Press Bulletin Series Issued Twice Quarterly

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
A. M. SHELTON, *Director*

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief, Urbana*

No. 14 **ILLINOIS PETROLEUM** March 17, 1928

STRUCTURE AND OIL PROSPECTS OF EASTERN CLARK COUNTY

By Gail F. Moulton and Jackson Young

Introduction

Following the early development of the main eastern Illinois oil fields in 1906, 1907, 1908, and 1909, there was some haphazard drilling in eastern Clark County. The various wells drilled at this time were mainly shallow, only testing the possible oil-bearing formations to a depth of 1000 feet. Although a deep well in Terre Haute, Indiana, had been producing oil from the upper part of the Devonian limestone for more than 20 years at that time, other wells drilled nearby had resulted in failures, and the operators in Illinois were not willing to spend the additional money required for deeper tests.

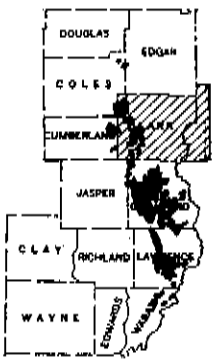


Fig 1. Index map

There was considerable drilling in Clark County in 1925 and 1926, when the operators were busy developing the proved deep producing area southwest of Martinsville, where production had just been discovered in the upper zone of the Devonian limestone (call "Niagaran" and "Corniferous" by various drillers). By the end of the latter year very few undrilled locations remained, and interest in the area had practically disappeared. Late in 1926, however, a well drilled in sec. 6, T. 9 N., R. 10 W., Sullivan County, Indiana, obtained a production of about 50 barrels per day of very light oil accom-

panied by sufficient gas to cause the well to flow. The producing zone is in the upper part of the Devonian lime and was found at a depth of a little more than 2100 feet. The owners of the discovery well formed the Siosi Oil Corporation, and proceeded with the development of the remainder of the favorable acreage, which apparently was all under their control. Up to the present time about 15 wells have been completed which had reported initial productions ranging from 35 to 100 barrels.

As a result of the discovery in Indiana, considerable interest was aroused in eastern Clark County, and at least two new wells were drilled in the hope of finding extensions of the Indiana pool.

Geological conditions affecting oil accumulation in eastern Clark County have not been well understood, except in a very general way, because of lack of satisfactory data. The recent drilling has provided new data which permit a more accurate determination of structure and stratigraphy. It is the purpose of this report to make this new information available for the use of the oil operators. To that end a structure map has been prepared to show the configuration of the top of the Devonian limestone, a program of structure drilling is herein recommended, and an area favorable for testing is described. The relation of the area described in this report to the main southeastern Illinois oil fields is shown in figure 1.

Geology

Stratigraphy

The general stratigraphic sequence typical of the region is well illustrated by the cross-section accompanying this report (fig. 2). Additional details of the characteristic conditions in the eastern part of Clark County are given in the log of the Wernz well, sec. 22, T. 11 N., R. 11 W., which is published as part of this report because it is the deep well nearest the favorable area.

Driller's log from well on Wernz farm in sec. 22, T. 11 N., R. 11 W.

Barometric elevation—606 Feet

No.		Thickness *Feet*	Depth *Feet*
	Pleistocene system		
1.	Soil, sandy	8	8
2.	Gravel, brown, hard, fresh water	28	36
	Pennsylvanian system		
3.	Shale, green, soft	39	75
4.	Sand, gray, hard, fresh water	8	83
5.	Mud, blue, soft	77	160
6.	Mud, green, soft	30	190
7.	Red rock, red, soft	7	197

