ILLINOIS

State Geological Survey

BULLETIN NO. 2.

THE PETROLEUM INDUSTRY OF SOUTHEASTERN ILLINOIS,

BY

W. S. BLATCHLEY.

URBANA:
UNIVERSITY OF ILLINOIS.
1906.

ILLINOIS

State Geological Survey

BULLETIN NO. 2.

THE PETROLEUM INDUSTRY OF SOUTHEASTERN ILLINOIS,

BY

W. S. BLATCHLEY.

URBANA:
UNIVERSITY OF ILLINOIS.
1906.

SPRINGFIELD:
ILLINOIS STATE JOURNAL CO., STATE PRINTERS
1906

STATE GEOLOGICAL COMMISSION.

GOVERNOR C. S. DENEEN, *Chairman.*

PROFESSOR T. C. CHAMBERLIN, *Vice-Chairman.*

PRESIDENT EDMUND J. JAMES, *Secretary.*

H. FOSTER BAIN, *Director.*

CONTENTS.

Contents—Concluded.

ILLUSTRATIONS.

PLATES.

FIGURES.

LETTER OF TRANSMITTAL.

STATE GEOLOGICAL SURVEY,
UNIVERSITY OF ILLINOIS,
URBANA, June 20, 1906.

To Governor C. S. DENEEN, *and Members of the Geological Commission:*

GENTLEMEN—I submit herewith a report upon the petroleum industry of southeastern Illinois, and respectfully recommend its publication as a bulletin of the survey.

The discovery in 1905 of deposits of oil and gas of commercial importance in the eastern portion of the State was in every way a fortunate circumstance. While these materials have been known to occur at various points in Illinois, and, as detailed in these pages, there had been some years ago developments of some local importance near Litchfield and Sparta, our State was commonly believed to be signally barren of these important fuels. The first successful wells in Clark county led to rapid wildcatting through Coles, Cumberland, Crawford and adjacent counties, and as one after another successful wells were brought in, explorations began in other parts of the State.

As promptly as possible after the organization of the survey Mr. Arthur W. Lewis was detailed to make a preliminary study of the situation. In the course of the winter he made several visits to the principal fields, and collected such drill records and other data as circumstances permitted. His notes have been used at a number of points in this report, as indicated by Professor Blatchley. Sickness forced Mr. Lewis to give up the work, but not before he has published at my request a preliminary account of the field in the Mining World of April 14th. This, it is believed, was the first description of the new fields published in a technical journal. It stimulated the already active development, and with the coming of spring and consequent improvement of the roads, drilling operations went forward rapidly. In the meantime arrangements have been made for Professor W. S. Blatchley of Indianapolis to report upon the field for the Survey. Professor Blatchley's familarity with the Indiana oil and gas fields and industry peculiarly fitted him for the task, and we are, I think, to be congratulated that he could spare time for the work.

Professor Blatchley visited the eastern Illinois fields in April and May, and promptly wrote the accompanying report as a result of his work. The importance of having numerous level lines throughout

the area in order to properly correlate the various oil sands appeared so great that the report has been held in order to incorporate the results of surveys made by Mr. E. M. Scheflow and Mr. Loren Digby.

Taking advantage of this delay notes have been collected on the other gas and oil fields of the State so far as time and circumstances permitted. The finished paper therefore includes, in addition to Professor Blatchley's report on the eastern Illinois fields, notes by Mr. Grout on the Saline and Randolph county developments, and by Mr. Savage upon the very encouraging gas field in Pike county. Scattered notes on other counties have been added, and Dr. Stuart Weller has discussed the present condition of our knowledge of the lines of deformation within the State. The importance of the latter topic lies in the circumstance that anticlinal areas furnish the most favorable regions for the accumulation of gas and oil if the other conditions be favorable.

Analyses of oil from several points in the State have been made in the laboratory of applied chemistry at the University, under the direction of Professor S. W. Parr, by Mr. F. F. Grout, assistant chemist of the Survey, and certain additional tests have been made by Mr. J. W. Gill. These are given in the body of the text. A careful analysis is also given of the salt water found with the petroleum near Oilfield. For this we are indebted to Dr. Edward Bartow, of the State Water Survey.

No attempt has been made in the present bulletin to note the occurrence of natural gas as it occurs in the drift deposits of the State. Small pockets of such gas are known and in use at a number of points, but their importance will always be local.

The present development is so rapid that before this is printed there will doubtless be many discoveries. No such report can ever be entirely complete, and it has seemed better that this should be issued as promptly as possible in measurably complete form rather than held for more details. The present report is essentially industrial in character. There has been neither time nor opportunity to work out the many interesting geological problems involved, and, indeed, many of them could not be solved at this time. It is hoped none the less that the report will be of service in the additonal development of the known oil fields of the State and in the discovery of new ones. There are many square miles of untested territory in Illinois, and while probably only a minor part of the area will prove productive, there is room for the discovery of many productive fields. There will undoubtedly be important additional discoveries, though much drilling will inevitably end in disappointment.

Respectfully submitted,

H. FOSTER BAIN,
Director.

Unless otherwise stated the data upon which this report is based were all collected prior to May 10, 1906.

THE PETROLEUM INDUSTRY OF SOUTHEASTERN ILLINOIS.

By W. S. Blatchley.

INTRODUCTION

Nature and Use of Petroleum.

Definition of petroleum.—Crude petroleum, or "rock oil", is a natural bitumen, composed mainly of the combustible elements, carbon and hydrogen. In its most common form it is a brownish-black, ill-smelling liquid, with a specific gravity of about 0.86. When kindled it burns readily with a bright flame and without leaving a residue. When exposed to the atmosphere it gives up slowly its volatile gases and is, in time, reduced to a thick, semi-solid, asphaltum-like mass. The name petroleum comes from two Latin words, "*petra*" a rock, and "*oleum*" oil, and in many localities it is known as "rock oil",, or simply "oil."

Distribution of petroleum.—Petroleum is widely distributed throughout the countries of the world, and is found in the rocks of almost every geological formation, from those of the old Archean time up to the later members of the Tertiary. In some of the older countries, as India and Japan, it has been known to and used by man as a remedial agent for more than 2,000 years. For many centuries, however, it uses were few, its possibilities of furnishing valuable products by distillation not being known. With the advancement in the knowledge of chemistry came a better understanding of its component elements, and within the past quarter of a century it has come to be one of the great and necessary resources of modern industry.

During the year 1904, the latest date for which statistics are available, the United States produced 117,063,421 barrels of petroleum, which brought, delivered into pipe lines, $101,170,466. In the same year Russia produced 78,500,905 barrels. The United States thus not only stood first in the rank of petroleum producing countries, but produced more oil than all the rest of the world combined, amounting to 53.4 per cent of the total output.

The oil from the different parts of the United States varies much in character and grade. That from Pennsylvania, New York, West Virginia and southeastern Ohio, known as "Pennsylvania Oill," is considered best for making illuminating products, and brings the highest price on the market. The "Lima Oil" from the Trenton rocks of northwestern Ohio and northeastern Indiana, ranks second in grade.

Like Pennsylvania oil, it possessess a paraffine base, but contains a certain percentage of sulphur, not found in the former, and for that reason is more expensive to refine. The oils of eastern Illinois, Kansas, Colorado and Corsicana, Texas, have also a paraffine base, and rank about equal with the Lima oil in value. Most the petroleum produced in Louisiana, Texas and California has an asphaltum base, and consequently yields an illuminating oil of low value. It is used largely for fuel and brings a much lower price per barrel than the oils with a paraffine base.

Uses of Petroleum.—The average person has but little knowledge of the many uses to which crude petroleum is put or of the variety of products made from it in the great refineries. The most important and best known of these products is, of course the illuminating oil known as kerosene. or "coal oil." This oil has become one of the greatest adjuncts of modern civilization; in fact, such a necessity of daily life that millions of inhabitants of this and other lands would find it difficult to do without. Besides kerosene, all gasoline, the demand for which has been largely increased in the past few years, and all the benzine and naptha of commerce come over as distillates from the crude petroleum. Among the solid products are vaseline, used so extensively as an external application, and paraffine, the candles of which have almost wholly superseded the old tallow "dip". Much paraffine is also used in making matches; as a preservative for eggs and various food stuffs; in laundry work as an auxillary to soap, and for many other purposes. Rhigolene, a volatile product of crude petroleum, is a valuable anesthetic, particularly for local applications to produce cold.

Both petroleum products and crude petroleum are much used in the manufacture of artificial gas. In the making of "air gas", or carburetted air, gasoline is needed, while for "oil gas" and carburetted water gas, crude petroleum is also often used, the liquid hydro-carbon of the oils being converted into permanent gas of high illuminating power. The crude petroleum is also often used for the enriching of coal gas, i. e., for making it of higher illuminating power.

Mineral oils from petroleum and the crude product itself are now almost wholly used for lubricating machinery, especially railway engines. As noted above, the poorer grades of crude petroleum, essecially those of an asphaltum base, are extensively used as fuel.

In the words of the superintendent of one of the leading refineries of the country: "Practically nothing is now allowed to go to waste. Our by-products are really more valuable than the refined oil itself. Benzine and gasoline, which were formerly not considered by us, are now very valuable commodities. The coke which results from the burning of crude oil was formerly dumped into the river; now it is used in the manufacture of the carbons for electric lights, and we cannot get enough of it. The vapors arising from the oil are condensed and recondensed, and are added to our list of by-products. In fact, nothing is premitted to get away which can, in any manner, shape or form, be utilized, and this is ascertained by our chemists and inventive men. "There is not a thing designed or invented that will aid us either

in our manner of refining the oil, or in effecting a saving so that we can untilize what was formerly wasted, that we do not have in our refineries. The changes that have taken place in the last ten or fifteen years are simply wonderful. Take refined oil, for instance. Many of our people can easily recall when it was almost as yellow as saffron; now it is as clear as crystal, and has been refined to such a degree that not a drop of it need be wasted. Our oils are used in soaps, perfumes, liniments, vaseline, and in so many different ways that I have neither the time nor the inclination to try to define their varied uses."

Historical.

OIL DEVELOPMENTS IN ILLINOIS TO 1904.

The search for natural gas and petroleum in Illinois dates back to about the middle of the Nineteenth century, one or two bores yielding marsh gas having been drilled near Champaign in 1853. Near Lowell, in LaSalle county, oil is reported to have been found a few years later.

Clark county.—In the early "sixties", when the first oil excitement spread over the eastern United States, about a dozen bores were sunk eight miles north of Casey, Clark county, by parties from Chicago. The first of these was drilled on a farm then owned by T. R Young, in section 17, Parker township.

Some of these wells were being drilled in 1865, and six were located on the Young, Robinson, Williams, Dr. Briscoe and John Briscoe farms in Parker township, between the towns of Oilfield and Westfield, and one on Blue Island in Westfield township. These early wells were drilled with the holes full of water, as but little, if any casing was used. This water held back the oil, so that no good showing was obtained. As a result the drillers became discouraged and the attempt was abandoned. Enough oil was found in the vicinity to give the name Oilfield to the hamlet which sprang up during the excitement. This name, together with the stories of the older inhabitants, finally led to renewed drilling in 1904, which opened up the present lively "Casey Oil Field." The results have amply shown that it is not safe for any one to say with emphasis that neither gas nor oil will be found in any locality simply because a few shallow bores have proven barren. In Indiana and Illinois, where oil and gas occur in isolated pools and in several different rock formations, no man can say with certainty what the drill will reveal.

Montgomery county—Oil was discovered many years ago while prospecting for coal, and for some years a small production was maintained by skimming the oil off the water in a mine sump. At Litchfield, Montgomery county, about 105 miles west of Casey and 40 miles south of Springfield, about 1886 a number of wells were drilled for oil and gas. Both were found at a depth of 640 to 670 feet, "below the Lower Coal Measures, bordering on the Devonian." About two and a half miles south of Litchfield a large gas well was struck in 1882, the pressure of which was between 400 and 450 pounds to the square inch. This well was spoiled by salt water in 1884. The well was drilled dry and cased at 580 feet, with no salt water found in

the gas sand; but after drilling down 200 feet further a heavy vein of salt water was struck. This could not be successfully plugged off, and finally drenched out the gas, which was reached at 640 feet.*

"The best gas was discovered at a depth of 666 feet. About seven miles of pipe were laid, ranging from three to eight inches in diameter, and the gas was supplied to about 500 stoves in Litchfield, being used chiefly for domestic purposes."†

In 1889 some of the wells began to yield oil, the yield being continued until 1903. In Mineral Resources of the United States for 1889, page 353, the following account of this oil production is given: "The oil is a lubricating one, dark, almost black in color, and of 22° B. specific gravity. The cold test is remarkable, the oil remaining fluid at 20° below zero, Fahrenheit. It is largely used by the factories in the neighborhood of Litchfield, and is sold to consumers at near-by points for lubricating purposes, bringing from 8 to 10 cents per gallon in bulk, according to quantity. In all there have been thirty wells bored in the neighborhood of Litchfield, chiefly for gas. The depth of these wells ranges from 640 to 670 feet. All save five were abandoned years ago. These five wells continue to produce the character of petroleum mentioned above. The average production of these wells is about four barrels per day. They are pumped by heads, and one man attends to them all. Natural gas from wells near by is used to some extent in furnishing fuel for pumping the wells. The supply of gas ts about equal to twelve tons of coal a year, and twelve tons additional are used in pumbing. The supply of natural gas is gradually diminishing."

Between 1889 and 1903, when the production ceased, the total yield of oil from the Litchfield wells was as follows:

Production of Petroleum at Litchfield, Illinois, from 1889 to 1903.

	Barrels.		Barrels.
1889	1,460	1897	500
1890	900	1898	360
1891	675	1899	360
1892	521	1900	200
1893	400	1901	250
1894	300	1902	200
1895	200		
1896	250	Total	6,576

Crawford county—The Crawford County Oil, Gas & Coal Company was organized in the spring of 1900 for the purpose of developing the natural fuels of Crawford county. They started drilling in the southeast quarter of section 35, Robinson township, one and a half miles east of Robinson, the county seat. At a depth of 820 feet, before the oil bearing rock was reached, some salt water was encountered. At about that depth the bore began to cave and was abandoned.

In the spring of 1901 the rig was moved to the D. C. Jones farm, one and a half miles north of Robinson. Here a second bore was started in which a small supply of gas was found at 1,040 feet. This burned about eight feet above the casing. It was shut off and the

*Mineral Resources U. S., 1885, p. 167.
†Mineral Resources U. S., 1886, p. 512.

well drilled to a depth of 1,190 feet where a strong vein of salt water prevented further drilling. Three additional attempts in the years 1901, '02 and '03, resulted in a loss of tools in the wells at depths between 900 and 1,000 feet.

A sixth bore in the spring of 1904 resulted in a small supply of gas and oil, at depths ranging between 900 and 1,100 feet. The bore was continued down to 1,340 seet, and there abandoned. A record of the various strata passed through, will be given on a subsequent page. The company, after expending more than $10,000 without returns, finally gave up the search as useless; though in less than eighteen months good productive oil wells were found within six miles of Robinson.

Randolph county—Near Sparta, in Randolph county, natural gas was found in June, 1888, and J. M. Nickles, writing in 1895, enumerated twenty-two wells which had been put down, of which the larger number produced some gas.(*) The developed gas territory covered less than two square miles. The output for the year, 1889, was estimated at 120,000,000 cubic feet. The gas was found at a depth of 850 feet. It occurred in the Chester formation underlying the Coal Measures. The production gradually decreased and eventually ceased altogether.

ILLINOIS OIL AND GAS FIELD ON MAY 1, 1906.

In 1905 and the early part of 1906 determined efforts were made to develop gas and oil at a number of points in the State. These efforts were most successful in southeastern Illinois, but in the southern and western parts of the State some encouraging results were obtained. The known occurrences of gas and oil, aside from gas pockets in the drift, is shown in plate 1, on which is also shown the known lines of deformation. In most of the localities either by reason of the small quantity as yet found or the absence of pipe lines, there was at the date mentioned no production. That portion of the State actually producing crude oil and natural gas in commercial quantities on May 1st, was mostly comprised in a strip of territory about forty miles in length and twelve miles wide, extending from Westfield, Clark county, a little east of south to below Oblong, Crawford county. The present report is mainly devoted to this area.

The strip of territory mentioned comprises parts of three counties, viz.: Clark, Cumberland and Crawford, which lie on or near the eastern boundary line of the State, and a little south of its center. It comprises a part of each of the following civil townships: Westfield, Parker, Casey and Johnson of Clark county; Union and Crooked Creek of Cumberland county, and Prairie, LaMotte and Oblong of Crawford county. The center of operations in Clark county is Casey, a thriving town of 1,800 population, situated on the Vandalia and C. H. & D. railways, thirty-five miles west of Terre Haute, Ind., and 133 miles east of St. Louis; while in Crawford county, Robinson, the county seat, located thirty-eight miles southwest of Terre Haute, on the Cairo division of the Big Four and the Illinois Central railways,

* Rept. Board Worlds' Fair Commissioners, 1903, pp. 183-190.

is the operating center. The surface of the area producing oil is, in the northern and southern parts, mainly prairie with little deviation in level, while in the central part, along the streams, it is quite hilly or broken. Wherever bluffs or hills are found they are the results of erosion. But few outcrops of rock occur within the oil field. and they are limestones, sandstones or shales of the Carboniferous, exposed in gullies or along the streams where the water has eroded channels through the drift and boulder clay everywhere covering the oil territory to a depth of from fifteen to 100 feet.

But few of the roads of the oil territory have as yet been improved with either stone or gravel. As a result they are, from Dec. 1st to April 5th, almost impassable for the heavy hauling necessary to the proper development of an oil field. For that reason the work must be mainly done in the remaining seven and a half months of the year

PETROLEUM PRODUCING ROCKS OF ILLINOIS.

The rocks producing oil in southeastern Illinois belong to the Carboniferous system, the district being within the Eastern Interior coal field. This coal field covers an area of 46,000 square miles in central and southern Illinois, southwestern Indiana and northwestern Kentucky. It occupies an elliptical basin with a center in southeastern Illinois, toward which the different layers of rocks slope or dip from every direction. At the center of the basin there is an area of considerable extent within which the strata are nearly horizontal. This lies between the Wabash and Embarras rivers on the east, the Kaskaskia river on the northeast and the Louisville and Nashville Railway on the south,

The rocks of this basin in Illinois and Indiana are separated by geologists into three great groups or subdivisions, (1.) Upper or Barren Coal Measures; (2.) Lower Coal Measures; (3.) Mansfield sandstone.

Mansfield sandstone—The basal or lowermost one of these groups in that of the Mansfield sandstone or Millstone grit; also known in geological literature as Conglomerate sandstone, Pottsville conglomerate, etc. This is a bed of sandstone which, in eastern Illinois, ranges up to 110 feet in known thickness. It varies greatly in texture, color and thickness. In places the sandstone is a coarse conglomerate, from which it grades into coarse sandstone by the decrease in the number and size of the pebbles and the corresponding increase in the relative amount of sand. It is in places a massive sandstone, but elsewhere more or less laminated, and in many places shows cross-bedding. Locally it contains many nodular iron masses which are generally hollow. It is not rich in fossils, but sometimes contains fossil coal plants, and locally it contains small coal seams and beds of fireclay. The color varies from light gray through buff, yellow, yellow-brown to red. It is more durable than either the under-lying or the over-lying rocks, and where exposed along its eastern outcrop in Indiana it forms bold cliffs along the water courses.

The Mansfield sandstone markes a period of inflow of the sea. Previous to its deposition, there had been withdrawal of the sea, and

erosion had cut numerous valleys to varying depths, while the land had been covered with the products of weathering. The incoming sea gathered up the fragments of rock waste and filled the depressions of the former land area, thus forming a mantle of sand, gravel, clay and coal, which rests unconformably upon the underlying uneven surface. Under such conditions different deposits would be forming in different parts of the area at the same time. On the advancing shore line there would be in many places quite violent waves which would result in mixed deposits of sand and gravel, more or less inclined to the horizontal in which the characteristic beach structure would show itself. Out from the beach in deeper water, deposits of fine sand and mud would be formed on which, as the water shallowed, swams and bogs that later became coal beds would form. At this time such vegetable deposits were quite limited in both vertical and areal extent in comparison with those formed in the next succeeding period.

