmes	484	Salem						- 217 to - 223	60/0		Open hole
33527	8	6N	5W	Lea	No. 4 Holmes	486	Devonian	-1075 to -1109			18 min	103				
32746	8	6N	5W	Barkley	No. 1 Holmes	489	Salem	- 220 to - 233	20	45						
32449	8	6N	5W	Citizens	No. 1 Comm. Page	523	Salem	- 161 to - 193	485			185 (OC)	- 175 to - 185	150/0		
							Salem						- 197 to - 201			
33494	8	6N	5W	Citizens	No. 3 Page & Anderson	521	Devonian	-1033 to -1096		290	5 min					
							Devonian	-1096 to -1126		1000	18 min	120 (GC)	-1095 to -1101	5/0	100	
32455	8	6N	5W	Citizens	No. 2 Comm. Doyle	514	Salem	- 169 to - 206	570			120 (OC)	- 192 to - 196	150/20		
							Salem						- 202 to - 209			
32448	8	6N	5W	Citizens	No. 1 Fred & Lucille Rollison	505	St. Louis	- 149 to - 170				5				Discovery well
							Salem	- 175 to - 190	350			30 (OC)	- 183 to - 193	120/0		
							Salem	- 223 to - 250	60	375 (OC)		210 (OC)	- 200 to - 205			
							Devonian	- 993 to -1043				20	-1101 to -1106	20/120		Tested
							Devonian	-1045 to -1074			7 min	120	-1111 to -1116			
							Devonian	-1080 to -1104				70				
							Silurian	-1091 to -1134		380 (GC)		150 (GC)				
32470	8	6N	5W	Citizens	No. 2 Rollison	545	Devonian	-1066 to -1110				45				
							Devonian	-1132 to -1180		400						
32437	8	6N	5W	Citizens	No. 4 Rollison	526	Salem	- 159 to - 194	468			185 (OC)	- 172 to - 176	200/0		
							Salem						- 179 to - 185			
32454	8	6N	5W	Citizens	No. 5 Rollison	497	Salem						- 185 to - 196	120/50		
32574	8	6N	5W	Citizens	No. 6 Rollison	519	Salem	- 209 to - 239	10	540		5 (OC)	- 183 to - 191	75/0		
32438	8	6N	5W	Citizens	No. 3 Rollison	510	Salem	- 168 to - 202	510	60 (OC)		90 (OC)	- 180 to - 186	200/2		
							Salem	- 211 to - 232	385	60 (OC)		210 (OC)	- 188 to - 197			
33492	8	6N	5W	Citizens	No. 7 Rollison	514	Salem	- 182 to - 211	180			160 (OC)				
							Devonian	-1043 to -1080			8 min	150 (OC)	-1100 to -1102	8/0	25	
							Devonian	-1078 to -1110		225 (GC)	40 min					
							Devonian	-1111 to -1140		400		225 (GC)				
32582	8	6N	5W	Citizens	No. 1 Rollison & Barge	534	Salem	- 168 to - 196				90 (OC)	- 174 to - 176	100/0		
							Salem						- 180 to - 186			
33934	17	6N	5W	Arthalony	No. 8 Holmes & Indiana	532	Salem						- 193 to - 196	250/0		Open hole
34271	17	6N	5W	Lea	No. 8-A Comm. Holmes & Ind.	533	Devonian						-1089 to -1093	10/0		
							Devonian						-1098 to -1106			
34274	18	6N	5W	Arthalony et al	No. 1 Comm. Antibus	538	Salem						- 202 to - 219	35/0		Open hole
34356	18	6N	5W	Lea	No. 3-A Holmes	544	Ste. Genevieve						57 to 45	50/0		Open hole
34139	18	6N	5W	Lea	No. 7-A Holmes	533	Salem						- 213 to - 225	40/0		
33905	18	6N	5W	Lea	No. 3 Holmes	544	Salem						- 207 to - 220	240/0		Open hole
33757	18	6N	5W	Lea	No. 6 Holmes	542	Salem						- 228 to - 231	Water		
							Salem						- 235 to - 240			

[1] OC - Oil cut
[2] GC - Gas cut