Driller's log from well on Wernz farm in sec. 22, T. 11 N., R. 11 W.—Continued

Barometric elevation--606 Feet

No.		Thickness *Feet*	Depth *Feet*
8.	Mud, blue, soft	13	210
9.	Sand, gray, hard, dry	40	250
10.	Lime, gray, hard	3	253
11.	Slate, blue, soft	52	305
12.	Shale, sandy, gray, hard	97	402
13.	Coal, black, soft	5	407
14.	Slate, gray, soft	8	415
15.	Lime, gray, hard	6	421
16.	Slate, gray, soft	14	435
17.	Coal, black, soft	5	440
18.	Lime, gray, hard	5	445
19.	Shale, gray, soft	35	480
20.	Lime, gray, hard	2	482
21.	Coal, black, soft	2	484
22.	Slate, blue, soft	4	488
23.	Shale, gray, soft	42	530
24.	Shale, black, soft	10	540
25.	Slate, gray, soft	35	575
26.	Sand, gray, hard, dry	10	585
27.	Slate, gray, soft	22	607
28.	Coal, black, soft	5	612
29.	Slate, blue, soft	25	637
30.	Slate, gray, soft	10	647
31.	Lime, gray, hard	6	653
32.	Sand, broken, gray, hard, dry	7	660
33.	Slate, blue, soft	10	670
34.	Slate, gray, soft	130	800
35.	Lime, gray, hard	5	805
36.	Slate, gray, soft	15	820
37.	Sand, gray, hard; salt water	15	835
38.	Slate, blue, soft	10	845
39.	Slate, gray, soft	15	860
40.	Slate, blue, soft	30	890
41.	Sand, gray, hard	17	907
42.	Slate, blue, soft	3	910
43.	Lime, sandy, gray, hard	12	922
	Mississippian (?) system		
	Chester (?) series		
44.	Slate, blue, soft	28	950
45.	Lime, shell, gray, hard	5	955
46.	Slate, blue, soft	15	970
47.	Lime, brown, hard	10	980
48.	Slate, gray, soft	20	1000
	Lower Mississippian system		
	Lime series		
49.	Sand, gray, hard; salt water (probably lime)	50	1050
50.	Slate, blue, soft	7	1057

Driller's log from well on Wernz farm in sec. 22, T. 11 N., R. 11 W.—Concluded

Barometric elevation—606 Feet

No.		Thickness *Feet*	Depth *Feet*
51.	Sand, gray, hard; salt water (probably lime)	28	1085
52.	Slate, blue, soft	15	1100
53.	Lime, brown, hard	10	1110
54.	Sand, gray, hard	7	1117
55.	Slate, green, soft	3	1120
56.	Lime, white, hard	110	1230
57.	Lime, gray, very hard	35	1265
58.	Lime, brown, hard	10	1275
59.	Lime, gray, and white	45	1320
60.	Lime, brown	30	1350
61.	Lime, gray, broken, hard	30	1380
62.	Lime, gray, very hard	15	1395
63.	Lime, sandy, gray, very hard; salt water	40	1435
64.	Lime, gray, hard	140	1575
65.	Lime, white, hard	20	1595
66.	Lime, sandy, very hard; salt water	27	1622
67.	Lime, black, hard	103	1725
68.	Lime, slate break, black, hard	50	1775
	Mississippian-Kinderhook shales		
69.	Slate, blue, soft	30	1805
70.	Shale, black, hard	113	1918
71.	Sand, gray, hard; salt water 1923	52	1970
72.	Shale, black, break	5	1975
73.	Sand, gray, hard; little salt water	15	1990
74.	Slate, black, hard	10	2000
75.	Slate, blue, soft	15	2015
76.	Sand, gray, hard; little salt water	6	2021
77.	Shale, black, hard	42	2063
78.	Lime, gray, hard	3	2066
79.	Slate, black, soft	19	2085
80.	Slate, blue, soft	20	2105
	Devonian-Sweetland Creek shale		
81.	Lime, gray, hard	8	2113
82.	Shale, brown, soft	93	2206
	Devonian-Onondaga lime		
83.	Lime, brown, hard	14	2220
84.	Lime, gray, hard	10	2230
85.	Sand, gray, hard; little salt water	5	2235
86.	Lime, gray, hard	20	2255
87.	Lime, sandy, gray, hard; little salt water	19	2274
88.	Sand, gray, very hard; full of salt water	14	2288

Casing record

12-inch set at 36 feet
10-inch set at 193 feet
8-inch set at 980 feet
6-inch set at 1650 feet

In general, the important changes in rock sequence which should be noted, as compared with conditions in the old fields in the western part of the county, are the greater thickness of both the Pennsylvanian beds and the