Recently some geologists have been inclined to assign the origin of more or less of the conglomerate and sandstone to the action of streams bearing sand and gravel from distant uplands and depositing them on the low ground of the basins in which the formation is found. Not improbably the land streams and the sea co-operated in the process.

In southeastern Illinois the Mansfield sandstone lies from 800 to 1,100 feet below the surface, with many impervious shales above. Being often coarsely granular and therefore very porous, it furnishes a typical storage reservoir, wherein petroleum, salt water or other fluids may be retained.

Lower Coal Measures—Above the Mansfield sandstone are the rocks of the lower or productive coal measures, which consist of alternating beds of shale, sandstone, clay and limestone, with occasional beds of compressed vegetation in the form of coal. During the Carboniferous period, when the coal and its accompanying shales and sandstones were in process of formation, the area now comprised in the eastern interior coal field was a great basin or flat but little above the level of the sea, and surrounded on every side except the southwestern, by the higher lands of the older formations. By successive alterations of level, ranging through thousands of years, this basin became at times an arm of the southwestern sea, again a fresh water lake, and then for a period a vast swamp or marsh. When high enough to form a marsh, vegetation sprang up from the ooze and mud at the bottom and flourished for centuries—the newer growths springing from between the fallen masses of the older, as in the peat bogs of today, and so formed a mighty mass of carbonaceous material.

The marsh was at times covered by sheets of fresh water, into which rivers from the surrounding highlands flowed, bearing with them millions of tons of clayey sediment and sand, the remains of the older decayed rocks. This sediment was spread out over the mass of submerged vegetation, and by protecting it from complete decomposition and by compressing it, aided in its conversion into the hard,

mineral coal. The clayey sediment itself was in time hardened into vast beds of shale and the sand into sandstone. Where fresh water shells and other forms of lime secretions were sufficiently abundant, limestone was formed. At some times and in some places the sea covered the basin and brought in marine forms of life, forming marine limestones as well as marine shales and sanstones, but none of the limestones cover an extensive area or are of great thickness.

After each submergence, with the resulting formation of shale, sandstone or limestone, an emergence followed. The floor of the basin was brought to the surface or so near the surface that the vegetation for a new coal seam could spring up, and the processes detailed above were again undergone.

The thickness and composition of the different beds of shale and sandstone were determined almost wholly by the character and source of those streams of water which flowed into the old basin in which the shales were formed. If the stream was a large one and flowed for a long time with sufficient velocity to carry sediment far out into the deeper part of the basin, the bed of shale or sandstone is thick, covers a large area, and is comparatively uniform throughout. On the other hand, if the stream was small a flowed slowly, the shale or sandstone bed is correspondingly thin, of small extent, and more apt to be varied in its composition. The kinds of rocks over which these ancient rivers flowed on their way to the basin determined the constitutents of the sediments they brought down, and therefore the character and composition of the shales and sandstones into which this sediment was afterward formed.

It must also be remembered that most coal seams, as well as strata associated with them, are necessarily more local in their occurrence than are thicker strata of purely marine origin. Conditions are more uniform over the sea bottom than over a land area, especially a swamp area, such as that of the old basin of the carboniferous coal fields. As this area was subject to many periods of emergence and submergence during the accumulation of the carbonaceous deposits that form the coal beds, there would from necessity be many swamp, lake, sea and land areas. While it is possible that a vegetal swamp might have extended over the entire Indiana-Illinois coal field, it is much more probable that over such a large area so near sea-level, there would be portions of the area under water too deep for vegetation to grow, and other portions so far above the water that no vegetation might accumulate. Hence, the coal might form either in separated basins or in one large basin, with many barren spots, where the upland areas and the deeper water areas were at the time. It should be kept in mind that many coal seams and their accompanying shales and sandstones cover only a few acres, or a few hundred acres, while others may extend over hundreds, or even thousands of square miles.

Any one of the limestones or the sandstones of the Lower Coal Measures may, in certain restricted areas, be porous enough to serve as a reservoir for the storage of petroleum, and may be petroleum-bearing, provided the necessary conditions of accumulation and preservation of oil in commercial quantities be present. These conditions will be hereafter treated.

Upper or Barren Coal Measures—Above the rocks of the productive Coal Measures, last described, are those of the barren Coal Measures, which include six or seven thin beds of coal alternating with shales, sandstones and limestones, as in the productive measures, These barren Coal Measures attain in Illinois a thickness of 700 feet. and any one of the sandstones and limestones present may be productive of petroleum, provided the conditions are favorable for the accumulation and preservation of oil.

General section—The foregoing description of the Carboniferous rocks of southeastern Illinois, within which the petroleum of the Casey and Robinson fields occurs, may, perhaps, be the better understood by a study of the following detailed section of the Carboniferous rocks of the state, as given by A. H. Worthen, in the sixth volume of the Illinois Geological Survey, pages 2 to 5. In a preface to this section, Dr. Worthen stated that the "best exposures of the upper or barren coals and associated strata were found on the upper course of the Kaskaskia and its tributaries, and to the east and southeast, including the counties adjacent to the Wabash river, from Clark county on the north to the south line of White county, where the limestone separating the upper and lower Coal Measures is found out-cropping at New Haven on the lower Wabash."

General Section of the Carboniferous Rocks of Illinois.

		Feet.	Inches.
1	Sandstone and sandy shale, upper part gray, middle brown, with fragments of fossil plants	50	
2	Bituminous shales and septaria	6	
3	Dark clay shales	4	
4	Dark, ash-brown shaly and nodular limestone	1	6
5	Blue and olive shales	5	
6	Gray sandstones and sandy shales	26	
7	Thin coal	.....	6
8	Fire clay	5	
9	Buff sandstone	12	
10	Clay shale with bands of fossiliferous iron ore	35	
11	Bituminous shales and pyritiferous limestone with clayey shales containing silicious wood	9	
12	Gray, pyritiferous sandstone	30 to 40	
13	Shales with fucoids	40	
14	Gray limestone	4 to 8	
15	Calcareous shale	1	6
16	Coal No. 16	1 to 3	
17	Fire clay	1 to 3	
18	Sandstone and shales	80 to 90	
19	Bituminous shale	2	
20	Coal No. 15, "Shelby coal"	1 to 3	
21	Fire clay	2 to 5	
22	Buff limestone	.....	4
23	Sandstone and shales	15 to 50	
24	Shales, partly calcareous	10 to 15	
25	Calcareo-bituminous shales, passing into shelly, bituminous limestone, fossils abundant	2 to 4	
26	Coal No. 13, "Pana coal"	1	6
27	Fire clay and clay shale	3 to 5	
28	Calcareous sandstone	2 to 5	
29	Sandstone and sandy shale	50	
30	Shaly limestone with fossils similar to those of the bed below	4	
31	Hard, gray limestone	5 to 25	
32	Shales	6	
33	Coal No. 13	1 to 1	6
34	Bituminous and agrillaceous shales locally fossiliferous	6 to 8	
35	Sandstones and sandy shales	75 to 85	
36	Dark, shaly limestone and calcareous shales	2 to 4	
37	Coal No. 12	6 in. to 1	6
38	Shales	10	
39	Gray or buff limestone, partly shaly	5 to 20	
40	Bituminous shale, locally fossiliferous	2 to 4	

Carboniferous Rocks of Illinois—Concluded.

		Feet.	Inches.
41	Coal No. 11	1 to 1	6
42	Sandy and clayey shales	35 to 40	
43	Limy, bituminous shales	2 to 3	6
44	Coal No. 10	7 in. to 3	6
45	Fire clay	1 to 4	
46	Sandy shales and brown sandstone	4 to 8	
47	Band of cone in cone, replaced in White county, at Carmi, by a band of brown iron ore	.....	2
48	Clayey shales with flattened iron stones	20	
49	Dark, ash-gray or chocolate colored limy sandstones	2 to 5	
50	Sandy shales and sandstone	30 to 60	
51	Hard, brownish-gray limestone of Shoal Creek, Carlinville and New Haven, and the recognized boundary line between the upper and lower measures	4 to 7	
52	Greenish-drab and blue shales	4 to 6	
53	Bituminous shale	2	
54	Blue shale with flattened concretions of iron	8 to 10	
55	Coal No. 9	6 in. to 2	
56	Fire clay	1 to 2	
57	Sandy shales and sandstone	35 to 65	
58	Limey, bituminous shale, passing locally into a clayey limestone abounding in fossils	2 to 3	
59	Coal No. 8	1 to 2	
60	Dark ash-gray fire clay	2 to 3	
61	Nodular shale passing locally into hard, silicious limestone	3 to 4	
62	Sandy shales and sandstone	40 to 75	
63	Dark ash-gray silicious limestone	1 to 7	
64	Bituminous shale	1 to 3	
65	Coal No. 7	2 to 9	
66	Fire clay	2 to 3	
67	Sandstone and sandy shale	30 to 50	
68	Gray clayey limestone	3	
69	Laminated bituminous shale	2 to 4	
70	Coal No. 6	18 in. to 5	
71	Fire clay	1 to 3	
72	Sandstones and shales	25 to 75	
73	Hard, black shale, with concretions of limestone containing numerous fossils	1 to 5	
74	Coal No. 5	4 to 7	
75	Fire clay	1 to 3	
76	Sandstone and sandy shale	30 to 75	
77	Bituminous shale and clayey limestone	2 to 4	
78	Coal No. 4	2 to 4	
79	Fire clay and clay shale	2 to 10	
80	Sandstone and sandy shale	50 to 75	
81	Bituminous shale passing passing locally into dark blue limestone	3 to 6	
82	Coal No. 3	2 to 4	
83	Fire clay	1 to 3	
84	Hard, tough, sleel-gray limestone weathering to a rusty-brown color	18 in. to 3	
85	Sandstone and silicious shale	25 to 30	
86	Blue clay shale filled with fossil plants	2 to 3	
87	Coal No. 2	2 to 5	
88	Light gray fire clay	2 to 3	
89	Sandstone and silicious shales, about 50 feet in thickness, on the northern and western borders of the coal field, but in Gallatin county attaining a thickness of about 440 feet, with some thin seams of coal	50 to 140	
90	Dark clayey limestone, sometimes highly silicious	3 to 8	
91	Bituminous and silicious shales forming the roof of coal	3 to 8	
92	Coal No. 1	18 in. to 5	
93	Silicious shaly fire clay	2 to 3	
94	Silicious shales with concretions of carbonate of iron	0 to 70	
95	Coarse sandstone or conglomerate forming the base of the Coal Measures*	20 to 110	

Surface deposits—Over the Carboniferous rocks of Illinois there is almost everywhere a bed of drift or glacial debris, ranging in thickness from five to 100 feet or more. This is a complex of clay, sand, gravel and boulders of foreign origin, sometimes bedded and sometimes indiscriminately mixed. When drilling for oil an iron pipe, usually ten inches in diameter, is driven through this drift to the

*In the southern portion of the State this sandstone is largely developed, with an average thickness of more than 100 feet, but in the northern portion it is seldom found attaining a thickness of more than 25 to 30 feet, and is often wanting altogether. It appears at several localities at Whiteside county, as outliers of considerable thickness, several miles beyond the present boundary of the coal field.

first rock which will support it, which is most often a shale. This is done to prevent the caving of the loose material of the drift; the pipe being known as the "drive pipe."

GEOLOGIC STRUCTURE OF THE STATE.

(By Stuart Weller.)

While in general the rocks of the State are flat lying or have an imperceptible dip, they are not absolutely horizontal. Taken as a whole the eastern interior coal field is a great shallow basin with slight dips toward the center from all sides. These dips can only be measured in feet per mile. There are, however, a few lines along which the dips are reversed, so that there are certain rather poorly defined arched areas. These have not yet been carefully worked out, but such as have been certainly recognized are indicated upon the accompanying map, (plate 1).

At least six distinct lines of structural deformation of the strata may be clearly recognized within the State. This deformation is exhibited in the slight folding and faulting of the strata, but in no case have all the structural details been worked out. All of these lines have a northwest-southeast trend, although three are more clearly east and west than the others and most of them are within the southern half of the State.

The northern-most of these lines extends into Illinois near Savanna but is best displayed in Jackson county, Iowa. The most important deformation line crosses the Illinois-Wisconsin boundary in Stephenson county and continues with a direction of about twenty-three degrees east of south, crossing the Rock river at Grand Detour and the Illinois between LaSalle and Utica. This line seems to be a simple low arch or anticlinal swell with the southwestern limb much the steeper. It brings small areas of the Lower Magnesian limestone and larger areas of the St. Peter sandstone to the surface in Ogle county and again in LaSalle county. This arch continues southeastwardly beyond the Illinois river, but the rock surface of this portion of the State is so deeply buried by drift that it is not easy to follow such a line of deformation. A well drilled at Tuscola,* however, to a depth of 792 feet, seems to show that the Coal Measure strata are absent at that point, a fact which would indicate the position of the axis of the arch. To the southeast of Charleston the oil field now being developed is probaby associated with the southward continuation of this LaSalle anticline, as it is called. How much the deformation amounts to here is uncertain. and its influence in localizing the oil is probably general only.

The third line of deformation crosses the Mississippi river in southern Calhoun county with a direction of about ten degrees south of east. It crosses the Illinois river a few miles above its mouth, into Jersey county, but soon strikes the Mississippi again by reason

*Geol. Surv. Illinois, Vol. 8, p. 25.

of the southward bending of that stream, and following the course of the river is soon lost. It is not improbable that additional observations will demonstrate the continuation of this line of deformation further to the eastward than is now recognized. Where this line crosses the Mississippi river from Missouri into Calhoun county, it is a fault having a throw of about 1,000 feet, the St. Peter sandstone of the Cap au Grés bluff being brought to the surface by the upthrow to the north, the strata on the southern side of the fault line being the Mississippian limestones. According to the reports of the former Geological Survey, this fault is rapidly transformed into an anticlinal fold to the eastward, the fault having entirely disappeared where the line crosses the Illinois river into Jersey county.

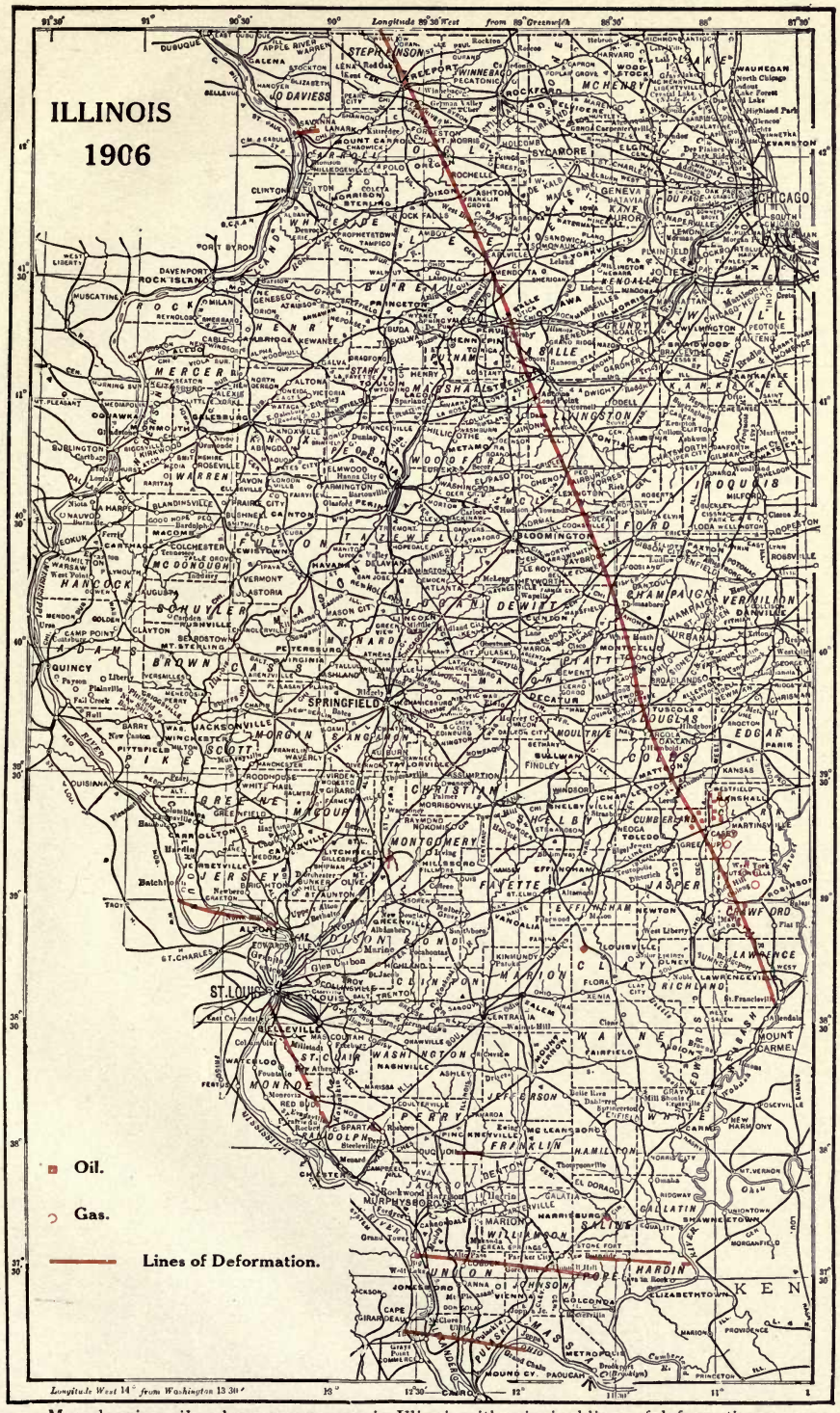
A fourth line of deformation and perhaps the slightest of the five here recorded, is recognized in the Mississippi river bluffs of southern St. Clair county. It has a direction of twenty degrees east of south, but cannot be traced any considerable distance because of the deep mantle of drift present in that portion of the State away from the Mississippi river bluffs. The deformation is in the nature of a low arch, the northeastern limb having a very gentle dip and the southwestern limb a steeper dip of from twenty degrees to thirty degrees.

In the extreme southern portion of the State, two arches are recognized, which pass from the Mississippi river on the west to the Ohio river to the east. The first of these passes from near the mouth of Big Muddy river in a direction of about seven degrees south of east, crossing the Ohio somewhere in Hardin county. At the west Devonian and Silurian rocks are brought to the surface, while eastwardly the Mississippian limestones form the arch, with a small area of Devonian black shale in Hardin county. In Pope and Hardin counties Bain* has recognized faults, more or less transverse to this arch, which were doubtless formed at the same time as the arching. Much more extensive faulting of a similar sort has been mapped by Ulrich† in the adjoining area across the Ohio river in Kentucky. Similar faulting will doubtless be recognized further west along this axis with more detailed study of the region, which will more or less modify the stratigraphic interpretation of the older survey.

The southern-most deformation axis which has been recognized passes from the vicinity of Thebes with a direction of about seven degrees south of east to Grand Chain on the Ohio river. At Thebes this arch brings the rocks of Trenton age to the surface, where they form a reef in the Mississippi river which at times is dangerous to commerce. Eastwardly this axis is buried beneath the Tertiary formations, but at Grand Chain, on the Ohio river, a similar reef to that in the Mississippi is recognized.

In connection with coal mining a considerable number of small faults and folds have been encountered. These have not yet been traced in detail and need further study. Further work will doubtless bring to light other lines of deformation, as well as give us far more accurate knowledge of those here recognized.

*Bain, U. S. G. S., No. 255, pl. 2.
†Prof. Pap. U. S. G. S., No. 36, pl. 2.



Map showing oil and gas occurrences in Illinois with principal lines of deformation.
By Stuart Weller.

ORIGIN OF OIL AND GAS.

GENERAL.

Among geologists and scientists in general it is now commonly believed that petroleum has been derived from the decomposition of animal or vegetable bodies, or both. Many laboratory experiments and facts observed in nature tend to confirm this belief. For example, when the body of an animal or plant is distilled in a closed retort, or undergoes decay in the absence of air, certain gaseous and liquid products are always derived. Again, oily water frequently exudes from peat mosses; and marsh gas, the chief constituent of natural gas, bubbles up from every stagnant pool which contains rotting vegetable or animal matter at its bottom. There is, therefore, no need of far-fetched chemical theories to explain what is more or less a matter of common experience.