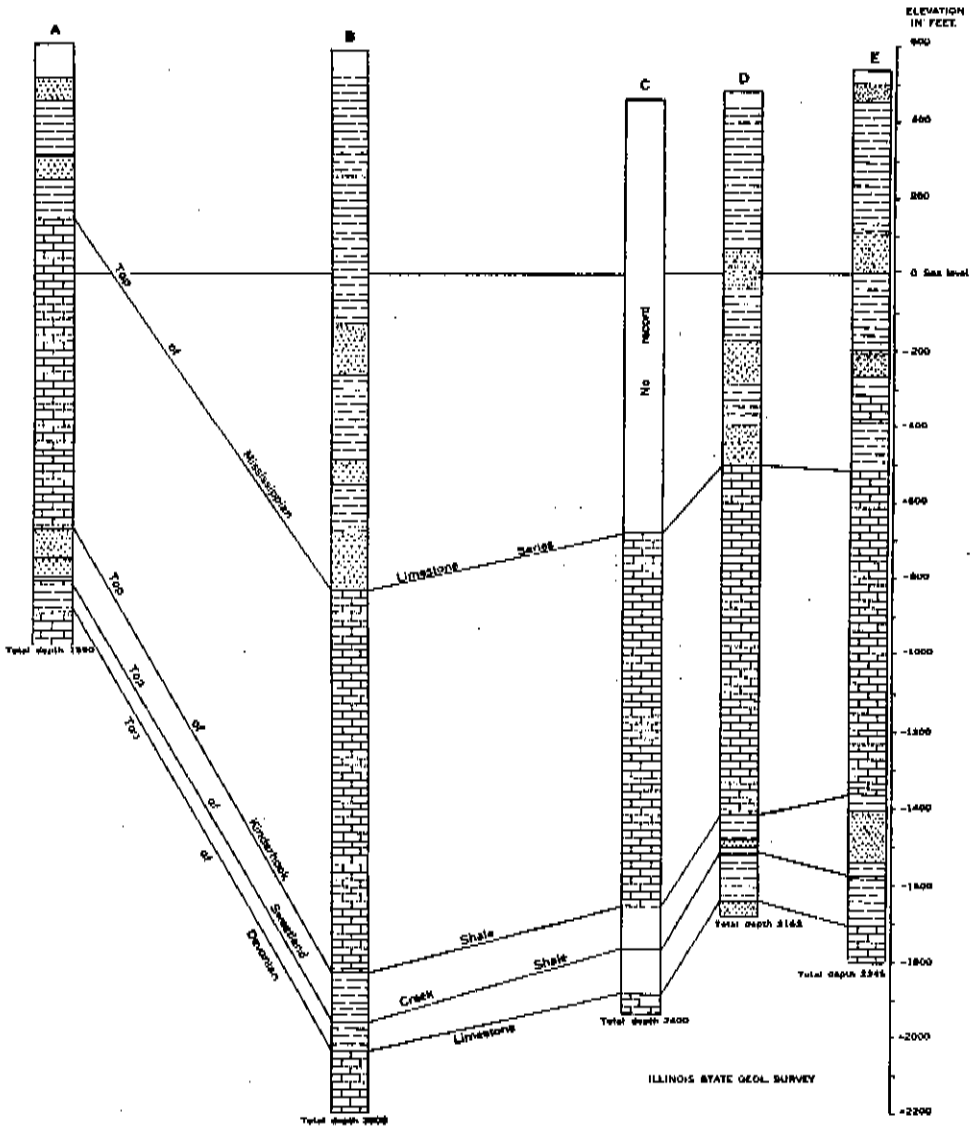


FIG. 2. Section showing stratigraphy and structure from the Martinsville pool to a well near Middletown, Indiana. (See fig. 3.)

Mississippian lime, and the generally less sandy character of the Kinderhook shales. It is further to be noted that the interval from the top of the Missis-