The Newberry Theory.—However, two distinct views prevail among geologists as to the manner in which the decomposition has been brought about. One of these views, first set forth by Prof. John S. Newberry, former State Geologist of Ohio, probably accounts best for the oil found in the sandstone strata of southeastern Illinois. Prof. Newberry claimed that the great beds of bituminous shales, such as the Huron, Genesee and Utica shales, have been the chief sources of petroleum—that the animal and plant remains in those beds have undergone a kind of distillation or secondary decomposition, resulting in petroleum, which, by hydrostatic pressure, *has been carried to the rock strata in which it is now found.*

All shale beds are sedimentary in their origin, being composed of particles of clay (an inorganic material) which have been carried long distances and redeposited in water. Now it is well known that clay has a particular affinity for oily matter. Oily substances floating in muddy water have been found to attach themselves to suspended particles of clay and sink to the bottom and produce there a stratum rich in oil, which in time would be compressed by the newer overlying strata into shale. Much of the petroleum of the shale was doubtless thus derived from organic matter undergoing decomposition in other and remote strata.

At the time that the theory of Dr. Newberry was published, the large deposits of oil in the Trenton limestone rocks of Ohio and Indiana were unknown. His theory was based largely upon the Pennsylvania fields, and seems more clearly than any other to explain the origin of the petroleum there found. The Pennsylvania oil, like that of southeastern Illinois, occurs in a series of sandstone strata which contain few, if any, organic remains, and could not, therefore, have furnished the original source of the oil. These sandstone strata lie in close relation to the bituminous and other shales and, from their porous nature have served as reservoirs in which the oil, oozing from the shale, has passed and accumulated in large quantities.

The Hunt theory—The second theory was first promulgated by Dr. T. Sterry Hunt about 1862 and better than any other, accounts for the oil in limestone rocks wherever found. Dr. Hunt asserted that petroleum has been formed from the remains of animals or plants in

the *same rock strata now yielding the oil*, the decompisition having taken place under such conditions that the organism passed directly into petroleum which has since remained in the rocks where it was formed.

Among the proofs of his theory, Dr. Hunt stated that in some cases petroleum is found filling the cavities of large fossil shells (orthoceratites) in the Trenton limestone. "From some specimens nearly a pint of petroleum has been obtained." Again he cited the fact that a stratum of Niagara limestone near Chicago is so filled with petroleum that blocks of it, used in building, were discolored by the exudations which, mingled with dirt, formed a tarry coating upon the exposed surfaces.

The theory of Dr. Hunt was made known about 1862, long before oil was discovered in the limestone rocks of Ohio and Indiana. The facts gathered and observations made in the Trenton limestone field of these states have furnished much evidence in support of his theory; and it is now commonly believed by scientists that the oil found in limestone has been produced in the rock by the direct decomposition of organisms originally inhabiting the water in which the rock was deposited. Moreover, it is believed that, for the most part, these organisms were animals, since the limestone oil possesses more sulphur and nitrogen, it is of a darker color, higher specific gravity, and has a more rank and disagreeable oder than the "shale oil" produced in Pennsylvania, wich probably owes its origin to the decomposition of plants in the manner set forth in the theory of Dr. Newberry, as given above.

Animal life was undoubtedly abundant in the waters of the old basin in which the Carboniferous rocks of southeastern Ilinois were deposited. Fishes, mollusca and many lower forms, such as rhizopods, corals, etc., abounded. The presence of such swarms of animal life made necessary the existance of an abundance of plants, since the plant must ever preceed the animal and gather for the latter the energy, and form for the food, the living protoplasm, necessary to its existence. The aquatic plants were mostly algæ, or seaweeds, while those on land, or growing in the shallow marshes were closely allied to the ferns, horsetails and ground pines of the present day. Myriads of spores and other remains of the land plants were undoubtedly washed down by the streams and deposited with the mud and silt in the old basins. Within these beds of sediment both plants and animals found a grave, their bodies in vast numbers being burried beneath the slowly accumulating deposits of centuries. Once buried in such deposits, they did not decay, as do animals on land, because by the waters above and the ooze around them they were shut off from free oxygen, and the organic agents in decay. Gradually this ooze or fine sediment was by the agency of the sea water, cemented and consolidated into shales, sandstones and limestones.

The remains of animals and of plants were thus effectually sealed within their rocky prisons, and the oil and gas derived from them were similarly retained. This oil and its more volatile portion, the natural gas, was not formed in a short time, but is the result of a slow

decomposition or destructive distillation carried on through thousands of centuries. Accumulating in the more porus portions of the sandstones and limestones, it there remained until man came with his iron drill and furnished a vent through which it could rise. Then by combustion he caused it to yield up the stored energy, conserved since the sun's rays fell on the plants of the old Carboniferous age.

Origin of natural gas—From what has been said it will be seen that both the natural gas and the oil of Southeastern Illinois had a common origin, viz.: the destructive distillation, carried on through thousands of years, of the remains of the plants and animals which had existed in the waters or about the margins of the old basin in which the Carboniferous rocks were laid down. As already noted, it is a well known fact that if wood, coal or the tissue of any animal be placed in an air tight retort and heated, a distillation will occur, and the object will be changed to gaseous, oily and solid matters. In the absence of heat and air a very long period of time will bring about the same results. By this is meant the process of "slow destructive distillation" above mentioned. The primary product of such distillation was probably a light oil, which, in the course of long time has, by volatilization, yeilded the gas, and has itself been condensed into the heavier petroleum. The gas being lighter and more volatile than the oil, gradually rose into the higher porous rocks of the region. If an open barrel be filled with crude petroleum from the Casey or Robinson field and exposed for a single summer to the air, more than half of its contents will pass away in the form of a vapor, and a sticky, tar like residue will remain. If by some means the escaping vapor could be collected and analyzed it would be found in the main to have the same composition as natural gas; in fact, it would be natural gas, and would burn as freely as a sample of that valuable fuel collected in the ordinary way. In the depths of the rock the evaporation of the oil has been extremely slow, and the amount has been limited both by the varying pressure of the overlying gas and the underlying water. There is little doubt, however, but that all the natural gas of the Illinois fields has been so derived.

MODE OF OCCURRENCE OF ILLINOIS PETROLEUM.

DISTRIBUTION IN ROCKS.

The majority of people who have never seen an oil field imagine that both petroleum and natural gas occur in immense caverns or hollow spaces in the rocks beneath the surface of the earth. They believe that great lakes or underground cavities of liquid oil or highly compressed gas exist, and that when tapped with a drill, these yield in abundance the oil and gas of commerce. Such beliefs or imaginations are wholly wrong, for no large cavities or open spaces of any size occur in the rocks of oil or gas producing areas. All rocks are, however, porus; even shale of the closest grain will hold some liquid in the minute and microscopic cavities which it, in common with all rocks, contains. Now the oil and gas sands are simply very porus rocks which contain not one great cavity, but millions upon millions of small or microscopic cavities, so that oil, gas, water,

or all three together, it may be, occupy these numerous little spaces, and thus saturate the rock just as water does a piece of cloth or a sponge. Not only Trenton limestones, but most other limestones, as well as many shales, have in the past produced petroleum in greater or less quantities. Distributed in minute proportions through the substances of the rocks, petroleum easily escapes notice, but when intelligently looked for its presence is revealed, and, though the percentage is small, the aggregate is often vast. If, for example, a stratum carries but one-tenth of one per cent of petroleum and is 500 feet in thickness, it contains more than 2,500,000 barrels to the square mile. Indeed, so common is the occurrence of petroleum in stratified rocks that, wherever a close grained shale occurs there is almost always a small accumulation of oil directly underneath it. The same thing is found where an impervious stratum of any other composition than shale occurs in the geological series. The larger the pores in an oil bearing rock are, and the greater the volume they occupy in proportion to the volume of the rock mass, the greater will be the contained oil or gas supply, and this proportion in fairly good producing sands usually varies between one-fifth and one-tenth; that is, a cubic foot of rock would hold, say, six to twelve pints of oil, and of course would contain an equal volume of cavities for water or gas should either of these substances be present instead of oil.

CONDITIONS OF ACCUMULATION.

If petroleum has been thus generally formed throughout the Carboniferous rocks of southeastern Illinois, why do not all parts of the area covered by those rocks yield it in somewhat equal amounts? Why is it that a bore that pierces the "sand" in one locality is a "dry hole," while another, but a short distance away, results in a "hundred-barrel" well? The answer to such questions lies in the fact that the formation of large accumulations of oil depends as much upon the presence of suitable strata to receive and retain them as upon an adequate source of supply. In the minutely diffused state in which the oil was originally formed it was wholly without value. Like all other forms of mineral wealth it had to be concentrated into reservoirs, the so-called "pools" of the oil field, before it could be utilized by man. The thousands of bores put down for oil and gas in Indiana, Illinois and other States have proven that four conditions are necessary before an accumulation and preservation of oil in commercial quantities can take place. If any one of these conditions is absent, a dry hole or salt water well will invariably result. These necessary conditions are:

1. A porous stratum of rock to form a reservoir.
2. An impervious cover above the reservoir.
3. An arched or anticlinal structure of the rock in which the reservoir is located.
4. A pressure behind the oil to force it into the reservoir.

The porous stratum—The Coal Measure sandstones and limestones of southeastern Illinois vary exceedingly in texture and porosity. Some are cross grained, with large spaces between the grains; others very fine grained with exceedingly small pores. As already noted,

the conditions at the time of their deposition are very different from that when the Trenton limestone or any other strictly marine deposit was laid down. The area covered by any one highly porous stratum in the Carboniferous rocks is apt to be small and very irregular in outline. There are evidently many small areas containing porous reservoirs instead of one large one. These porous rocks or "oil sands" occur at different depths and vary much in composition. In Clark county, as we shall see, there are at least two, and probably three, "sands," one being a limestone or a magnesium-calcium carbonate, and another a quite pure sandstone or silica, For this reason the boundaries of the pools containing the oil bearing strata cannot be located except by more extensive wild-catting than is necessary in a more uniform and widely distributed formation such as that of the Trenton limestone of Indiana.

Wherever the sandstones or limestones become close grained or merge into a shale, they cease to be oil bearing to a remunerative extent. The change from an area containing porous rock into one almost lacking in pores is often abrupt. It is only the former which contains the oil, and there is not known method of determining where the porous rock occurs except by drilling.

The impervious cover—In order to properly retain the accumulated petroleum the porous rock must be entirely covered with an impervious stratum, i.e., one through which neither oil nor its volatile gas will pass or can be forced by the enormous pressure behind it. Such a cover is usually a fine grained shale, and wherever such a stratum covers a porous rock petroleum in greater or less quantities is usually found. In the main Indiana oil field the Trenton rock is covered by an average thickness of 250 feet of that dark brown, close grained deposit known as the Utica shale, which possesses every quality of a typical impervious cover. In the southeastern Illinois field there are several strata of the Carboniferous shales above the oil bearing sands. These vary somewhat in color, texture and thickness, according to the particular layer of productive sand which they cover. In part of the Clark county field from 10 to 40 feet of a black bituminous shale, known as "slate;" which, when drilled, resembles a pasty coal, overlies the oil bearing stratum, which is a limestone. In other portions of the field a lighter gray, but close grained shale is the cover. In general these shales do not contain free oil, though a certain small percentage could probably be obtained from them by distillation. If a shale or other impervious cover did not intervene between the porous reservoir and the surface, the oil would long since have volatilized and passed off as escaping natural gas, leaving behind a tarry, asphalt-like residue, which represents the solid portion. In many locatities in the United States sandstones or limestones occur which are highly impregnated with such an asphalt substance. These deposits are found close to the surface with no shale above them. Had a shale been present, the strata containing the tarry substance would be oil bearing. Thousands of dollars have been spent in drilling such localities in search of an oil which long since escaped in the form of gas.

When the oil bearing stratum lies close to the surface, with only a thin shale above it, a heavy lubricating oil results. Such an oil, registering 20.8 degrees Beaumé, is found in Jasper county, Indiana, where it occurs in the Corniferous limestone at a depth of only 100 feet, beneath 45 to 55 feet of close-grained black shale. In southeastern Illinois, the depth and the aggregate thickness of the layers of overlying shale are sufficient to have prevented any great volatilization of the oil, so that it has a specific gravity of .870 to .887 and registers 28 degrees to 31 degrees Beaumé.

The anticlinal structure—The surface of an oil bearing stratum is not level as many people suppose, but, like the surface of the earth, is a series of alternating arches and depressions or ridges and valleys. The arches or domes are like inverted troughs and vary much in width and area, as do also the depressions between them. Wherever gas and oil occur they will be found in a porous stratum in one of the arches or *anticlines*, as they are called. If a bore happens to be put down and strikes a depression or *syncline* between the arches, salt water will usually be found. If both gas and oil are present in a certain area, and the bore strikes the flank or side of the arch, oil will result. If the bore strikes the crest or dome of the arch, gas will flow. The cause of this is simple, being due to the arrangement of the three fluids according to their relative weights. When the oil was first formed, it was pushed or carried hither and thither by the heavier salt water behind it. Much of it was carried away by the water and lost, but wherever one of the porous areas existed in the side or top of an anticline, the oil was carried into it and there remained.

During the ages which have elapsed much of the oil was changed into a volatile gas, which rose into the higher porous portions of the anticlines or ridges of the sandstone or limestone strata. As this gas accumulated, it pressed back the remaining oil into the sides or flanks of the arch. The oil being lighter than the water, rested upon the latter and prevented it from rising into the higher porous portions of the stratum. When a bore is put down and strikes gas the latter will flow until the quantity which is stored in the porous area of the anticline is exhausted, when the oil, if any be present on the flanks or lower portions of the porous stratum, will rise in the gas well. It may be that the oil has been carried by the salt water into the porous portions of another anticline, and that only salt water occurs beneath the gas. If this be true, the water will fill the porous reservoir as soon as the gas is exhausted.

The anticlines vary much in size, their domes running from scores of miles down to a half mile or less in width. The gas in the higher part of each anticline is, therefore, often shut off from that in neighboring anticline by the intervening oil or water, or both. In the same way the oil in an anticline which contains oil only may be shut off from that in another anticline by the salt water filling all the porous portions of the syncline between. It often happens that a gas bore is put down which strikes the crest of a narrow anticline or

raised portion of porous rock which has not before been pierced. As a result, the so-called rock pressure of the gas is at first high, but rapidly declines on account of the small size of the anticline.

In the Illinois oil fields the production of a new well can usually be foretold by the depth at which the top of the sand or oil bearing rock is found. If it is from five to ten feet higher then the average in the nearby productive wells, the chances are that it will yield much gas and little oil. On the other hand, if the sand is struck 10 to 15 feet lower than the average, the bore has pierced a trough or syncline, and a salt water well or dry hole results. Sometimes, however, there are apparent exceptions. Of two wells in which the sand is found at the same depth, one will be a big producer and the other, but a short distance away, a "dry hole." The only explanation which can be given in such a case is that the latter has pierced a close-grained or non-porous area of the formation, into which no fluid has found its way.

The pressure behind the oil—Whenever the drill pierces a stratum of porous rock containing oil, the latter is pushed upward by the so-called "rock pressure" behind it. Sometimes this pressure is so great that when the oil stratum is reached the oil escapes in a fountain, rising high above the derrick, much of it being lost before the flow can be controlled. In most instances, even if the well proves to be one of small production, the oil is forced upward several hundred feet in the drill hole. As noted above, this rock pressure has, in the past, had much to do with the accumulation of oil in porous reservoirs.

It is now almost universally admitted that the rock pressure in most oil fields is nothing more or less than water pressure, as in artesian wells, the water entering the oil bearing stratum at some point where the latter outcrops and so forming a head or source. The porous rock contains a limited amount of oil, held in place by the overlaying shale. The salt water is below this oil, ever pressing it upward into the vent furnished by the drill hole. As the supply of oil is gradually lessened, the water rises to fill the pores, and the rock pressure is lowered. The pressure does not tell us anything about the volume or amount of oil stored in the rock; but the rate of diminution of pressure furnishes an excellent index of the rapidity with which that amount is being lessened. When the supply of oil is exhausted, as it naturally will be in time, there is no source from which it can be renewed The salt water will rise and occupy the space which formerly held the oil and it will come to stay.

Accompanying salt water—The quantity of salt water in the oil-bearing strata of the Illinois fields is not as great as in those of Indiana and other states. It occurs, however, abundantly in the porus strata below those yielding oil and gas, and when once encountered in quantity in a bore, it is seldom or never that oil is found beneath it. It is usually thought that a much greater proportion of the oil can be secured from a productive stratum when a quantity of salt water is present. The wells penetrating it are usually longer lived, as the salt water seems to renew the quantity of oil by bringing it in from quite a distance.

Moreover, the water seems to keep the pores of the oil rock free from paraffine and other materials which have a tendency to clog them up, and a well producing four or five barrels of water a day in connection with the oil, is preferred by many operators to one that produces oil alone.

In the Illinois field salt water is common, but not troublesome. A sample from the wells on the Charles Lee farm (northeast quarter section 8, Parker township, Clark county) was analysed at the laboratory of the State Water Survey with the following result:

Analysis of the Mineral Content of the Salt Water from the Oil Wells Near Westfield.

LABORATORY NO. 14238.

IONS.	Parts per million.
Potassium, K	77.4
Sodium, Na	8,315
Magnesium, Mg	285.2
Calcium, Ca	291.6
Iron, Fe	26.6
Aluminium, Al	.6
Nitrate, NO_3	5.3
Chlorine, Cl	13,424
Sulphate, SO_4	113.6

HYPOTHETICAL COMBINATIONS.	Parts per million.	Grains per gallon.
Potassium Nitrate, KNO_3	8.6	.50
Potassium Chloride, KCl	147.5	8.59
Sodium Chloride, NaCl	21,103.1	1,230.95
Magnesium Chloride, $MgCl_2$	854.4	49.83
Magnesium Carbonate, $MgCO_3$	131.2	7.65
Magnesium Sulphate, $MgSO_4$	142.4	8.30
Calcium Carbonate, $CaCo_3$	728.9	42.51
Ferrous Carbonate, $FeCo_3$	55.1	3.22
Aluminium Oxide, Al_2O_3	1.2	.07
Silica, SiO_2	32.0	1.87
Bases with Silica	60.0	3.50
Total	23,264.4	1,356.99

Quantity of petroleum to the acre.—If the amount of oil obtained from a productive sand be estimated at one gallon per cubic foot, and the sand is five feet in thickness, an acre (43,560 square feet) will yield about 5,000 barrels of forty-two gallons each. If the sand reservoirs be exceptionally thick or of very great porosity, the production will be much greater. It is estimated that Spindle Top Hill, in Texas, produced over 25,000,000 of barrels from less than 200 acres. This, however, was a low grade oil with an asphalt base. Such oils are usually more abundant in limited areas than those of higher grade.

By the ordinary processes of drilling and pumping it is impossible to get all the oil from any sand, even if a well be put down on every five acres. One-fourth or more will probably remain in the rock, held there by capillary attraction, which neither the accompanying gas nor the attraction of gravity can overcome.