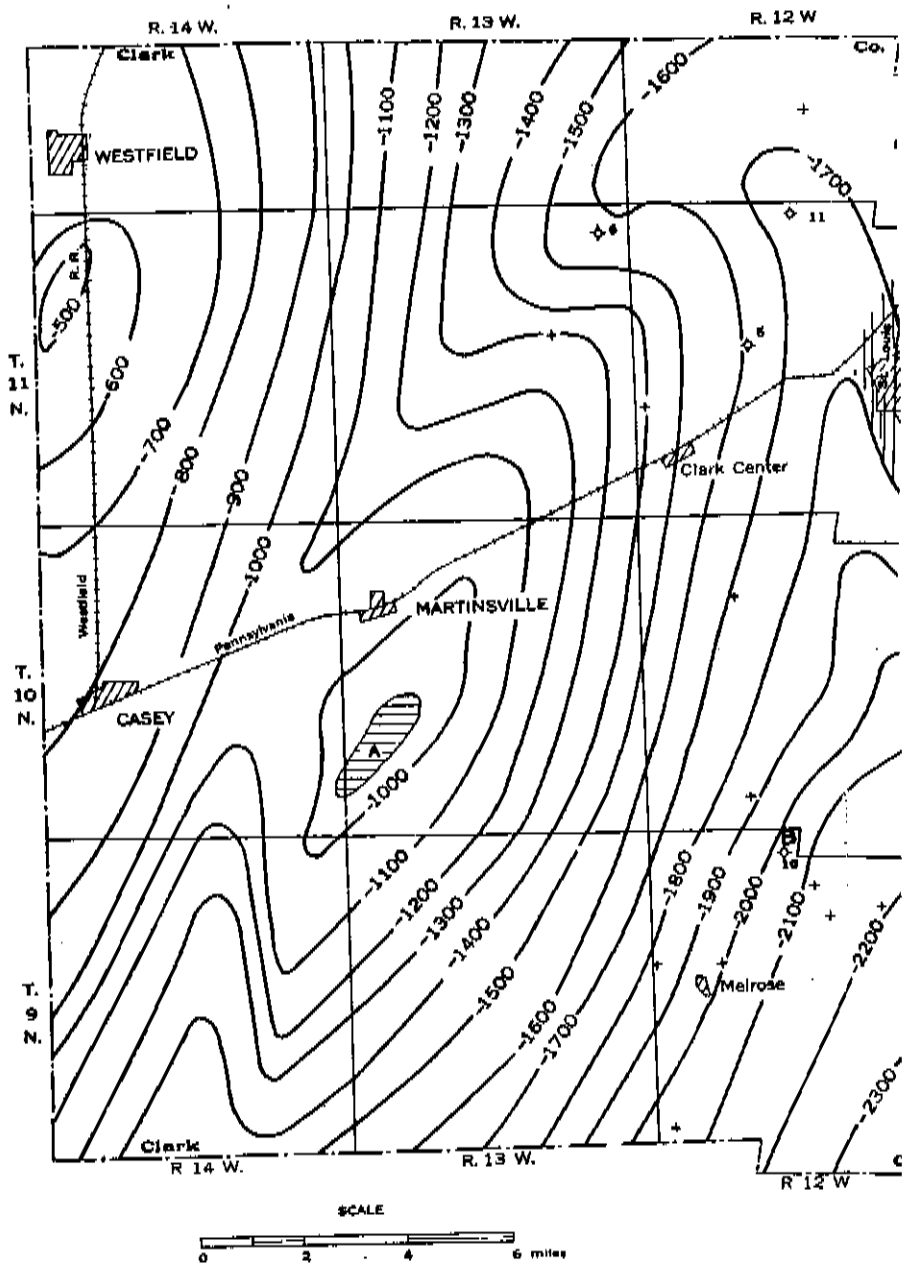
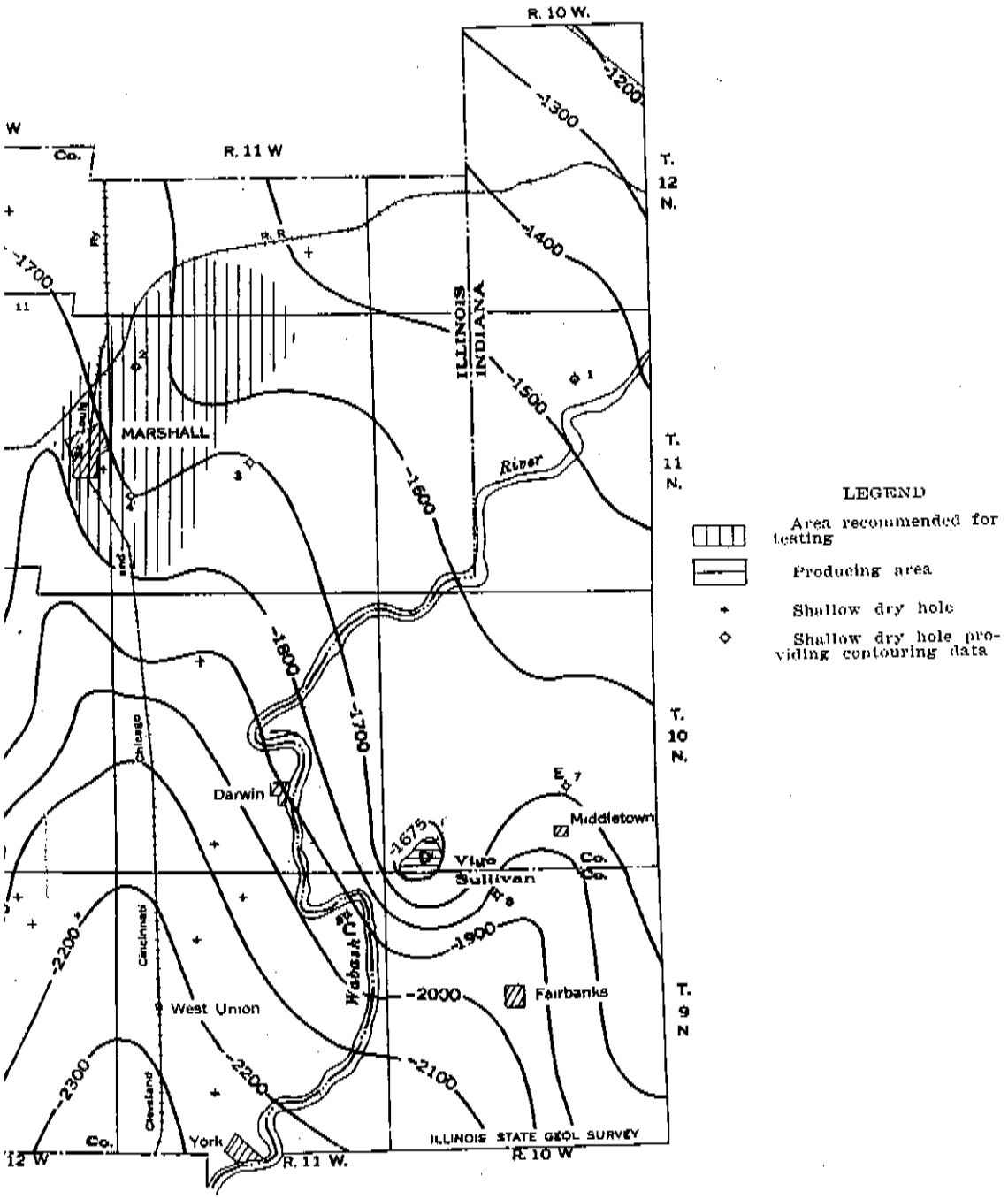