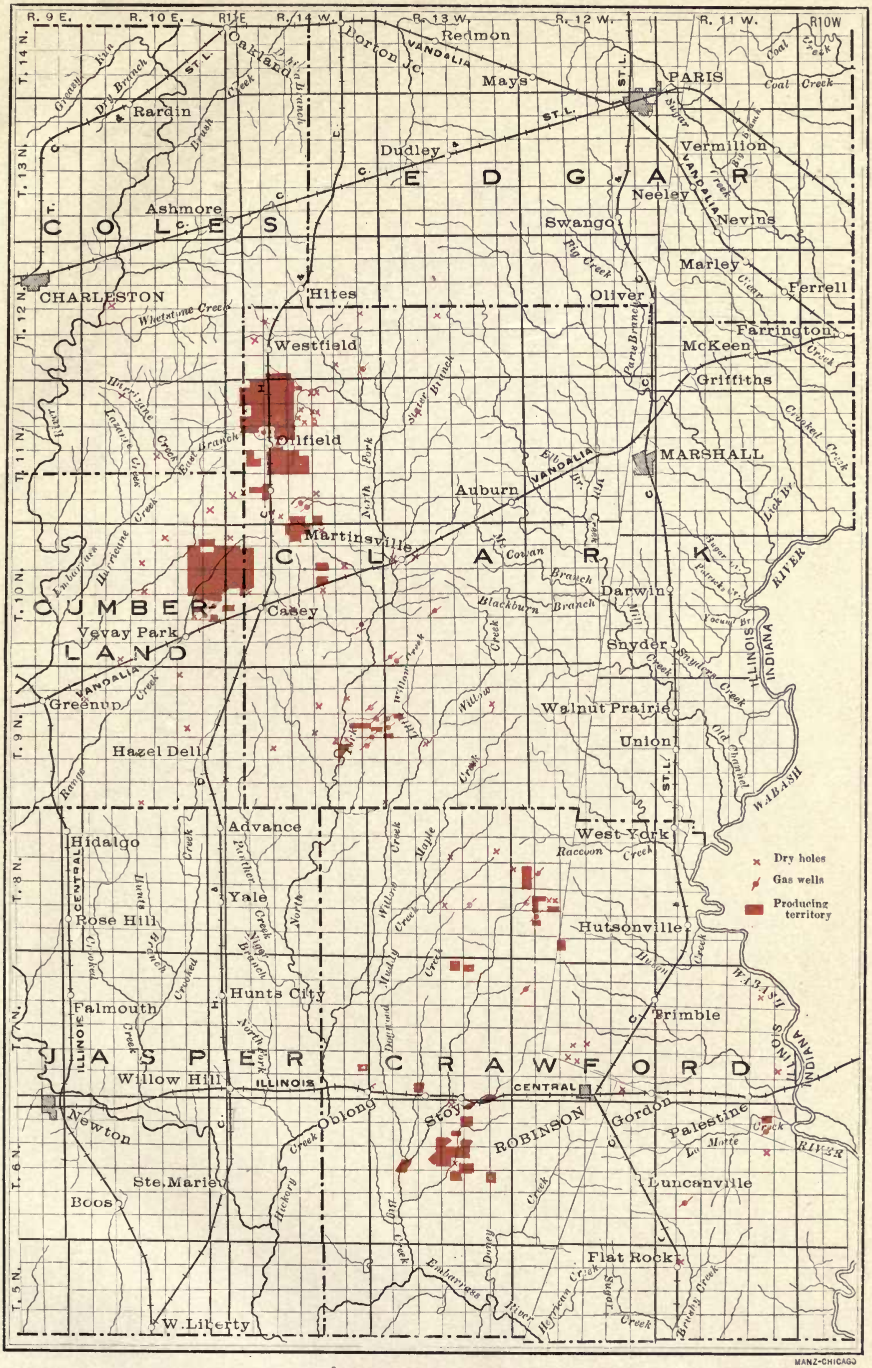
Pools not necessarily connected.—A fallacy which should not gain credence among would-be operators in the Illinois field is that oil fields or pools run in lines, and that one field is connected with all others, the oil flowing from one to the other through a continuous strip of porous rock. This may in part be true in the Pennsylvania and West Virginia oil regions, but it is wholly untrue in the Trenton limestone area of Ohio and Indiana, or in the Carboniferous rock area of southeastern Illinois. While all the so-called pools of the Illinois field will be found in the anticlines of the Carboniferous formation, they are not necessarily connected, nor do the anticlines run in straight lines. From what has been said about the origin of the Carboniferous rocks of southeastern Illinois it will be seen that a pool may be of any shape, and may lie in any direction from any other pool. Its boundaries may be straight or sinuous; its area one square mile or 1,000 square miles. It the conditions necessary for the storing of petroleum, namely a porous reservoir, located in the fiank or dome of an anticline, with an impervious cover above it and a water pressure below it, have been present in the past the oil will very likely be found, whatever the shape, size or relative location as to other similar reservoirs. If any one of these conditions is lacking or has been lacking the bore is sure to be a dry hole. Inasmuch as the top of the oil bearing strata in the Illinois field is everywhere from 300 to 1,000 feet below the surface, it will be seen that the problem of locating in advance a paying well is a difficult one.

Dry holes and condemned territory—The distribution of the oil bearing strata in the Illinois fields is such that isolated bores which are dry or very small producers should not condemn a large territory. While the average operator is always in search of big wells, and is inclined to reject territory where wells come in for ten barrels or less, it should be remembered that small wells which are stayers or long time producers yield the larger profit. A dry hole within a reasonable distance of a fair or good producer should not, therefore, condemn a square mile or more of the area about it. From what could be learned of the areas already partly drilled in Clark county at least, a bore is a test for but one location; that is for an area of but a few acres about the well. Inside of known productive territory, as far as it has been defined by the drill, the number of dry holes is much fewer in the Casey field than in the average Trenton rock field of Indiana. Most of the dry holes which have, up to the present, been sunk, have been wildcat ventures in wholly virgin territory. It is probable that a number of them would have been productive had they been put down to greater depths, instead of stopping after penetrating what was supposed to be the Casey sand.

Experience has proven that the Illinois operator, like those in every other field, is taking chances with every bore he sinks. He has no way of knowing beforehand what the results will be. He may pierce the center of a reservoir and get a 300 barrel well; he may strike near its outer rim and get a ten barrel well; he may miss it altogether and get a dry hole. One thing he can rely upon if he strikes a productive well, and that is, that he is drawing upon a stored product which is not now being formed in the rock from which it is drawn, and that, therefore, he must eventually exhaust the stock of oil from the immediate vicinity of his bore.

Surface indications—In Illinois, as in Indiana, there are absolutely no surface indications which denote the presence of either gas or oil in paying quantities in the underlying rocks. Gas and oil are found in commercial quantities in the southeastern field only at depths ranging from 300 to 1,100 feet below the surface, and the conditions are such that no man can, with certainty, locate in advance a productive well in any portion of the field. In many places bubbles of gas may be noted as escaping from some pond, spring or stream; or a scum of oil be found floating upon the surface of some pool of water. To the average beholder these are thought to be "surface indications" of a larger supply beneath. As noted above, however, there is always found between the formation containing the oil or gas in commercial quantities, and the surface, one or more close grained shales which are wholly impervious to both gas and oil; i. e., no particle of either of these fluids can find its way through them. In fact, such a shale is an absolute necessity to the presence of a commercial body of either gas or oil, or else both of these would long sisce have found their way upward into the atmosphere. The bubbles of gas, which may be seen escaping from the water are, in almost every instance, marsh gas, which is formed by decaying organic matter at the bottom of the water, or in some deposit of carbonaceous material near by. The oil has exuded in minute quantities from some shale, clay, limestone or sandstone, as all such rocks contain some oil. But a drop or two is necessary to form many square feet of film or scum over the surface of a spring or pool. In many instances the supposed oil on the surface of a spring is not oil, but a brownish yellow precipitate of iron oxide.

Again, the oil producing rocks of Illinois follow no definite direction, as in some other states. There is no northwest-southeast, or northeast-southwest axis or trend of 30, 45 or any other number of degrees which the intelligent operator can follow and sink a productive bore ninety-five times out of a hundred. His operations in the State must always have an element of chance connected with them. If he keeps well within the bounds of productive territory his chances of failure are much fewer than if wild-catting on the outside of such limits. But on the best area known within the bounds of productive territory an occasional bore will come in dry.



Map showing Oil and Gas Fields of southeastern Illinois. Scale 8 miles to the inch.

One fallacy believed by a number of intelligent operators in the Casey field is that that field will be found to extend to the northeastward and connect up with the shallow developments in the Corniferous rocks of Jasper county, Indiana. Anyone with the slightest knowledge of geology should know that this is impossible. The Corniferous rocks belong to the Dovonian age and were in existence millious of years before those of southeastern Illinois were formed. They dip strongly to the southwestward and, if represented near Casey, are 1,700 or more feet below the surface. Neither is the Casey sand continuous with or synonymous with that found productive near Princeton, Indiana, the latter being a Huron sandstone of Lower Carboniferous age. The belief in some kind of a northeast or southeast line is probably largely responsible for the erroneous opinion that the Princeton, Casey and Jasper county fields will be found continuous.

SYSTEMATIC DESCRIPTION OF THE OIL FIELDS.

Clark County.

GEOLOGY.

This county lies on the eastern border of the State, between Edgar and Crawford counties. and is bordered on the west by Coles and Cumberland counties. It is 21 miles in length from north to south and 26 miles in greatest width, its area being 515 square miles. The western part of the county is either prairie or gently rolling, while the eastern portion is more broken, especially in the vicinity of the Wabash bluffs, where it becomes quite hilly. and is often broken into steep ridges along the courses of the small streams.

The principal streams in the western part of the county are North Fork, which traverses the county from north to south, and empties into the Embarras river in the eastern part of Jasper county. Throughout nearly its whole course it runs through a broad, flat valley affording no exposures of the underlying rocks. The bluffs on either side are composed of drift clays, and rise from 30 to 50 feet or more above the valley. At several points where wells have been sunk these clays and underlying quicksands are found to extend to an equal depth beneath the bed of the stream. In the eastern part of the county Big creek, and two or three of less note, after a general southeast course in this county, empty into the Wabash river.

"The Quarternary system is represented in this county by the alluvial deposits of the river and creek valleys, the losses of the Wabash bluffs, the gravelly clays and hardpan of the true drift, and the underlying stratified sands that are sometimes found immediately above the bed rock. The drift deposits proper vary in thickness from 20 to 75 feet or more, the upper portion being usually a yellow gravelly

clay, with local beds or pockets of sands. The lower division is mainly composed of a bluish-gray hardpan, exceedingly tough and hard to penetrate, usually impervious to water, and from 30 to 50 feet in thickness. This is underlain by a few feet of sand, from which an abundant supply of water can be had where it cannot be found at a higher level."*

Three railways furnish fair means of transportation, viz.: The Vandalia Division of the Pennsylvania, running south of west across the full width near the center; the Danville and Cairo Division of the Big Four from north to south across the eastern third, and the Sidell and Olney Division of the Cincinnati, Hamilton & Dayton, north and south near the western boundary. The elevation in feet above tide of the principal railway stations in the county are as follows: Auburn, 619; Casey, 645; Dennison, 571; Farrington, 565; Marshall, 614; Marshall Junction, 613; Martinsville, 568; Martinsville Weather Bureau, 575.

Although several hundred bores have been sunk in Clark county to the oil bearing strata or below, it was impossible to secure a record of any one of them which showed in detail the character of the strata passed through. The driller calls them shales, slates, sandstones, etc., but keeps no accurate record of their thickness or sequence. The operator keeps a careful record of the amount of iron pipe used in each bore, the distance to the top of the oil bearing rock or sand, its thickness and the total depth of the well. These are the only records in which he is interested and are, for the most part, the only ones which are given in the pages which follow. They have a practical meaning to the operator if not to the geologist, and as this report is prepared mainly for the use of those who are trying to develop the field, it is hoped that it will be of sufficient value to justify their publication.

In his report on the geology of Clark county, Prof. A. H. Worthen gave a general section of the Coal Measure rocks of the county, as follows:

General Section of the Coal Measures of Clark County.

		Thickness, Feet.	Total Feet.
1	Sandstone, nowhere found well exposed	30 to 40	30 to 40
2	Quarry Creek and Martinsville limestone	20 to 30	50 to 70
3	Shales, lower part bituminous	10 to 15	60 to 85
4	Coal (No. 14?)	1	61 to 87
5	Shaly fire clay	2 to 3	63 to 89
6	Sandstone and shale, some bands of iron carbonate	18 to 20	81 to 109
7	Bituminous shale	1 to 2	82 to 111
8	Coal (No. 14?)	1	83 to 112
9	Clay shale and fire clay	4 to 6	87 to 118
10	Cinnamon-brown limestone	3	90 to 122
11	Coal (local?)	0	90 to 122
12	Sandy shales passing into massive sandstone below	40 to 50	130 to 172
13	Dark shales with nodules of fossiliferous limestone	5 to 8	135 to 180
14	Hard black shale approaching cannel coal	1 to 3	136 to 183
15	Evenly bedded sandstone	20 to 25	156 to 208
16	Greenish sandy shales	20 to 40	186 to 248
17	Sandstone	8 to 10	194 to 258
18	Gray limestone	5 to 8	199 to 266
19	Shale enclosing a 6 to 10 inch coal (No. 12?)	7 to 8	206 to 274

*Worthen, Ill. Geol. Survey, vol. 7, pp. 9, 10.

General Section of the Coal Measures of Clark County.—Concluded.

		Thickness, Feet.	Total Feet.
20	Limestone, lower bed at Livingston	7 to 8	213 to 282
21	Argillaceous and sandy shales	30 to 35	243 to 317
22	Coal (No. 11?)	6 in. to 1	243 to 318
23	Brown and gray sandstone	24	267 to 342
24	Shale, lower part bituminous	25	292 to 367
25	Coal, local	0	292 to 368
26	White fire clay	3	295 to 371
27	Green fire clay	3	298 to 373
28	Shale and sandstone	36	334 to 410
29	Chocolate-brown impure limestone	3 to 4	337 to 414
30	Bituminous shale	3 to 6	340 to 420
31	Coal No. 10	1	341 to 421
32	Drab colored shales	30 to 40	371 to 461
33	Compact brownish-gray limestone*	4 to 5	375 to 466
34	Green, blue and red clay shales	10 to 12	385 to 478
35	Sandstone	12 to 15	397 to 493
36	Argillaceous and sandy shales	45 to 50	432 to 543
37	Bituminous shale	1 to 2	443 to 545
38	Coal No. 7	5	448 to 550

Of the above section Professor Worthen wrote: "All the rocks found in Clark county belong to the Coal Measures, and include all the beds from the limestone No. 33 that lies about 75 feet above coal No. 7, to the sandstone† No. 1 above the Quarry Creek limestone, and possibly coal No. 14 of the general section. These beds are all above the main workable coals, and although they include a total workable thickness of about 400 feet, and the horizon of five or six coal seams, yet none of them have been found in this county more than from 12 to 18 inches in thickness."

With the three limestones Nos. 2, 18 and 20 of Professor Worthen's section we are especially interested, since No. 2 forms a level from which we can guage the approximate depth to the oil bearing strata of the county, *while No. 20 is the principal oil bearing rock of the Westfield-Casey pool*, and No. 18. where sufficiently porus, yields part or all of the gas found in the bores.

It will be noted that Professor Worthen does not give any drift or surface material above his rocks. This drift varies in thickness in the different parts of the field, but its thickness at any one point is closely guaged by the number of feet of drive pipe given in the well records. This drive pipe, which is the first and larger pipe put down, is usually ten, though sometimes eight inches in diameter, and it seldom penetrates more than two or three feet of the upper stratum of rock, and more often rests directly on it. It will also be noted that the distance from the top of No. 1 to the top of No. 20 of Professor Worthen's section is from 204 to 271 feet. If in the main Westfield-Casey pool the length of drive pipe be added to 270, the sum will, in most cases, be within a few feet of the distance to "top of sand," given in the well records.

Moreover, as already noted, the stratum just above the oil sand in this field is a black, close grained, pasty shale, resembling coal. This is represented by No. 19 of the section, which gives: "Shale, enclosing

*This limestone is about 75 to 80 feet above the coal in the shaft just across the river from Terre Haute, which is No. 7 of the Illinois section, and the intervening beds would give the continuation of the section if carried down to the horizon of this coal, but they do not come to the surface in Clark county.

†This sandstone is very likely a sandy shale in many places, as a number of the drillers report the first rock struck in the bores to be a "slate" or Sand slate."—W. S. B.

a 6 to 10-inch coal, 7 to 8 feet in thickness," as occupying that horizon. The black shale and coal, when pounded up by the drill, moistened and bailed out, cannot be distinguished one from the other. By some of the drillers the mixture is called coal and by others black shale. Taking the above facts into consideration, there is no doubt in the writer's mind but that Professor Worthen's No. 20, or Lower Livingstone limestone, is the oil bearing rock of the Westfield-Casey pool.

Of the three limestones—Nos. 2, 18 and 20, in Clark county, Professor Worthen wrote as follows: Of No. 2 he said: "The beds forming the upper part of the general section in this county are exposed on Quarry creek south of Casey, and one mile and a half east of Martinsville, on the upper course of Hurricane creek, and the Blackburn branch southeast of Parker prairie. At the quarry a mile and a half east of Martinsville, the limestone is heavy bedded, and has been extensively quarried for bridge abutments, culverts, etc., on the old National road. The bed is not fully exposed here, and seems to be somewhat thinner than at Quarry creek, where it probably attains its maximum thickness, but thins out both to the northeast and southwest from that point.

"At Quarry creek, about a mile and a half south of Casey, on section 28 (10 N., 14 W.) this limestone appears in full force, and has been extensively quarried both for building stone and the manufacture of quicklime. It is here a mottled gray, compact limestone, partly in regular beds from six inches to two feet or more in thickness. At least 25 to 30 feet of limestone is exposed here, and as the overlying sandstone is not seen, its aggregate thickness may be even more than the above estimate. At its base the limestone becomes thin bedded and shaly, passing into a greenish, calcarious shale with thin plates and nodules of limestone, abounding in the characteristic fossils of this horizon. At one point on this creek a bed of green shale, aboat two feet in thickness, was found intercalated in the limestone."*

Of Nos. 18 and 20, the Livingston limestones or gas and oil bearing strata, he wrote: "Near the center of section 4 (9 N., 12 W.) the following beds were found on Joe's Fork, above the site of the old Anderson mill:

Section on Joe's Fork.†

		Feet.
12	Massive sandstone, the same seen on Hurricane creek	25
13	Dark shale with nodules of limestone	5 to 8
14	Black shale	1 to 2
15	Sandy shale and evenly bedded sandstone	20 to 25
16	Greenish colored sandy shales	35 to 40
17	Hard concretionary sandsiones with softer beds below	8 to 10
18	Gray sparry limestone	5
19	Shale with 10 inch seam of coal	8
20	Brownish gray, hard brittle limestone	7 to 8

*Geol. Surv. of Ill., Vol. 6, 1875, pp. 12-13.

† I have numbered the strata to correspond with the numbers given the same strata in the county section. W. S. B.

"The above includes Nos. 12 to 20 of the county section. The limestones at the base of the above section are the equivalents of the Livingston limestones hereafter described, and they pass below the bed of the creek here about a mile above the old mill. The sandstone overlying the upper limestone here, when evenly bedded, is quarried for building stone and affords a very good and durable material of this kind for common use. At the mouth of Joe's Fork the lower limestone is partly below the creek bed, the upper four feet only being visible, and above it we find clay shale 2 feet, coal 10 inches, shale 5 to 6 feet, succeeded by the upper limestone which is here only three or four feet thick. The upper limestone at the outcrop here is thinly and unevenly bedded and weathers to a rusty brown color. The lower limestone is more heavily bedded, but splits to fragments on exposure to frost and moisture. It is of a mottled gray color when freshly broken, but weathers to a yellowish brown.

"At the railroad bridge northwest of Livingston the following section may be seen:

Section at Railroad Bridge Northwest of Livingston.

		Feet.	Inches.
18	Gray sparry limestone		7
19	Blue shale		6
20	Gray limestone, heavy bedded		5
21	Sandstone and sandy shale	30 to 40	
22	Thin coal (reported)		0 6

"The upper bed of limestone (No. 18 of the county section) is traversed by veins of calcite and brown ferruginous streaks that give the rock a mottled appearance when freshly broken. The upper layer of the lower bed is about thirty inches thick and is a tough, compact, gray rock that breaks with an even surface and has a slightly granular or semi-oolitic appearance. The lower part of this bed is a mottled gray fine grained limestone and breaks with a more or less conchoidal fracture. The fossils found in the limestone here were *Athyris subtilita*, *Productus costatus*, *P. nebrascensis*, *Pinna peracuta*, *Spirifer cameratus*, *S. plano-convexus* and joints of *Crinoidea*. The upper division of this limestone thins out entirely about a mile above the bridge and passes into a green shale like that by which the limestones are separated.

"The following section is seen about one mile above the railroad bridge in the creek bluffs and adjacent hill tops:

Section One Mile Above the Railroad Bridge at Livingston.

		Feet.
14	Covered slope with tumbling masses of Quarry Creek limestone	20
15	Sandstone, upper part massive, with shaly beds below	40 to 50
16	Pebbly sandstone	8 to 10
17	Green clay shales, with a streak of coaly matter	21
18	Limestone, upper division of Livingston bed	3 to 0
19	Green shale	3 to 5
20	Limestone (partial exposure)	3

"The tumbling masses of limestone that are found in the hill tops hereaway no doubt belong to the Quarry Creek bed, which is found in partial oucrops not more than half a mile back from the creek and

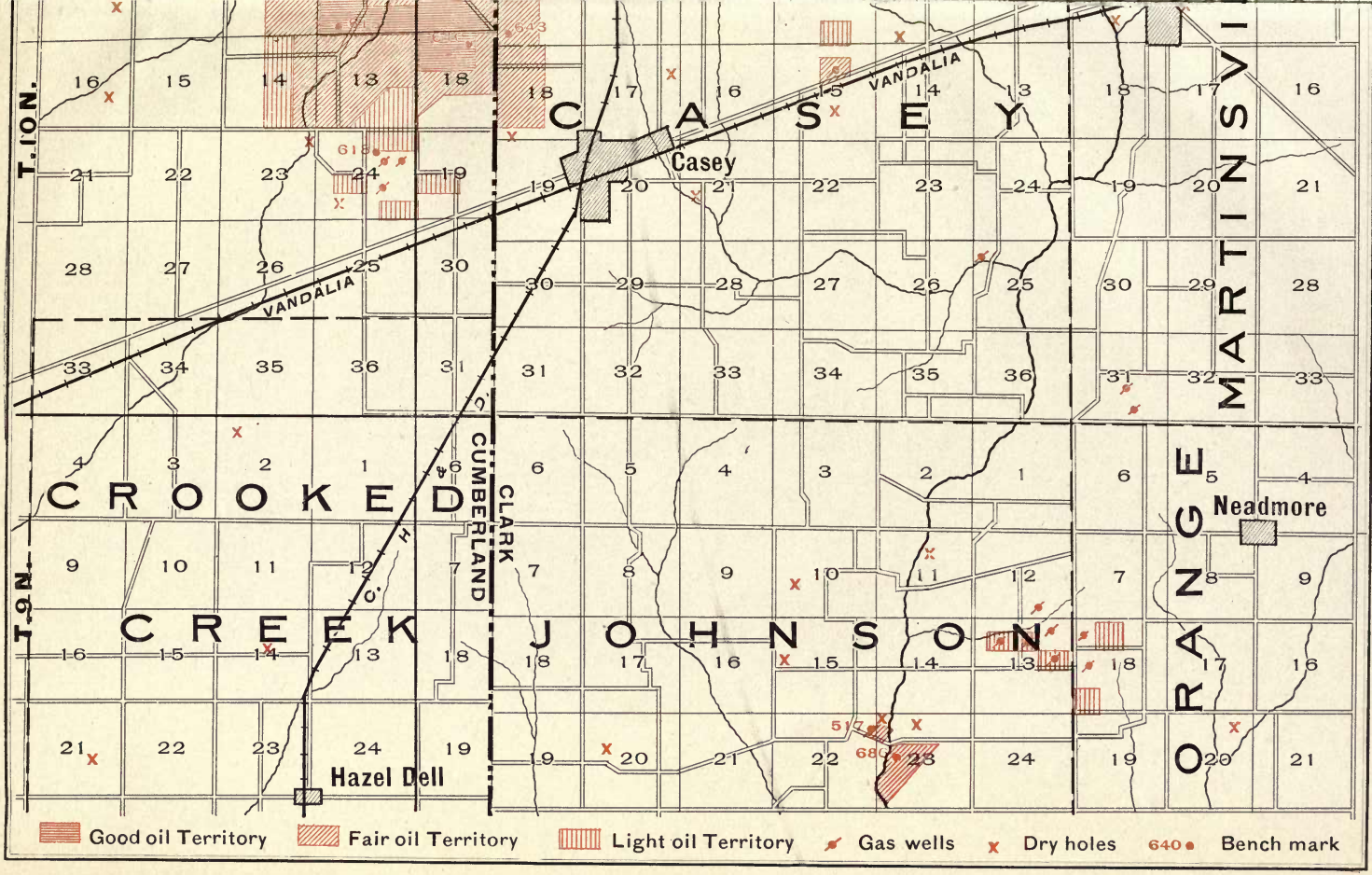
from eighty to ninety feet above its level. The intervening sandstones and shales which separate these limestones in the north-eastern part of Clark county are much thinner than where they outcrop on Hurricane and Mill creeks, in the southern portion, indicating a general thinning out of the strata below the Quarry Creek bed to the northward. Sometimes I have been inclined to believe that this upper limestone was unconformable to the beds below and its disappearance beyond Parker Prairie to the southwest, where the apparent trend of its outcrop would naturally carry it, seems to strengthen this conclusion, but the outcrops of the underlying beds are so partial and widely separated that it is difficult to determine this point satisfactorily. At any rate, the thickness of the beds between these limestones north of Livingston does not exceed seventy-five or eighty feet, while south of Martinsville they are from 125 to 150 feet apart, at least, showing that they thin out rapidly to the northward. The upper division of the Livingston limestone can be seen to thin out entirely about a mile north of the railroad bridge northwest of Livingston, and the other division must also disappear before reaching Edgar county, as Professor Bradley failed to find it there, as will be seen in his report on that county. The Quarry Creek limestone is undoubtedly the same bed described by him as No. 3 of his Edgar county section; and if the Livingston beds extended into that county they would be found not more than sixty to seventy-five feet below his No. 3. Possibly this lower limestone may be represented there by his No, 11, which is described as a 'sandy argillaceous limestone, containing pebbles of black limestone and fragments of fossils,' as we have nothing in Clark county that can be correlated with that unless it is one or both divisions of the Livingston limestones. The distance from his No. 3 down to coal No. 7 he makes from 185 to 250 feet, while in Clark county the distance from the limestone on Quarry Creek to this coal is from 350 to 400 feet."*

OIL WELLS.

First wells of the present Casey oil field—In 1903, Col. L. D. Carter, of Oakland, Ill., who was familiar with the early attempts to secure oil near Oilfield, Clark county, laid the facts concerning those attempts before Mr. J. J. Hoblitzell & Son, prominent oil operators of Pittsburgh, Pa., and finally induced them to test again, with modern methods of drilling, the territory about Oilfield. After leasing a large acreage, the first bore was drilled on the Young farm, near Oilfield. In April, 1904, it had reached a depth of 1,400 feet. Both oil and gas were found, but the oil was limited in quantity and was shut off, while gas from the bore has since been used in drilling many additional wells.

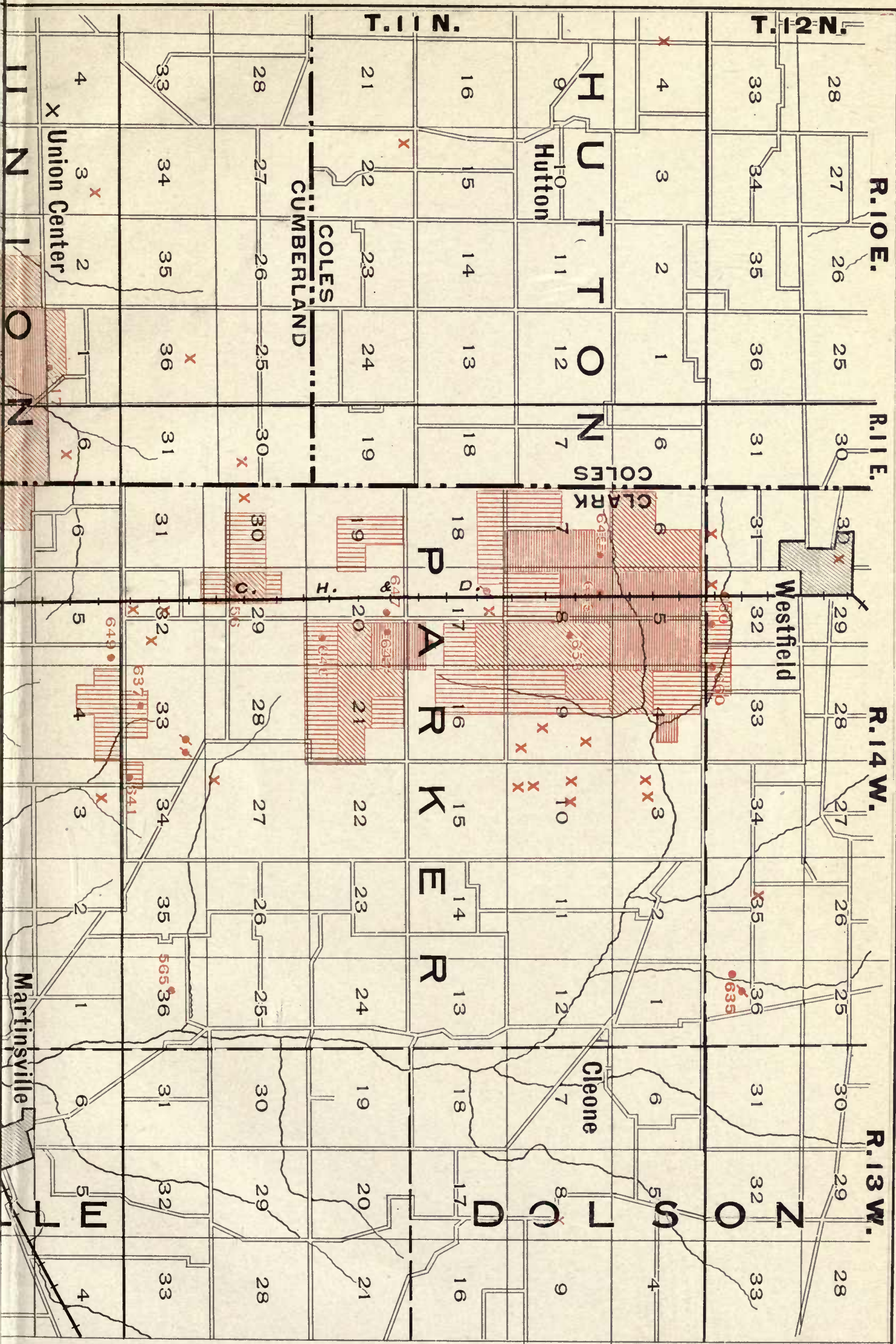
A second well was soon located on the J. S. Phillips farm, in the northeast quarter of section 18, Parker township. It was completed and shot on Oct. 20, 1904, its initial production being thirty-five barrels of oil per day. From that day to the present the Casey field has been in active operation.

*Loc. Cit. pp. 15-17.



ILLINOIS GEOLOGICAL SURVEY.

The Clark county oil



ds. Scale 2 miles to the inch.

Westfield township—This civil township corresponds to the lower half of congressional township 12 north, 14 west, comprising sections 19 to 36. The town of Westfield, in sections 29 and 30, is situated on a morainic ridge which rises fifty or more feet above the level plain to the south, on which most of the wells of the Parker township field are located. It is only along the north border of this plain, near the south line of the township, in sections 32 and 33, that oil in commercial quantities has been found in the township.

A bore on the White lease, in the southwest quarter of section 20, developed a big flow of salt water in a limestone at a depth of 475 feet. Just above the regular oil bearing stratum, said to have been struck at 440 feet, there was a "white sand," 25 feet in thickness. Only a light show of oil was found.

On the southwest quarter of the northwest quarter of section 24, a dry hole was also drilled, the top of the sand* being found at 353 feet.

A third dry hole was drilled in the town of Westfield, in the northeast quarter of the southeast quarter of section 30, in which a barren black sand was found at 509 feet. Still another dry hole was drilled on the edge of the plain in the southwest quarter of the southeast quarter of section 31, the sand being found at 340 feet. No record of the amount of drive pipe or thickness of drift of these four dry holes was obtainable, hence it is impossible to locate the stratum in which the drill stopped.

A number of light producers have been drilled on the Endsley, Barlow and James farms along the south line of section 32. On the Barlow farm of twenty acres the No. 2 bore in the northeast corner had the following record:

	Feet.
8 -inch drive pipe	52
6¼-inch casing	215
4⅞-inch casing	333
Top of sand	333
Total depth	396

The sand was penetrated 30 to 35 feet before striking oil, and the oil bearing sand continued to the bottom. Another bore on the Endsley farm developed gas at 321, oil at 331 to 337, and stopped in a shale at 392 feet, the cover of drift being about the same as in the preceding.

Six or seven light wells which are farther east than any other producers in Westfield township, are located on the S. James lease, in the southwest quarter of section 33. A record of No. 4 showed:

	Feet.
8 -inch drive pipe	51
6¼-inch casing	308
Top of sand	320
Total depth	387

A black shale here overlies the sand. The above records show that the oil producing limestone dips to the west from this point, at the rate of about 15 feet to the mile.

No drilling has been done in section 34. In the east half of the northwest quarter of section 35, a dry hole on the Cornwell lease found the top of sand at 378 feet; the elevation and thickness of drift

* Unless otherwise mentioned, the term "sand" in this field denotes the gray limestone producing oil in Westfield and Parker townships.

not being known. On the J. Bennett lease, near the center of section 36, the drift was 160 feet in thickness. At 258 feet a supply of gas sufficient to pipe several houses was developed. The oil bearing limestone found at 440 feet, was hard, non-porous and barren. The bore was continued to a depth of 540 feet, where a salt-water sand was encountered. No records of coal veins were obtained from any of the wells drilled in Westfield township.

The dry holes mentioned as having been drilled in sections 20, 24, 35 and 36 have stopped farther developments in the northern and eastern parts of the township. As no surface levels were run, it is possible that only the upper limestone, No. 18, was reached in some of the bores.

Dolson township.—This civil township lies east of Westfield and the north half of Parker townships, and embraces the south half of congressional township 12 north, 13 west, and the north half of 11 north, 13 west. No oil is being produced within its bounds, and as far as can be learned, but two bores have been drilled. One of these, a dry hole, on the southeast quarter of the northeast quarter of section 8, is said to have passed through a seven foot vein of coal just above the oil sand, the latter being struck at 508 feet. This "coal" was doubtless the black shale No. 19 of the section. Another dry hole was finished near the north line of the township, on the southeast quarter of the northeast quarter of section 21, in which the sand was struck at 400 feet. These records, taken by Mr. Lewis, count for little, as neither the difference in elevation nor the thickness of the drift is known. One is by no means certain, therefore, that the "sand" belongs to the same stratum in both wells.

A third bore was recorded by Mr. Lewis as having been sunk on the Burns lease, four miles east of the east line of section 24, Dolson township, to a depth of 1,500 teet. No other record was available.

Parker township.—This civil township, corresponding to congressional township 11 north, 14 west, contains the most productive developed territory in the Casey oil field. During the month of April, 1906, 39 bores were completed within its bounds, all of which were productive. The total initial output was 1,265 barrels, an average of 32.5 barrells to the well, which is a most excellent record. All the oil in this township, except that from a few bores along its southern margin, is found in a grayish magnesian limestone. Under the glass, chunks of this stone shot from the well show numerous pores, and in some pieces cavities easily seen with the naked eye appear, which are lined with crystals of quartz and iron pyrites.

The principal production is in the west half of the township, the eastern half showing only a few light wells and a number of dry holes. The surface of the western half is, for the most part, a level prairie, occupying a wide valley which lies between the North Fork and the East Branch of Hurricane creek. The eastern half is more broken by the erosion of the tributaries of the North Fork.

No drilling has been done in sections 1 and 2 as two dry holes were sunk on the Houghton lease, in the southwest quarter of section 3, which, with the one in section 36, Westfield township, were held to condemn the northeastern corner of Parker township.

The eastern half of section 4 is undrilled with the exception of one bore on the Endsley lease, in the northeast quarter, which is a good producer. On the west half some light wells are located on the Lee farm and some better ones in the southwest quarter on the Fuller and Newlin leases. These wells started at 15 to 40 barrels each, but dropped down to three to five barrels in six months. In No. 10 on the Fuller lease, no sand whatever was found, but only "black mud" in its place, though the bore was located only 450 feet from a 75 barrel well. The operating company sold 80 acres of leases and nine producing wells to the Ohio Oil company in February, 1906, for $42,500.

Section 5 has yielded much oil, several of the best wells in the Casey field having been drilled within its bounds. One of the most productive leases has been that of the G. A. Fuller farm, in the southeast quarter, where it is said nine wells yielded 32 inches (80 barrels) a day for 18 months. The largest of these started at 180 barrels in October and was down to 25 barrels in February. The biggest well in the history of the field was on the D. Lee farm just to the north, having started in September, 1905, at more than 300 barrels. Much oil was wasted before it could be shut off after shooting with 100 quarts. A number of other good producers were drilled on the same farm.

These rich strikes caused farmers in the immediate vicinity to ask very high prices for leases. M. L. Briscoe received $8,000 bonus, or $222.00 an acre and one-sixth royalty for the oil rights on 36 acres of his farm in the west half of the section; the entire farm of 100 acres being leased for $14,000 and one-sixth royalty. It is claimed that the operating expenses are so low, on account of the shallow depth of the wells, that even at these prices, the producers will make money, provided the output is anything like the wells on the Fuller and Lee farms.

No. 3, on the south third of the Briscoe lease, had the following record:

	Feet.
Drive pipe	42
Casing	308
Top of sand	310
Total depth	370

The pay sand was eight feet thick and the well was drilled 60 feet below the top in order to shoot with a large shot and give room to form a pocket below the sand in which the oil could accumulate. Nine wells were bored on the central 36 acres of the Briscoe lease by the Barnsdall Company. Six of these connected with the power and pumping on May 10th were said to be making 500 barrels a day.

On April 20, 1906, three drills were operating on one 40-acre lease in the northwest corner of section 5. One, which was down to the top of sand, was drilled through 16 feet of sticky black bituminous shale (No. 19 of the county section). This shale is said to run 5 to 18 feet thick above the sand in this section. The operator, on being asked why so many drills were operating on so small a track said: "The pool is like a big bowl of soup, and the sooner we get our spoons in the more we will get. It will not last long and we want our share."

The northeast quarter and the south half of section 6 contains a number of fair wells, while the northwest quarter is undrilled. On the A. Biglow farm, in the south half, No. 5 well had the following record:

	Feet.
Drive pipe	42
Casing	296
Top of sand	296
Total depth	352

One or two dry holes have been drilled on the northwest quarter of section 7, but the east half has yielded some good producers while the southwest quarter is light. The W. L. Briggs farm of 80 acres, with seven wells, was sold in February for $36,000.

No, 13 bore on the Spelbring lease in the northwest quarter of the northeast quarter showed:

	Feet.
8 -inch drive pipe	30
6¼-inch casing	165
4⅞-inch casing	305
Top of sand	305
Total depth	355

The oldest well on this lease started at twenty barrels in December 1904, and is still producing.

In the northwest of section 8, No. 8 bore on the Spelbring farm, had the following record:

	Feet.
8 -inch drive pipe	45
6¼-inch casing	160
4⅞-inch casing	255
Top of sand	265
Total depth	299

This well is three-quarters of a mile east of the one last mentioned. As noted, the top of sand dips west 40 feet in that distance. The eastern well with the higher sand is much the better producer. According to Mr. A. M. O'Donnell, the oil bearing limestone dips both north and west from a point near Oilfield, and the well records seem to bear out his statement.

On the Chas. Lee farm of 160 acres in the northeast quarter of section 8, sixteen fair producing wells have been drilled. The record of No. 15, near the northwest corner follows:

	Feet.
Drive pipe	35
Casing	260
Top of sand	297
First pay	317
Total depth	352

The pay sand was ten feet thick and the well was drilled in dry and shot, when it started at 25 to 30 barrels. A record of the production of the 16 wells on this farm for five days of the week of April 15, 1906, and of eight wells on the Detrow farm just to the south was as follows:

	Lee Farm. Bbls.	Detrow Farm. Bbls.
April 15	90	198
April 16	40	12
April 17	33	150
April 18	43	138
April 19	37	50

This shows the Detrow wells to be much the better producers, but they have been pumped a shorter time. Both leases are owned by the Ohio Oil Company and the 24 wells are pumped with one 25-horse power gas engine.