FIG. 3. Structure map of the top of the Devonian limestone in Clark Cou



Clark County and adjoining area, showing the locations of dry holes

sippian lime to the top of the Devonian lime is fairly regular throughout the eastern part of Clark County and the adjacent portions of Indiana included in the structure map (fig. 3). The parallelism between these two contacts does not exist in western Clark County, and has only recently been known to exist in the area to the east. Apparently pre-Pennsylvanian erosion, which was so important farther west on the high part of the main anticlinal structure, did not affect the Mississippian lime series in the syncline to the east. Therefore, the structure of some of the upper beds in eastern Clark County can be used to a much greater extent than in western Clark County for determining the structure of the Devonian lime. For the present, data on the top of the Mississippian lime in eastern Clark County can be used with confidence for this purpose; it is probable that further detailed work in certain areas in eastern Clark County will demonstrate the reliability of data on certain Pennsylvanian beds for determining the presence of deep folding.

A somewhat casual examination of available information on the lithology of the upper part of the Devonian lime, which includes the producing zone in the Martinsville and Siosi pools, shows that these beds are generally more permeable north of Clark County, and are commonly tight and less permeable in southern Crawford County and in Lawrence County. The wells drilled in Indiana are believed to indicate a somewhat similar change from the southeast to the northwest and north. Although it is probable that the variations in permeability are related to an old erosion surface, the data thus far considered do not provide a basis for a definite statement regarding areas in which favorable permeability of the Devonian lime will be found, except that such favorable conditions are demonstrated by oil production at Terre Haute, the Siosi pool and the Martinsville pool.

STRUCTURE

The structure of Clark County, Illinois, and the adjoining part of Indiana is shown in figure 3 by contours drawn to give the elevation of the top of the Devonian limestone below sea level. Since all of the elevations are below sea level, the lowest structures in the area are indicated by contours having the largest minus elevations.

The principal structural features of the area are the Westfield and Martinsville domes, the big dip to the east into the West Union syncline, and the rise to the east of this syncline into Indiana. The anticlinal nose in southern Vigo County, Indiana, where the present development is taking place, and the anticlinal nose in Clark County, Illinois, near Marshall, are structural features which appear to be of lesser importance at the present time, but it should be observed that the data for these structures, particularly the latter, are very general and it is possible that the full extent of local doming is not yet realized.