In section 9 are found the most easterly producing wells in Parker township. One of them, No. 1, on the A. B. Reeds place, had the following record:

	Feet.
Drive pipe	20
Casing	200
Top of sand	310
Total depth	322

Another bore on the northwest quarter of the northwest quarter of section 9 showed:

	Feet.
Drive pipe	60
Top of sand	335
Total depth	460

No oil was found below 370 feet. Two or three dry holes have been drilled on the east half of the section.

Three or four bores sunk in the west half of section 10 have proven dry. One of them, on the N. P. Daugherty farm, in the northwest quarter, showed:

	Feet.
Drive pipe	90
Casing	320
Top of sand	365
Total depth	377

Sections 11 to 15, and the east half of 16 are undrilled, while only a few light wells have been completed on the west half of 16.

It was on the Young farm, in the south half of section 17 that the first bore was sunk in the Casey field. It was put down to a depth of 1445 feet, and a partial record of it obtained by Mr. Lewis is as follows:

	Feet.
Top of sand	279
First oil	284
Bottom of limestone	750
Shale and slate	750–1,050
Sandstone	1,050–1,070
Shale	1,070–1,075
Sandstone	1,075–1,087
Black shale	1,087–1,185
Sandstone	1,185–1,287
Show of oil	1,287
Bottom of well in shale at	1,445

As already noted, this well yielded quite a quantity of gas and but little oil.

Several fair wells have been brought in in the northeast quarter of the section, one of which showed:

	Feet.
Top of sand	298
Gas at	302
Oil at	302-336
Total depth	356

thus denoting a dip northward from this point. Only the northern third of section 18 has been drilled, the eight or ten well thereon being light producers.

In section 19 the No. 1 Heach, in the northwest quarter, was a dry hole, its record being:

	Feet.
Drive pipe	44
Casing	264
Top of sand	324
Total depth	382

The east half of the section has only a few light wells to its credit.

That portion of the north half of section 20, east of the Cincinnati, Hamilton & Dayton railway, comprises some of the best territory in the field, while the south half is much lighter. On the Hollis lease of forty acres just east of Oilfield, there were twelve wells making nearly a tank a day on April 20th. The top of sand is said to have been uneven, varying from six to ten feet in depth in a number of the bores. The average well starts at seventy-five barrels. On the Jeffries farm just to the west, No. 8, finished April 11, started at eighty barrels and has the following record:

	Feet.
Drive pipe	41
Casing	297
Top of sand	294
Total depth	352

A public road separates the two farms, and the rival companies were "bucking the line," two wells being drilled opposite each other and not more than seventy-five feet apart; one of them within two and a half feet of the road line and the other but four feet distant from that line on the other side. One of the wells was drilled in thirty-six hours, a record time for the field. Five feet of nice coal (more likely black shale) was said to have been struck in most of the wells on the two leases at a depth of 140 feet.

The No. 2 bore on the Kelly-Nye lease in the northwest of the southeast of 20, had the following record:

	Feet.
Drive pipe	40
Casing	180
Top of sand	308
Total depth	403

Two streaks of pay sand were encountered, one five feet thick eight to thirteen feet in, followed by a hard streak fifteen feet or more thick, then a second pay, eight feet thick and better than the first.

On the I. N. Terrell farm of 100 acres, south half of the southeast quarter, eleven wells have been drilled, of which one was dry, the others light. The average well showed:

	Feet.
Drive pipe	40
Casing	240
Top of sand	297
Total	356

Section 21 is light to fair territory, with more or less gas. The northeast quarter is undrilled. On the Murphy farm, in the southeast quarter, the average of three bores showed:

	Feet.
Drive pipe	30
Casing	260
Top of sand	282
Second pay	318
Total	343

The oil is said to be found in a white sand; the wells starting at about fifteen barrels each. No limestone pay was encountered. On the lease to the north but one pay streak was found, and it was a brown limestone.

Sections 22 to 28 inclusive are undrilled with the exception of one bore on the southwest of 27 which was dry, the sand being struck at 400 feet.

On section 29 the only production is on the west half. An old well drilled in 1866 was located on the Briscoe lease. At present the same lease, on the southwest quarter of section 29, has eight producing wells. No. 1 in the southwest corner, showed:

		Feet.
1	8-inch drive pipe	40
2	First fresh water	180
3	First gas sand	270
4	Bottom of gas sand	285
5	Top of "coal"	304
6	Bottom of coal	310
7	Shale with gas	333
8	Top of "oil sand"	366
9	Showing of oil	377-383
10	Total depth	401

The bore was shot with 100 quarts and started at about four barrels, being the lightest well but one on the lease. The "coal," No. 5 of the section, is probably mostly a black shale, and doubtless corresponds to No. 19 of the county section.

This lease, operated by Bayliss, Haskell & Co., was visited on April 20, just at the time the No. 8 bore was being completed for shooting. Samples of the sand from just above the oil pay, at the most productive portion of the pay, and below the pay, were taken for examination and analysis.

Drillings from just above the pay, at a depth of 361 to 365 feet, showed under the glass as angular fragments of a grayish close-grained limestone, with crystals of calcite, iron pyrites, and particles of shale intermingled. Drillings from the best pay, 380 to 385 feet, were much darker in hue, due to the brownish discoloration by the oil. Under the glass they resemble a miniature mass of water worn gravel, the fragments being rounded instead of angular, and loosely cemented in small bunches. Less pyrites and no shale were visible. The layer below the oil pay was more like that from above, the fragments being angular as there, though darker in color. An analysis of the three samples, by F. F. Grout, assistant chemist of the Survey, showed their composition to be:

Analyses of Samples of Drillings from Well No. 8, Briscoe Lease, Southwest Quarter Section 29 (11 N., 14 W.) Parker Township, Clark County, Illinois.

	Above best pay 361-365 feet.	In best pay 380-385 feet.	Below best pay 395-400 feet.
Calcium carbonate ($CaCO_3$)	46.38	51.38	55.16
Magnesium carbonate ($MgCO_3$)	20.69	28.76	17.64
Iron oxide and alumina ($Al_2O_3+Fe_2O_3$)	10.93	3.71	2.47
Insoluble	21.69	11.45	24.47
Totals	99.69	95.30	99.74

The higher percentage of iron oxide and alumina in the portion from above the sand is due to the admixture of particles of shale from above. The analyses show that the best or most porous portions of the rock are those containing the highest percentage of magnesia; i. e. the ones which are most dolomitic in character. This is also true of the producing portions or pay streaks of the Trenton limestone of Indiana. These dolomitic portions or streaks were probably formed in or about shallow pools in the old sea bottom in which the limestone was laid down. The water in those pools became in time very briny, and caused a chemical change in the rock, more magnesia from the brine taking the place of some of the calcium carbonate of the lime rock. Wherever this change took place, which was only in the shallow briny pools mentioned, the resulting dolomitic portion was very porous. This increased porosity was due to the fact that the new crystals of dolomite were smaller than, and never entirely filled the spaces occupied by the older crystals of lime carbonate. The larger areas of the limestone deposit were either too pure to admit of a change into dolomite, or the condition of sea level were never such that the change took place; hence they are non-porous and barren of either oil or gas.

In places, where a second pay streak occurs in the limestone below the first, it is separated from it by a bed of unchanged, non-porous limestone. This alternation of dolomite and limestone strata is probably due to changes in conditions at the time the limestone was being transformed into dolomite. Wherever the limestone assumes its normal character and ceases to be dolomitic, it ceases also to be oil-bearing.

In some of the wells on the Briscoe lease, from which the above samples were taken, it is claimed that the oil "sand" or limestone runs forty to sixty feet in thickness, from twenty to thirty of which are pay sand. In No. 6 bore, near the north line of the lease operated by Bayliss & Haskell, there was no "porous sand" whatever at the usual depth, and only a thin stratum at 410 feet, while in No, 7, 320 feet south, there was a good pay streak at a depth of 375 feet. This shows the irregularity of the rock in this territory. Where the porous stratum is lacking it is usually replaced by a "broken limy slate."

A number of light producers have been drilled along the south line of section 30. In the north half of the southeast quarter of 30, a bonus of $25 an acre and one-sixth royalty was paid the Briscoe heirs for the oil rights. Six light wells and one dry hole have been sunk on the farm. Across the road, on the A. Lee farm, four or five light wells have been drilled, the average bore showing:

	Feet.
Drive pipe	84
Casing	346
Top of sand	363
Total depth	399

On the Ross Lee farm, just to the southeast, one bore was drilled in October which started at seventy-five barrels, but is now down to five or six. About twenty barrels are being produced daily from the

five wells on the two leases. A dry hole was bored on the Brown lease in the southwest corner the section and three or four small wells just to the east on the same farm.

No drilling has been done in 31, while in 32 three dry holes have been sunk. One of these, on the J. I. Barbee farm, showed:*

	Feet.
Top of first sand	355–360
Top of second sand	435–440
Total depth	575

The second sand produced a flow of salt water. The bottom of the hole was in brown sand. Several small producers have been drilled in on the Turner farm, south of the center of section 33. An average record shows:

	Feet.
Drive pipe	60
Casing	165
Top of sand	220
Total depth	306

The oil was here found in a sandstone, which is dirty brown in hue, due to discoloration by the oil. When washed, the grains of sand are white. A small piece of the rock in hand shows them to be cemented quite closely together, thus furnishing a good reason for the light output of the wells. It is probable that this is the lower part of stratum No. 12 of the county section.

An analysis of the drillings and of the sample of rock showed their constitutents to be as follows:

	Drillings.	Rock.
Calcium carbonate ($CaCO_3$)	1.05	0
Magnesium carbonate ($MgCO_3$)	.66	.78
Ferric oxide and Alumina ($Fe_2O_3 + Al_2O_3$)	1.51	2.12
Silica, etc. (Insoluble)	94.22	91.33
Totals	97.44	94.83

Two gas wells were also bored on the northeast quarter of this section, the top of the gas producing sand being found at 242 feet.

One of two light producers have been finished on the Kimlin lease in the southwest quarter of section 34. A record obtained from Mr. Lewis was as follows:

		Feet.
1	Drift and gravel	60
2	Flow of water in limestone at	94
3	Bottom of limestone	102
4	First gas in thin layer of sand	180
5	Second flow of gas	210
6	Top of oil sand	315
7	Bottom of oil sand	343

The limestones Nos. 2 and 3 of this section was doubtless the Quarry Creek limestone, No. 2 of the county section, the interval between the bottom of the drift and its top being filled with the sandstone of No. 1 of the county section.

No drilling has been done in sections 35 and 36 of Parker township.

Casey township—This civil township lies just south of Parker, and corresponds to congressional township 10 north, 14 west. The only

* Data by Lewis.

producing wells within its bounds on May first, were along the north border in section 4; on the west borders in sections 7 and 18 and between Martinsville and Casey in sections 10 and 15.

Outside of these sections dry holes have been bored in sections 3, 11 and 12, and a gas well in section 25.

The wells in section 4 produce oil from a white or grayish sand, somewhat similar to but finer than that on the Turner farm in section 33, Parker township. One of the bores, in the northwest quarter of the northeast quarter of section 4, has the following record.*

	Feet.
Top of first oil sand	303
Bottom of first oil sand	329
Top of second sand	390
Bottom of second sand	425

A visit to this field on April 20 showed one power on the Sloan lease, in the northeast quarter of section 4, pumping eight wells on six different leases, the total output of the eight being about twenty barrels per day. The wells are pumped only six or seven hours a day, the inflow of twenty-four hours being exhausted in that time. Samples of the cap rock above the producing sand on the C. Elliott place show it to be a very close, fine grained, micaceous sandstone.

The following partial record of the dry hole in the southwest quarter of section 11 was obtained by Mr. Lewis:

	Feet.
Broken sand	334
Broken limestone, 4¼ feet in thickness.	
Shale and coal	350
Oil sand (showing of oil)	401–421
Hard black shale	421–431
Hard limestone.	

A dry hole was drilled on the northwest quarter of the southeast quarter of section 15, the top of supposed oil bearing sand being struck at 307 feet. The rig was then moved onto the Deihl lease in the northeast quarter of the section. Here a bore was sunk which had the following record:

		Feet.
1	10-inch drive pipe	41
2	8-inch casing	125
3	6¼-inch casing	471
4	Top of first sand	471
5	Total depth	502

No "sand" was found at 307 feet or thereabouts, as reported in the well to the south. The Deihl well was shot with sixty quarts and was making twenty barrels a day at the end of a week. The producing rock was a loose white sand with scattering particles of iron pyrites. It was said to have been overlain with a cap of impure lime and sand, above which were "twenty feet of black shale." These facts, taken in connection with its depth, would bring it down to about No. 32 of the county section.

On the Johnson farm, in the southeast quarter of section 10, one-half mile north of the Diehl, the top of pay sand was struck at 470 feet, but here it had pinched down to a thickness of only 15 feet. The well was drilled 550 feet deep and got a big flow of salt water. This This was plugged off and the well is pumped from the 475 feet level,

*Data by Lewis.

but produces only three or four barrels a day. These two strikes in territory so far distant from other productive areas, caused much excitement in the vicinity, and on May 5th, T. N. Barnsdall paid $4,000 bonus and one-eighth royalty for 100 acres in the east half of the southeast quarter of section 15, adjoining the Deihl lease on the south.

A number of fair producers have been brought in on the Fuqua, Larue, and Emrich leases in sections 7 and 18, one and a half to three miles northwest of Casey. Some of these are said to have started at 150 or more barrels a day. The first one, drilled on the southwest corner of the Fuqua lease, was dry. These wells occur in the eastern part of the "Siggins pool," more fully discussed on a subsequent page. (Page 54.)

The dry hole on the Smith lease, in the southwest quarter of section 21, one and a half miles east of Casey, was drilled to a depth of 700 feet. Three thin layers of "oil sand" were encountered, but none with showing enough to justify pumping the well.

A bore on the J. Rush farm, in the northeast quarter of section 25, developed a gas well, with a capacity of about 1,000,000 cubic feet, at a depth of 490 feet.

Martinsville township—This civil township lies east of Casey and includes sections 4 to 36, inclusive, of congressional township 10 north, 13 west. No oil is being produced within its bounds, while but two or three bores are yielding gas and that in small quantity. Dry holes have been sunk on sections 7 and 8. In one of these, in the southeast quarter of section 7, just west of Martinsville, the top of the "sand" was struck at 440 feet. In the bore on the M. C. Rowe farm, in the northeast quarter of the southwest quarter of section 8, Mr. Lewis learned that the first rock struck below the drift was limestone, that a vein of coal seven to nine feet thick was encountered at 300 feet, and a second vein, five feet thick, at 350 feet, and that "sand" which contained a small amount of both oil and gas extended from 480 to 507 feet. Without knowing the thickness of the drift it is safe to say that the two "coals" represent Nos. 19 and 22 of the county section, with their accompanying shales.

A small gas well was completed on the northeast quarter of the southwest quarter of section 21, the gas sand being found at 315 feet.

Two wells yielding a small supply of gas have been drilled on the southeast quarter of section 31, in the southwest corner of the township. Concerning the northern one of these, Mr. Lewis gathered the following record:

		Feet.
1	Drift	125
2	Gas at	275
3	Salt water at	285
4	Top of "sand"	324
5	Bottom of "sand"	357
6	Second oil sand	456
7	Gas at	460
8	Total depth	483

The bottom was in sandstone. A small showing of oil was obtained, in sands Nos. 4 and 6, but not enough to justify pumping. The wells are at present shut in, awating a market for the gas.

Johnson township—This township lies south of Casey township and corresponds to congressional township, 9 north, 14 west. Some oil is being produced in its eastern half, but on account of a lack of pipe line facilities, most of the wells in which oil has been found are shut down. The country about the productive territory is rough and broken by the erosion of the tributaries of the North Fork, thus necessitating the hauling of supplies up and down numerous hills. The western half of the township is untested except by one dry hole in section 20.

A record of a dry hole on the M. Crouch farm, in the southwest quarter of section 10, was furnished by C. H. Hubbard, the contracting driller, as follows:

	Feet.
Drive pipe	82
Casing	None
Impure limestone at	503
Bottom of same limestone	563
Total depth	723

The bore ended in a black shale, and no oil, gas or salt water was found, Three veins of so-called coal were encountered, viz.: one, fourteen inches thick at nineteen feet; a second, four feet thick at 248 feet, and a third, six and a half feet thick at 425 feet. No limestone corresponding to that of the Casey-Westfield pool was encountered.

On the V. Bean farm, in the northeast quarter of section 11, a dry hole was also drilled, in which sand was struck at 292 feet and salt water at 402 feet. It is a difficult thing to determine just what is meant by "sand" in this section of the Clark county field. It is not believed that the contracting driller has any definite stratum which he starts out to find. If he strikes oil or gas, well and good. The stratum in which he finds it is dubbed "sand" and the driller of the next bore in the vicinity will try to find the same stratum. If oil or gas be not found, the drilling continues until a big flow of salt water is struck, or the operator thinks he has enough. The whole thing is a wild cat venture, and with meagre well records and few outcrops, the geologist is as much at sea regarding the nature of the sand as is the operator. He is only certain that the oil and gas is found in one of the numerous sandstone strata of the Upper Coal Measures. Which one, no man knoweth.

Seven bores have been sunk on sections 12 and 13. Two of these are gas wells, which in part supply the town of Casey with natural gas. Two are dry holes and the other three are light oil producers. One of the gas wells, on the J. W. Statler farm, in the southeast quarter of section 12, produces quite a quantity of gas and has a good showing of oil in a sandstone at a depth of 520 feet. Samples of the producing rock in hand show the grains of sand to be rather fine and angular, with sharp edges, white in natural hue, but discolored by oil, and so closely cemented that the visable pores under a glass are few.

The record of No. 1 bore, on the Bennett lease, in the northwest quarter of section 13, obtained by Mr. Lewis from the contractor, is as follows:

	Feet
First coal at	180
Second coal at	250
Third coal at	375
Top of oil sand	421
First pay streak	426
Bottom of sand	442
Second oil and gas sand	499
Bottom of second sand	510
Top of limestone	527–½

This is a small oil producer, and two others of the same nature occur on the eastern half of the section.

No drilling has been done on section 14, while the only bore on 15, on the Stewart lease in the southwest corner was dry. Its record follows:

	Feet.
10-inch drive pipe	26
8-inch drive pipe	93
Good flow of fresh water	124
6¼-inch casing	240
Brown sand	477
Bottom of brown sand	540
Total depth	568

A bore on the D. Baughman lease, on the west half of section 20, was sunk to a depth of 1200 feet, but developed only a plentiful supply of salt water.

The best oil producing wells of the township are in section 23, on the Weaver and Bennett leases. In the Weaver No. 1, drilled in May, 1905, on the northwest quarter of the section, an oil sand twenty feet thick was found at 421 feet. This well was shot with sixty quarts and has filled three tanks with oil, which are now on the ground. No. 2, 790 feet southeast, produced a large volume of gas and several tanks of oil, part of which was burned. A partial record of this bore shows:

	Feet.
Gas sand	385
Oil sand	421
Bottom of sand	439

W. W. Jamieson, of Clarksburg, West Virginia, who owned 8,000 acres of leases in this portion of Johnson township, and three producing oil wells and a gas well on the Weaver adjoining leases, is reported to have recently sold five-eighths of his interests in these holdings for $100,000 to Cochran and Funk, of Parkersburg, West Virginia.

The No. 1 Albright, 700 feet north of Weaver No. 1, was dry. Its record, as obtained by Mr. Lewis, shows:

	Feet.
Top of sand	290
Bottom of sand	320
Shale	320–428
Broken sand	428–430
Shale	430–469
Sannstone	469–472

On the J. P. Bennett lease, in the southeast quarter of section 23, two producing wells have been drilled, No. 71 starting at about seventy-five barrels. The rock first struck in them at a depth of fifty-seven feet from the surface, is a soft, grayish-blue, Carboniferous shale.

A test well on the A. Lane farm, 100 rods north of the Bennett No. 1, was barren, an abundant supply of salt water having been found at 505 feet.

Several gas wells in section 24 yield part of the gas used in Casey. One of these, on the Green lease in the northwest quarter, shows:

	Feet.
Drive pipe	101
Top of sand	524
Gas sand to	542

This well is said to have a rock pressure of 200 pounds and a capacity of 1,000,000 cubic feet per day. The best gas producing area found in Illinois to date is located in Johnson and Orange townships and in the northern third of Crawford county to the south. The dome of an anticline in the gas bearing stratum is doubtless here located. What stratum of sandstone it really is, the data at hand is not sufficient to say.

Orange township—This township, corresponding to congressional township 9 north, 13 west, lies just enst of Johnson. But five or six bores have been sunk within its bounds. One of these is on the C. M. Blakeman farm, in the southwest quarter of section 7. A partial record of its bore showed:

		Feet.
1	Drive pipe	81
2	First gas sand	390
3	Black shale	390–400
4	Limestone	400–405
5	Second gas sand	405
6	Bottom of second sand	510

A large volume of gas and a little oil was found. A second bore on the same farm developed a larger supply of gas. Both wells are now capped in, awaiting a market.

Of these wells, B. A. Kinney, State Gas Supervisor of Indiana, writes me, under date of May 10th: "I gauged the Blakeman wells with a 24-inch Pilot Tube and it would not hold the mercury, the wells being so strong that it was immediately blown out. I then put on a spring gauge, in which twelve pounds open flow is equal to twenty-four inches of mercury flow. No. 1 well gauged twelve pounds open flow on spring gauge through a four-inch casing, showing a volume of 9,783,836 cubic feet per day.

"No. 2 Blakeman, 1,200 feet south of No. 1, showed fifteen pounds open flow pressure through three-inch tubing, or 6,021,216 cubic feet per day. This flow was computed according to the Tobey Meter table as follows:

15 pounds on 1-inch pipe—27,876 cubic feet per hour.
12 pounds on 1-inch pipe—25,479 cubic feet per hour.
12 pounds on 2-inch pipe—25,479 x 4 cubic feet per hour.
12 pounds on 3-inch pipe—25,479 x 9 cubic feet per hour.
12 pounds on 4-inch pipe—25,479 x 16 cubic feet per hour.

NO. 1 WELL.

25,479 x 16=407,664 cubic feet per hour.
407,664 x 24=9,783,886 cubic feet per 24 hours.

NO. 2 WELL.

27,876 x 9—250,884 cubic feet per hour.
250,884 x 24—6,021,216 cubic feet per 24 hours.

The two Blakeman wells, one additional gas well and two small oil wells, together with 3,000 acres of leases, were recently sold to T. N. Barnsdall for $10,000. A franchise has been secured at Martinsville, and the gas will be piped there for domestic use.

One of the oil wells on the Newlin lease, in the northwest quarter of section 18, had the following record:

		Feet.
1	Drive pipe	40
2	8-inch casing	149
3	Coal	361
4	Top of first sand	365
5	Bottom of sand	378
6	Slate	378-386
7	Top of second sand	386
8	Bottom of second sand	406
9	Coal	414
10	Top of third sand	422
11	Total depth	439

Sands Nos. 4 and 7 were barren. The third sand at 422 feet had a good showing of oil in the first screw. It was shot before reaching the layer of sand in which gas is found in the Blakeman wells, but the yield is small.

An attempt has been made by one or two companies to secure a franchise from the city of Terre Haute, some 35 miles to the northeast, in order to pipe the gas thereto for domestic use. From the spotted nature of the territory in this region it is very doubtful whether such a franchise should be granted until a dozen or more good producing wells, some distance apart, have been drilled in. If that be done, the prospective consumer in the city would have something more substantial on which to base his hopes for a cheap and cleanly fuel.

A bore on the J. Nash farm, southwest quarter of section 18, developed a little oil and a small volume of gas. The well is said to have started at about ten barrels.

In the southeast quarter of section 11 a well was drilled to a depth of 1,136 feet. A partial record of its bore showed:*

	Feet.
Drift	60
Coal, 5-foot vein	320
First sand, fine gray	500
Bottom of first sand	532
Second sand, white water sand	700
Oil sand	940
Bottom of oil sand	960
Total depth	1,135

From 960 feet to the bottom were alternate strata, 5 to 15 feet thick, of shale and sandstone.

A dry hole on the northeast corner of section 20 developed a salt water sand at 700 feet and was abandoned at 735 feet. A bore on the southeast quarter of the northeast quarter of section 27 was also dry. An "oil sand" which contained no oil was here also struck at 700 feet and extended, still barren, to 748 feet, at which point the operator lost hope.

A dry hole was also bored on the Johnson farm, in the southwest quarter of section 31 in the extreme southwestern corner of the township. These bores show that Orange township contains some gas, but the oil outlook is not promising.

* Data by Lewis.

CUMBERLAND COUNTY.

GEOLOGY.

This county lies west of Clark and south of Coles counties, and comprises an area of 336 square miles. "The Embarras river traverses the county from north to south, and this river and its tributaries, are the only streams of any note within its borders. The central portion of the county along the river and its affluents is well timbered, while the eastern and western portions are mainly prairie.

"The surface deposits of this county comprise the alluvial bottoms of the Embarras and its tributaries, and a considerable thickness of gravelly clays and hardpan which increases in depth to the northward. In the southern portion of the county the drift deposits range from 20 to 40 feet in thickness, consisting mainly of brown or buff gravelly clays with numerous boulders; but to the northward this thickness is increased to 50 or 75 feet, the lower portion being a bluish-gray hardpan similar to that in Clark county.

"All the rock formations of this county below the drift belong to the Upper Coal Measures, and include the beds intervening between the Quarry Creek limestone of Clark county and the No. 15 or Shelbyville coal of Shelby county, making an aggregate thickness of 200 to 250 feet. No workable coal outcrops in the county, and for deep mining a shaft would have to be carried down from 600 to 1,000 feet to reach the main coals of the lower measures." *

The railway facilities of the county are good; the Vandalia Division of the Pennsylvania crossing its southeastern portion; the Illinois Central the central portion from north to south; while the T., St. L. & W. and the Illinois Central cut the northwestern corner. The elevation in feet above tide of the principal railway stations in the county are as follows: Greenup, 549; Jewett, 583; Neoga, 651; Toledo, 600; Vevay Park, 619; Woodbury' 584.

Oil in commercial quantities has as yet been found only in Union township in the northeastern part of the county. A number of bores have been sunk in Crooked Creek township, just to the south of Union, but so far all have proven barren. These two townships alone will be considered in the present connection.

OIL WELLS.

Union township—This civil township lies just west of Barker and Casey townships, Clark county, and comprises parts of six congressional townships, viz: Townships 11 and 10 north, ranges 11, 10 and 9 east. Townships 10 and 9 north, range 11 east comprise but a single row of sections lying adjacent to the Clark county line. This is due to a correction line running north and south on this meridian.

The oil producing area in Union township is known locally as the "Siggins Pool", as a large part of it was originally leased and the first wells sunk by a man of that name. He disposed of his holdings, about 600 acres of leases and six producing wells, to the Ohio Oil

* A. H. Worthen, in Vol. 6, Ill. Geo. Surv., pp. 98, 103.

Company for $135,000.00, the sale being made in February, 1906. The pool lies two to four miles northwest of Casey and forms an important part of the present Casey oil field. The surface is for the most part level, though cut in places by the smaller tributaries of Range and Lost creeks. No accurate record of bores have been kept, and it is not, therefore, possible to refer the oil bearing stratum to any one member of the Upper Coal Measures. During the month of April, 1906, thirty-five bores were drilled in the township, but three of which were dry. The total initial output of the thirty-two producing wells was 1,721 barrels, an average of 53.8 barrels per well, which is far above the average initial output for the same number of wells in most fields.

In the northern part of Union township, embraced within the congressional townships 11 north, 11, 10 and 9 east, there are no producing wells. A dry hole was sunk on the N. Wood lease, in the southeast quarter of section 30 (11 N., 11 E.), and a second one on the Schuyler farm, in the northeast quarter of section 36 (11 N., 10 E.)

In the southeast quarter of section 6 (10 N., 11 E.) a bore on the Stotts lease was also barren, as was one on the Reinbolt farm, in the northeast quarter of section 3 (10 N., 10 E.) In the latter bore a white salt water sand was struck at 300 feet, and "coal," five feet thick, at 420 feet. A second water sand was found at 560 feet, and continued to 604, when the hole was abandoned.

The Yanaway farm of 320 acres in the south half of section 1 and the north half of section 12 (10 N., 10 E.) was leased to the Jennings Bros., of Pittsburg, for $15,000.00 bonus and one-sixth royalty, though dry holes, above mentioned, had been drilled on three sides of it. The first bore on the lease started at twenty-five barrels. The same company paid $6,000.00 bonus and one-sixth royalty for the Emrich lease of eighty acres in the northwest quarter of section 7, Casey township.

The Siggins pool, as outlined by the drill up to May 10, covers an area of a little more than six square miles, extending from the middle of sections 7 and 18, Casey township, to the center of sections 11 and 14, Union township. It is thus about two miles wide from north to south by three miles in length. In this area the drift, while it has a comparatively level surface, varies much in thickness, a range of 40 to 160 feet, sometimes occurring on a forty-acre tract. The oil of the Siggins pool is found in a grayish or whitish sandstone, 25 to 60 feet in thickness, the top of which lies 320 to 410 feet below the surface. This sandstone rests upon a black shale, 10 to 18 feet thick, below which is sometimes found a blue shale and in other places a white salt-water sandstone. Above the producing sand there is in most places a close-grained blue shale, fifteen or more feet in thickness, which has served as an impervious cover to retain the oil. In other places a limestone about five feet thick lies just above the sand. In a number of wells two veins of "coal" are reported, one, three feet thick, at 160 to 170 feet below the surface; the other five feet thick about 300 feet below, and usually 20 to 40 feet above the sand. Where

this so-called coal exists a blue shale usually fills the space between the coal and sand, though it is sometimes replaced in its lower part by lime.

A number of good producing wells have been completed on the west half of section 7 and the north half of section 18 (10 N., 11 E.) One of these on the Kite lease, in the northwest quarter of section 18, had the following record:

	Feet.
Drive pipe	90
Casing	325
Gray shale	325–362
Top of sand	362
Total depth	427

This well was shot with 100 quarts and started at about eighty barrels.

Four bores have been sunk on the Chrysler lease adjoining, in the northeast quarter of the section. The records of Nos. 1 and 4 follow:

	No. 1—feet.	No. 4—feet.
Drive pipe	95	90
Casing	320	338
Top of oil sand	419	389
Bottom of oil sand	450	459
Shale to	500	472
Total depth	518	472

In both wells the "shell" or cap of the producing sand was a hard, impure nodular limestone, containing crystals of iron pyrites. This cap ran 3 to 5 feet in thickness and lay just below twenty or more feet of a close-grained blue-gray clay shale. The top of the producing sand in No. 4 below the cap was a micaceous sandstone, rather fine grained, and light gray in hue. The sand gradually became coarser, darker and more porous, up to 434 feet, where the best oil was found. The grains were here more rounded or less angular than above and below this point. At 439 to 444 feet it was still quite productive, but was much finer and lighter in hue. At 459 feet it became coarser and darker again, and at 464 feet had merged into a dark bituminous shale. In No. 1 well this dark shale, struck at 450 feet, was twelve feet thick and was followed by a blue shale in which the drill stopped at 518 feet. The casing in most of the wells in the Siggins pool is set on the streak or cap of lime or "shells" just above the pay.

When shot with 100 quarts No. 1, Chrysler made 117 barrels in eleven hours, and the four wells on the same lease averaged eighty barrels initial output. When the productive rock was struck it showed oil immediately. A bluish gray shale was the first rock encountered below the drift.

Three or four good wells have been completed on the Larue lease of eighty acres in the southwest quarter of section 7 (10 N., 11 E.) The records of Nos. 1, 2 and 3 show:

	No. 1. (feet)	No. 2. (feet)	No. 3. (feet)
Drive pipe	60	65	68
Casing	288	306	323
Top of sand	314	325	323
First oil	340	349	340
Bottom of sand	382	407	407

No. 2 was 600 feet east of No. 1, and No. 3 the same distance east of No. 2. It is said that a soft, bluish shale lies immediately above the oil sand and merges gradually into it.

Section 12 (10 N., 10 E.) is also a rich producing area. Two bores on the Dunn lease on the northeast quarter had the following record:

	No. 1. (feet)	No. 2. (feet)
Drift	140	156
Top of limestone	180	212
Coal and black shale	330	331
Top of sand	338	336
First oil	376	374
Total depth	412	405

The first rock struck was a shale, 140 to 156 feet below the surface. In these wells the limestone at 180 and 212 feet was evidently the Quarry creek limestone No. 2 of the Clark county section. From the top of this stone to the top of the sand was 158 feet. As the oil occurs in a sandstone immediately below a "coal," it is perhaps No. 15 of the Clark county section, which there lies beneath a hard, black shale approaching cannel "coal," 168 feet below the top of the Quarry creek limestone.

On the Haworth lease in the southeast quarter of the southwest quarter of section 11, were eight producing wells on April 20, which were taking 240 to 270 barrels per day. The records of No. 5 and No. 8, 1,400 feet west were as follows:

	No. 5. (feet)	No. 8. (feet)
Drive pipe	164	143
Casing	330	330
Top of sand	345	340
Best pay	376	380
Total depth	384	433

In well No. 1, on the same lease, the drift was 133 feet thick, and the top of the oil sand 315 feet deep; so that the sand runs pretty uniformly in this region about 180 to 185 feet below the top of the first rock struck in the bore, which would bring it near No. 15 of the Clark county section.

The pay sand in No. 1 bore is said to have run continuous from 337 feet, where the first oil was struck, to 395 feet, a distance of 58 feet. In No. 8 the bore was still in sand at 433 feet, but it was harder than where struck at 360, a distance of 73 feet. Nos. 15, 16 and 17 of the county section aggregate 58 to 75 feet. These might all be called sand by the driller. The best wells on the Haworth lease would, it is claimed, make eighty barrels per day when pumped separately.

Samples of the oil producing rock from the Haworth lease show a fine grained white sandstone, tinged brown with oil, and with occasional glistening scales of mica intermingled. An analysis by F. F. Grout showed its composition to be:

	Per cent.
Calcium carbonate ($CaCO_3$)	2.98
Magnesium carbonate ($MgCO_3$)	2.00
Alumina and iron oxide ($Al_2O_3+Fe_2O_3$)	3.17
Insoluble or silica (SiO_2)	89.08

On the lease just west of the Haworth, in the southwest quarter of the southwest quarter of section 12, there is said to be 84 feet of oil sand "resting on coal." When they strike this coal in this region they quit drilling, as below it salt water is usually found. This "coal" is probably, like all others in the region at that horizon, a black shale.

Only the east half of section 11 has been drilled. Here the top of the sand occurs at 363 feet, while the oil is found at 409 to 415 feet, and the wells start from 15 to 40 barrels each. There is no production west of this point.

To the south, in section 14, a well which had but a very little show of oil was drilled on the Lancet farm, its record being:

	Feet.
Drive pipe	152
Casing	509
Top of sand	509
Total depth	551

This was the most westerly well in the Siggins Pool on May 10th. One or two good producers have since been finished on the Lacey farm to the east.

In section 13 the best wells have been sunk on the Queen farm, in the southwest quarter. Here in No. 1 bore the drift was 100 feet thick and the top of the sand 330 feet below the surface. The sand was 67 feet in thickness and below it was a carbonaceous shale, according to notes by Mr. Lewis. In No. 2 it was 50 feet through drift to a soft slate rock; to top of sand 292 feet. Total depth 384 feet, or 92 feet in sand.

On the Carpenter farm, in the northwest quarter of the northwest quarter, the top of sand was 330 feet down, and it was 64 feet thick. The majority of the wells in this section are only fair producers.

A dry hole was sunk on the northeast quarter of section 23, in which no sand whatever was found until a depth of 630 feet was reached, when a salt water sand was encountered. "Coal" six feet thick was found at a depth of 420 feet.

Several gas wells and one or more dry holes have been bored on section 24. One or two fair oil wells have also been drilled on the north half of the northeast quarter of the section; the 80 acres having

been leased to the Ohio Oil Company for $7,000 bonus and one-sixth royalty. A bore on the S. Rooks farm, in the south half of the northeast quarter had the following record:

	Feet.
Drive pipe	85
Casing	340
Top of sand	517
Total depth	536

This was quite a gas producer, the output from this and neighboring wells being used as fuel for drilling and pumping many of the bores in the Siggins Pool. The Ohio Oil Company charged $30.00 per well for fuel sufficient for drilling. The contracting driller pays for his own fuel and receives $1.00 per foot for his work.

Another gas well, 540 feet in depth, on the northwest quarter of the southeast quarter of the section, struck gas sand at 515 feet and a second layer at 525 feet, a thin layer of shale intervening. An oil well which started at about four barrels was drilled on the Miller farm in the south half of the southeast quarter of section 24, the producing sand being found at 490 feet. Another bore on the southwest quarter developed one layer of "sand" at 342, and the second or "gas sand" at 525 feet, but both were barren. Two small oil wells were later bored on the northeast quarter of the southwest quarter.

In section 19 (10 N., 11 E.) a small well has been sunk on the Gosset farm, in the north half of the southwest quarter. The top of sand was struck at 455 feet, and oil encountered seven feet lower. The oil sand went out at 470 feet, but the well was drilled to 492 feet, the underlying black shale being nine feet in thickness.

The above covers all the producing territory in Union township to May 10th. Several dry holes have, however, been drilled. One of these in the southeast quarter of section 16 had a record as follows:

	Feet.
Top of sand	320
Bottom of sand	370
"Coal"	444
Pebble sand	450
Total depth	721

Another dry hole is located on the southeast quarter of section 9, one-half mile south of Union Center. It showed:

		Feet.
1	Drive pipe	100
2	Limestone shell at	220
3	Top of sand	390
4	Bottom of sand	420
5	Limestone shell	620
6	Total depth	670

The "shells," Nos. 2 and 5, are usually found just above the producing sand. Only a little rotten sand was found below No. 5 shell at 620 feet, while only one screw (5 feet) of the productive sand found at 390 feet, was soft and loose enough to have held oil.

A dry hole in the southeast quarter of section 30 (10 N., 10 E.), three miles northeast of Greenup, had a record as follows:

	Feet.
Drive pipe	80
Casing	420
White water sand	320
Second sand	445
Bottom sand	500
Salt water sand	574
Bottom of water sand	580
Total depth	607

Bottom in shale.

The usual producing sand, struck at 445 feet, contained neither gas, oil nor salt water.

Crooked Creek township.—This township lies south of Union and west of Casey and Johnson townships, of Clark county. All bores sunk in it to May first were barren. In one of them, on the Tutewiler farm, in the southeast quarter of section 32, (10 N., 10 E.) sandstone was reported to extend from 140 to 420 feet below the surface. An "oil sand," which was barren, was struck at 555 feet and extended to 575 feet, the bottom of the bore.

Another bore on the Thomas lease, in the north half of section 14, showed:

	Feet.
Drive pipe	39
Casing	283
Top of sand	380
Bottom of bore	634

Fifteen feet of barren sand were found. A third bore near Hazel Dell, on the southwest quarter of section 30 (9 N., 11 E.) was drilled in 835 feet and stopped in sandstone, its partial record being:

	Feet.
Drive pipe	93
Casing	247
Gas at	475
Salt water	700

Others were drilled on the southeast quarter of section 21, 764 feet in depth, and near Hidalgo on the southeast quarter of section 33 (9 N., 10 E.), 755 feet deep, but no other records were obtainable. A well which produced a large supply of excellent mineral water was drilled in section 8, Greenup township, near the town of Greenup.

A dry hole on the Dorsey farm, in the west half of section 7 (9 N., 10 E.), two miles southeast of Greeup, was finished May 5th, its record showing:

	Feet.
Drive pipe	52
Limestone	315
Fresh water sand	345
Casing	460
Casey "sand"—shells only	464
Salt water sand	515
Black shale	530
Limestone	540
Salt water sand	650
Total depth	664

CRAWFORD COUNTY.

GEOLOGY.