The structure of the Westfield area has been taken from a map in a detailed report now in press,[1] and the structure of the Martinsville pool from a map published in a previous number of Illinois Petroleum.[2] Except in the Siosi pool the wells which provided data used in contouring outside of these areas are indicated on the map by serial numbers which refer to their further identification in a table at the end of the report. The other wells shown on the map are reported to have been drilled in the locations shown, but no records giving data which could be used to determine geologic conditions are available. For most such wells only the approximate total depth is known.

In preparing the structure map a contour interval of 100 feet is used because of the small scale of the map, the size of the structures mapped, and the considerable areas in which no data are available. Outside of the areas previously mapped the well elevations were determined by barometric methods, but the limits of error from this source are too small to introduce any important modification of the map. For most of the other maps recently published the Illinois Geologic Survey has used a contour interval of either 10 or 25 feet. In comparison with such maps the structures shown in figure 3 by the 100-foot contours do not appear as important as their relative size would indicate unless the difference in contour interval is kept in mind.

The presence of an anticlinal nose or terrace near Marshall, Illinois, is one of the most important facts brought out by this investigation. Two of the three wells which provided the data by which this structural feature was determined did not reach the Devonian limestone; one of them did not even reach the Mississippian limestone, but correlations which seem to be clearly indicated by a comparison of the logs of these wells show that there is a locally high structure in the area outlined on the map. Available data do not permit a conclusion as to the size or exact location of this structure, but it is apparent that it is of sufficient size to merit testing for possible production in the Devonian limestone.

RELATION OF OIL ACCUMULATION TO GEOLOGIC FEATURES

A combination of local structure and regional permeability within the producing zone determines the occurrence of commercially important pools of oil in the Devonian limestone. On the Westfield dome and on the Oakland dome to the north in Edgar County, Illinois, the limestone was found to be so open and permeable that very little oil remained, even on the high parts of these big structures. In the Martinsville pool the producing zone

[1] Mylius, L. A., Oil and gas in eastern Illinois: Illinois State Geol. Survey Bull. 54, Pl. XXVI. (In press.)

[2] Moulton, Gail F., Areas for further prospecting near the Martinsville Pool, Clark County: Illinois State Geol. Survey Illinois Petroleum No. 4, August 28, 1926.

is almost too permeable to permit the accumulation of an important amount of oil, as is shown both by the abundance of water produced with it, and the low saline content of the water.

In other parts of the area the permeability of the upper part of the Devonian lime is so restricted that its flow capacity is very small, and although oil accumulates in it, even on small structures, the rate of production is so slow that the wells are not profitable. The Riley pool in southeastern Vigo County, Indiana, is an example of this type of condition.

In areas with an intermediate permeability in the Devonian producing zone, wells drilled on favorable structures will consistently yield satisfactory production. The Siosi pool is believed to be typical of such favorable combination of conditions.

The effect of structure in determining the producing area in the Martinsville pool is very marked for the production from the Devonian lime. The boundaries of the producing area and the structure contours are closely parallel. Wells drilled high on the structure were characterized by their comparative freedom from water troubles. Successively lower wells on the structure had increasingly larger proportions of water to oil, until at the edge of the producing area the proportion of oil found was too small to make pumping profitable. A similar close relation between structure and the producing area seems to be indicated by the present development in the Siosi pool, and is to be expected for any other pools which may be discovered in the Devonian limestone. The uniformity of permeability is also important to oil producers because more uniform rates of production will be found over such a field than is usually true in the Illinois region for wells producing from sandstones.

These considerations lead to the conclusion that oil producers desiring to develop production from the Devonian lime should first determine the location of large areas which appear to have suitable permeability in the producing zone of the Devonian limestone, and then should attempt to locate favorable structures in such an area. One area which is thought to meet both these requirements is described in this report.

Although it is not believed that any rule of thumb method of determining the proper permeability of the producing zone of the Devonian limestone can be given at present, it seems probable that mineral analyses of the water found in any wells drilled to this bed in the future should give a substantial basis for comparing the effectiveness of water circulation through the zone at various points. The content of common salt, for example, in water from the Devonian lime producing zone in the Martinsville pool is only about half as great as that from the productive Mississippian lime above. On a basis of equal original salt content for the waters in these

zones, it appears that the effectiveness of fluid movements through the Devonian lime has been very much greater. Although the distance of an area from the point of inflow of fresh water, as well as the rate of movement of water, determines the amount of dilution of the original brines by waters percolating through the rocks later, it nevertheless seems probable that variations in distance from the point of inflow over eastern Clark County are so small that they are of much less consequence than the permeability of the limestone in controlling the amount of dilution which has taken place. For the purposes of this report dilution of the salt content of the water is taken as directly due to the effectiveness of the permeability of the limestone in permitting fluid circulation.

At the present time it is believed that only an exceptionally sharp structure would be competent to cause oil accumulation in the Devonian limestone if it were more open than at Martinsville. We may proceed on this basis with the conclusion that areas in this district in which water from the upper zone of the Devonian limestone contain less than about 20,000 parts per million of sodium chloride (common salt), the amount present in the Martinsville pool, are to be regarded as unfavorable. A sodium chloride content in this general territory of from 20,000 to 30,000 parts per million is believed to indicate favorable conditions of permeability; waters with a much larger salt content will probably be found only where the permeability of the upper part of the Devonian limestone is so reduced that the possibility of producing oil at a commercial rate is doubtful.

Recommendations

It is recommended that wells should be drilled to the top of the Mississippian lime in eastern Clark County to determine structural conditions which might be favorable for the accumulation of oil in the upper part of the Devonian limestone. During such structure-test drilling it is advisable to make an effort to detect characteristics of some of the Pennsylvanian formations which may permit their use as key beds, should they prove to have a structure essentially parallel to that of the Mississippian limestone.

It is recommended that the area shown as probably favorable on the map accompanying this report shall be the first locality tested by structure drilling, for a favorable structure is already indicated there and conditions of permeability in the Devonian limestone are believed to be favorable for satisfactory production. To start this program of development several structure test wells should be drilled in T. 11 N., R. 11 W. in the following locations and preferably in the following order: first, NE. ¼ sec. 19; second, NW. ¼ sec. 18; and third, NE. ¼ sec. 20. The first well should serve to test the interpretation of structure based on the data available at present. If this interpretation is verified within moderate limits, the other

structure tests should be drilled for the purpose of determining the size and exact location of the favorable structure, as well as its highest part. Deep drilling then could be undertaken with considerable confidence, and the locations should be chosen for the purpose of obtaining further structural information as well as oil production, at least until several deep wells had been completed. If the first test shows that the interpretation of structure given in figure 3 is seriously in error, an immediate reconsideration of plans is advisable.

A program of this sort is believed to be suitable for either a large producing organization, or for an association of smaller producers, for although the prospects of getting oil production appear to be fairly good, it is apparent that proper testing of this locality might require a larger expenditure than the usual Illinois wildcat proposition.

The State Geological Survey will be glad to cooperate with any organization desiring to undertake the testing of eastern Clark County, either in the favorable area described in this report, or in other localities which may appear favorable as a result of subsequent drilling. This cooperation will consist of furnishing any available detailed information from the files of the Survey, determining the elevations of wells, interpreting the data from the records of any wells drilled, and having chemical analyses made of the mineral content of water from the Devonian limestone from any wells located in that part of Illinois.

Tables of wells, numbered for reference on map

1. Nattkemper and Connelly, NW. ¼ sec. 11, T. 11 N., R. 10 W.[a]
2. Hodson, sec. 7, T. 11 N., R. 11 W.
3. Wernz, sec. 22, T. 11 N., R. 11 W.
4. Henbest, sec. 19, T. 11 N., R. 11 W.
5. Johnson or Cork? sec. 16, T. 11 N., R. 12 W.
6. Claypool, SW. ¼ sec. 1, T. 11 N., R. 13 W.
7. J. Stout, NW. ¼ sec. 26, T. 10 N., R. 10 W.[a]
8. Tutt Mayfield, SW. ¼ sec. 4, T. 9 N., R. 10 W.[a]
9. Welch Bros., sec. 11, T. 9 N., R. 11 W.
10. Beauchamp, sec. 4, T. 9 N., R. 12 W.
11. Golden, sec. 3, T. 11 N., R. 12 W.

[a] Logs of these wells were obtained through the courtesy of the Indiana State Geological Survey, Dr. W. N. Logan, State Geologist, Bloomington, Indiana. The other records were obtained through the regular work of the Illinois Geological Survey.