This county lies adjoining the Indiana line, south of Clark, east of Jasper and north of Lawrence and Richland counties. The surface of its area of 438 square miles is, for the most part, prairie or gently rolling upland. In the southern portion, in which the majority of the producing oil wells are located, it is more or less broken by the erosion of the streams tributary to the Embarras river, which runs diagonally across the southwestern corner of the county. Other water courses are the North Fork, traversing its western border from

north to south; Crooked creek, also in the southwest part; and Brushy Fork, Lamotte creek, Sugar creek, and some other small streams in the eastern portion of the county.

"The surface deposits of the county consist of buff or drab marly clays belonging to the loess, which are found capping the bluffs of the Wabash and attaining a thickness of ten to twenty feet or more and from twenty to forty feet of brown gravelly clays and hard pan, the latter resting upon the bed rock or separated from it by a thin bed of stratified sand or gravel. If these beds were found in a vertical section they would show the following order of succession:

	Feet.
Buff and drab marly clays or sands	10 to 20
Brown and yellow gravelly clays	15 to 20
Bluish gray hardpan	10 to 25
Sand or gravel	0 3

Generally these superficial deposits are thin in this county, and at most places the bed rock will be found within fifteen or twenty feet of the surface.

"The exposed stratified rocks of Crawford county, like those of Clark and Cumberland, all belong to the Upper Coal Measures, the lowest beds appearing in the bluffs of the Wabash river and the highest along the western borders of the county, and include the horizon of coals Nos. 11, 12 and 13 of the Illinois section."*

The following combined section of an exposure in the bluffs just below Palestine Landing with that of a shaft sunk 123½ feet deep in search of coal at that landing, give a fair knowledge of a portion of the Upper Coal Measure strata in the eastern part of the county:

Section of Bluff Exposure and Coal Shaft at Palestine Landing.

		Feet.	Inches.
1	Covered slope of loess and drift	15 to 20	
2	Shelly brown limestone with fossils	2	
3	Bituminous shale and thin coal No. 12	1 to 2	
4	Sandy shales and sandstone	45 to 50	
5	Bituminous shale with numerous fossils	2 to 3	
6	Coal No. 11	1	
7	Hard, dark gray bituminous limestone	2 to 3	
8	Shale	21	8
9	Coal No. 10	2 to 3	6
10	Fire clay	3	
11	Hard limestone	3	6
12	Sandstone	21	
13	Brown shale	6	6
14	Limestone with fossils	0	6
15	Gray sandy shale	2	
16	Limestone	0	8
17	Clay shale	1	4
18	Limestone	0	6
19	Sandstone and shale	38	6
20	Black shale	2	
21	Coal No. 9	0	6
22	Fire clay, not passed through		
	Total	186	2

"The shaft was sunk to reach a coal seam reported, in a boring previously made, to be four feet thick and at a depth of 123 feet. The bore was made about a mile and a half northwest of the shaft, and commenced fifteen feet below a thin coal which outcrops in the hill

*See p. 19

above. The bore was made for oil during the oil fever in 1865, and the shaft mentioned was sunk to the horizon of a coal seam reported four feet thick in the bore, but on reaching it in the shaft it proved to be two feet of bituminous shale and six inches of coal.

"Robinson is located on a sandstone deposit overlying all the rocks found in the bluffs at Palestine Landing, indicating a decided dip of the strata to the westward. When the demand for coal shall be such as to justify deep mining, the lower coals in this county may be reached at a depth of 400 to 600 feet. Their nearest approach to the surface is along the valley of the Wabash river and the depth would be increased to the westward by the dip of the strata and the elevation of the surface."*

The following detailed record of one of the bores for oil or gas made on the D. C. Jones farm, one and one half miles north of Robinson,† was furnished me by C. S. Jones of that town.

Record of Bore on D. C. Jones Farm, Southwest Quarter of Section 22 (T. 7 N., R. 12 W.)

		Feet.	Feet.
1	Soil	2	
2	Clay and sand	8	10
3	Sandstone	12	22
4	Shale ("soapstone")	42	64
5	Coal and black shale	2	66
6	Underclay ("gray shale")	4	70
7	Limestone	15	70
8	Shale	25	110
9	Water, sand	10	120
10	Gray shale	18	138
11	Dark shale (slate)	37	175
12	Light shale	15	190
13	Reddish shale	10	200
14	Light shale	8	208
15	Dark shale	12	220
16	Light sand rock	8	228
17	White shale ("clay"(	17	245
18	Dark shale	16	261
19	Light shale	14	275
20	Sandstone ("rock sand")	40	315
21	Brown shale	30	345
22	Black shale	5	250
23	Light shale	20	370
24	Brown shale	25	395
25	Dark slate	7	402
26	Dark lime	6	408
27	Light Shale	22	430
28	Hard lime rock	7	437
29	Dark hrown shale	10	447
30	Light shale	43	490
31	Dark shale	42	532
32	Coal	4	536
33	Fire-clay ("light shale")	8	544
34	Lime rock	5	549
35	Shale	8	557
36	Sandstone	18	575
37	Coal	2	577
38	Fire-clay ("rock")	5	282
39	"Slate"	10	592
40	Shale	8	600
41	Sandstone	27	627
42	Shale	8	635
43	Hard rock	4	639
44	Coal	2	641
45	Fire-clay	15	656
46	Sandstone	10	666
47	Shale	44	710
48	Sandstone	30	740
49	Brown shale	10	750
50	Gray shale	40	790

*A. H. Worthen in Ill. Geol. Surv., Vol. vi, pp. 23, *et. seq.*

†See p. 14.

Record of bore—Concluded.

		Feet.	Feet.
51	Black shale	40	830
52	Water sand (salt water)	40	870
53	Dark shale	35	905
54	Shale	55	960
55	Sandy shale (first gas)	10	970
56	Shale	30	1,000
57	Sand rock, white to brown	35	1,035
58	Shale	10	1,045
59	Sandstone	72	1,117
60	Dark shale with 16 in. vein of coal	7	1,124
61	Sandstone and sandy shale	40	1,164
62	Brown sand	10	1,174
63	Sandstone (second gas)	12	1,186
64	Sandstone	22	1,208
65	Shale	17	1,225
66	Limestone and shells	65	1,290
67	Limestone, hard, dark gray, crystaline	40	1,330

But little water was in the hole down to 1100 feet, but at that depth a heavy vein of salt water was struck in stratum No. 60, and another at 1170 feet in No. 63. Stratum No. 58 is said to be the oil bearing stratum of the Athey and other wells north of Robinson. When discolored by oil the sand is brown; otherwise white. Shale No. 57, lying between the first gas and first oil bearing strata, varies in thickness. In the Athey well it is said to have been replaced by nine inches of iron pyrites. The gas from stratum No. 64 came up through a bore nearly full of salt water, and burned eight to ten feet high for several hours.

OIL WELLS.

Prairie Township—This township lies in the northern part of the county and comprises parts of congressional townships 7 and 8 north, ranges 12 and 13 west. It has been recently formed by taking two and a half sections off of the east side of Licking township and three sections off of the west side of Hutsonville township as shown on the old maps. A number of bores have been sunk within its bounds, some of which are yielding oil, others furnish gas, while several were barren.

The first drilling was done on the W. F. Athey farm, in the west half of section 17, (8 n., 12 w.) in the summer of 1905. A partial record of the bore shows:

		Feet.
1	Lime rock	130
2	Red shale	430
3	Salt water	922
4	Top of gas sand	953
5	Good supply of gas	955
6	Second gas	970
7	Oil at	976
8	Total depth	978

A large amount of gas was developed which has since been piped to the town of Annapolis, two miles to the northwest. The well has not been shot, and the yield of oil is, therefore, slight.

Four other bores were soon put down on the east half of section 18, two of which yield gas and oil, one oil alone, while one, sunk to a depth of 1402 feet on the Emily Athey farm, in the northwest quarter of the section, is practically dry. A record of its bore from the top of the oil sand on, shows as follows:

	Feet.
Top of oil sand	963
Bottom of oil sand	988
Shale	988
Sandstone	998
Salt water in sand	1002
"Slate"	1036
Sandstone	1040
Salt water in sand	1050
Slate	1065
Coal, 5 feet thick	1105
Sandstone	1115
Slate	1110
Sandstone	1253
Slate	1377
Sandstone	1381
Limestone	1398
Total depth	1402

The limestone at 1398 feet is probably one of the Huron limestones, which underlie the Mansfield sandstone of the Coal Measures in western Indiana. There are three beds of these limestones, five to 30 feet in thickness, and two beds of alternating sandstone. It is in one of the latter that the oil occurs near Princeton, Indiana. But a small amount of oil was produced in the sand. The vein of coal at 1105 feet was probably black shale in part, and corresponds to the No. 61 of the Jones well section, found at 1124 feet. The presence of coal in these two deep bores, at a point below the oil producing stratum probably shows that the latter belongs to the Coal Measures or Carboniferous formation, and probably lies near the base of the Coal Measures just above the Mansfield sandstone or "conglomerate grit."

The two oil producing wells on the east half of the section yield about 10 barrels each when pumped. As there is no pipe line, the oil is stored in tanks.

Six or seven bores have been sunk on section 20, one mile southeast of the Athey wells. Three of these on the Cox farm, on the west half of the section, have flowed natural, without pumping, nine tanks up to date. Those on the Lyons farm to the west average 15 to 20 barrels each.

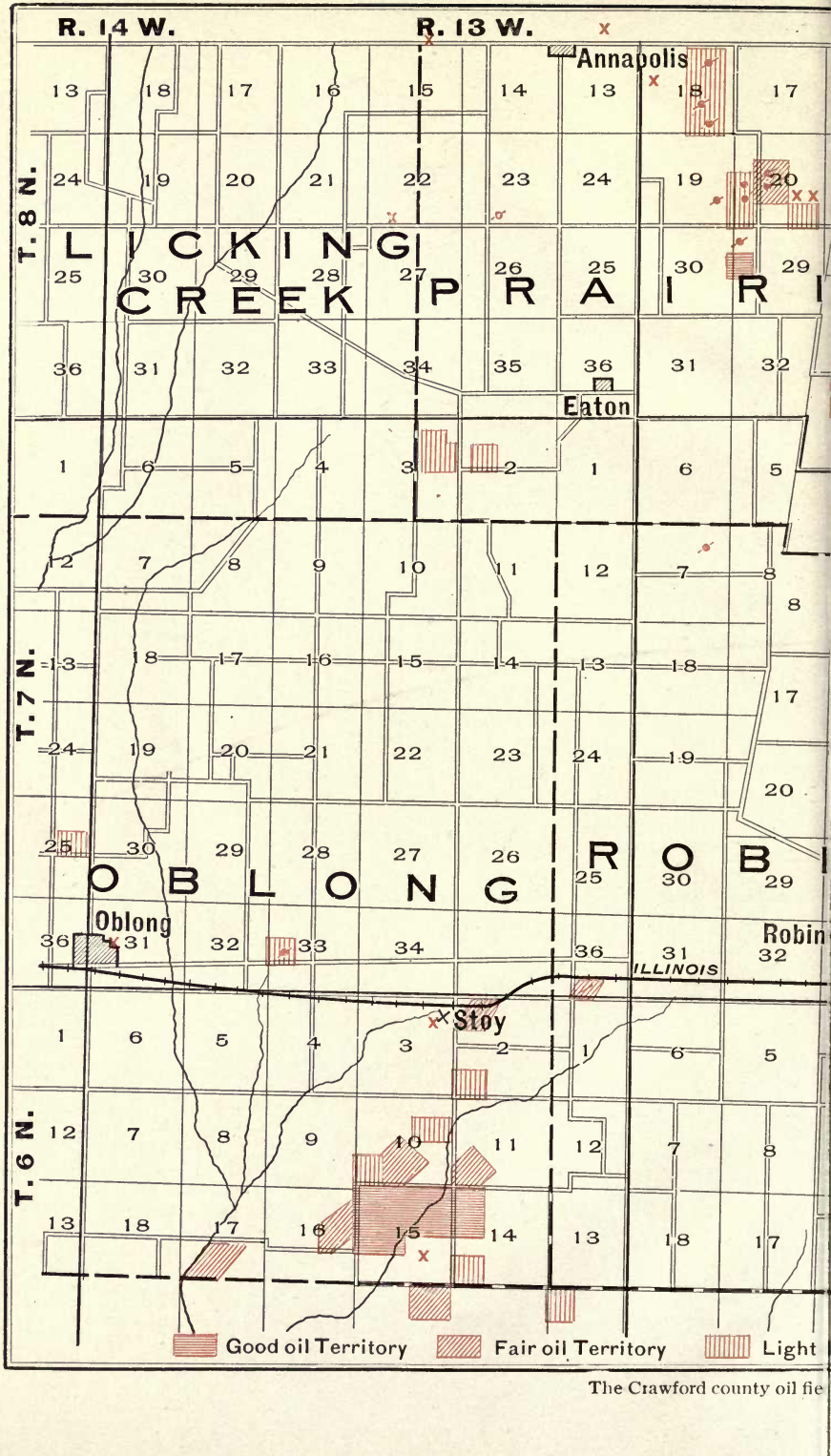
On the C. Newlin lease, in the southeast quarter of the section, the Ohio Oil Company has drilled in two light producers. The records of No. 1 show:

	Feet.
10-inch drive pipe	21
8-inch casting	603
6¼-inch casting	847
Top of sand	970
Total depth	1,004

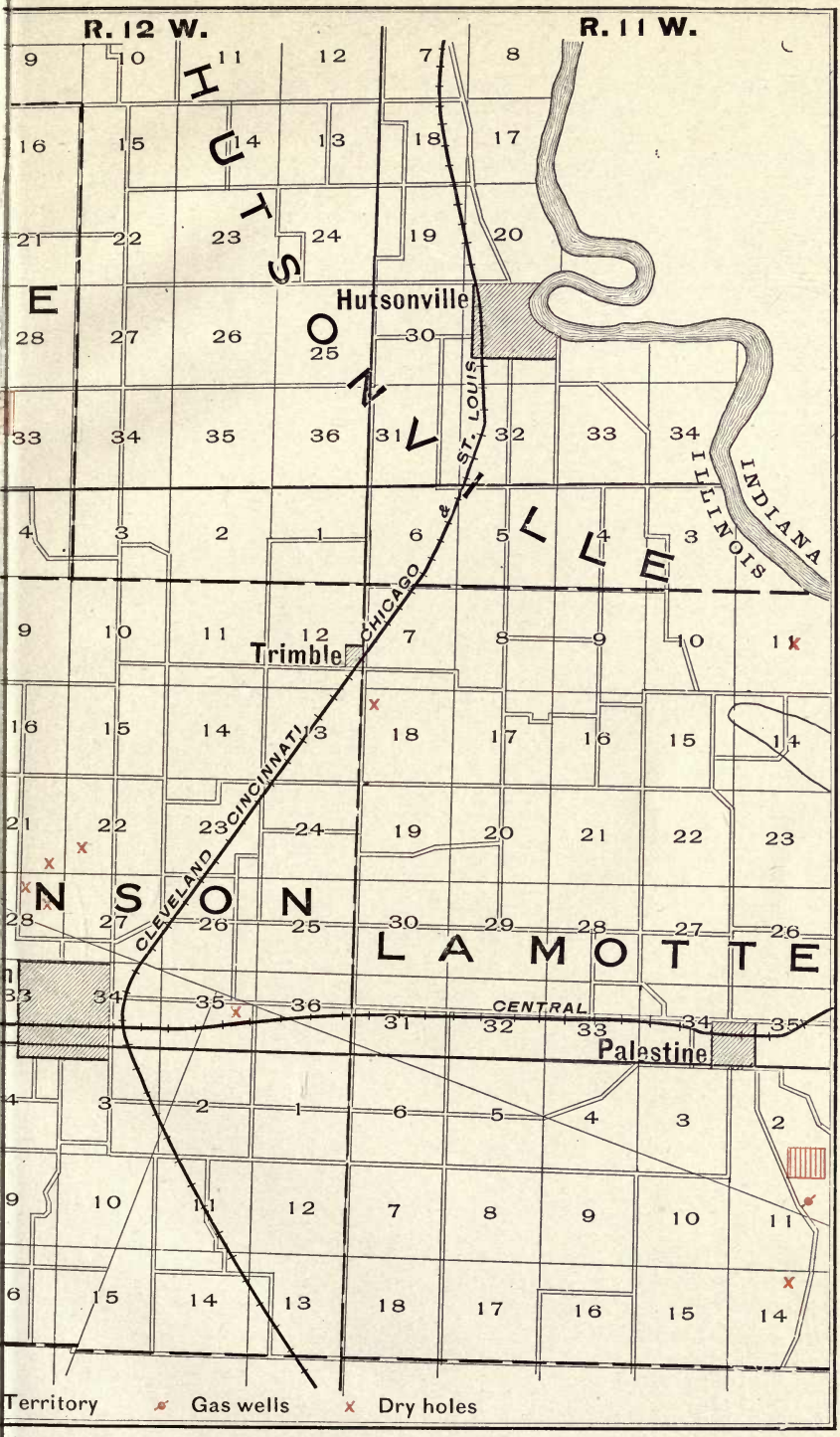
The oil is found in a light brown sandstone. No. 1, when shot and put to pumping, produced 25 barrels in five hours. No. 2 was practically barren.

A good gas well has been drilled on the C. M. Hill lease, in the northwest quarter of section 29, just south of the wells above mentioned. Its record shows:

	Feet.
10-inch drive pipe	28
8-inch casting	450
6¼-inch casting	940
Top of productive sand	947
Gas	957
Show of oil	947
Total depth	1,020



The Crawford county oil fie



Scale 2 miles to the inch.

The well was not shot. When packed it is said to have registered 280 pounds rock pressure. Bore No. 2 on the same lease was finished May 12, and is a good oil producer, yielding over 100 barrels the first day.

Two miles further southeast, in the northwest quarter of section 33, three bores on the H. M. Hill farm have each developed small oil producers. In No. 1 the top of the sand was struck at 1,011 feet and continued to 1,040. This well had a fair showing, but the casing was damaged in shooting, so that its real output cannot be gauged. No. 2, 600 feet south, found the top of pay sand at 1,000 feet and the bottom at 1,020 feet. It will yield 10 or 15 barrels per day when put to pumping.

The first bore sunk in that part of Prairie township formerly belonging to Licking, was on the Stanfield lease, in the southeast quarter of section 10, (8 N., 13 W.) in June, 1905. It struck a salt water sand at 820 feet, and was abandoned at 840 feet without having reached the productive sand afterward found in the bores to the east and south.

A bore on the Umstott lease in the northwest quarter of the southeast quarter of section 12, one mile northeast of Annapolis, was also barren, the sand being found at 925 feet and extending to 975 feet, at which point a strong vein of salt water was developed.

A dry hole on the Barrett lease, in the southwest quarter of section 22, just across the line in the Licking township, was sunk to a depth of 1,000 feet; while a light gas well was bored one mile east on the Joseph farm, in the southwest of 23; the top of sand showing at 800 feet.

Three miles farther south a bore on the R. Kenire farm, northwest quarter of section 2, (7 N., 13 W.) had the following record:

		Feet.
1	Top of rock	16
2	10-inch drive pipe	85
3	8-inch casing	570
4	6¼ inch casing	850
5	Top of sand	900
6	First oil	906
7	Bottom of pay	918
8	Black shale	918-965
9	White sandstone	965-995
10	Total depth	1,003

The bottom of the well was in black shale. Salt water was struck in quantity at 970 feet. The upper sand was shot with 20 quarts and a four-barrel well resulted.

The rig was moved 1,000 feet northwest, into the southeast quarter of the northeast quarter of section 3, where the top of sand was found at 914 feet, the pay streak running to 937 feet, where drilling stopped. The well was shot with 40 quarts, and shows up for a 20 barrel producer. A well of about the same capacity has also been completed on the A. Cain lease just to the north.

Lamotte township—This township lies south of Hutsonville and east of Robinson townships and embraces parts of congressional townships 6 and 7 north, 11 west. There is no oil produced within its bounds, but a number of bores have been sunk, whose records may be of interest to future operators.

The first drilling was done by the Palestine Development Company in the spring of 1904. This company put down a core drill in search of coal to a depth of 940 feet on the Patton farm, one and a half miles southeast of the town of Palestine. At 930 feet oil was struck in a close grained, light brown, micaceous sandstone. It was accompanied by salt water which filled up and flowed out of the hole. A Standard rig was erected and a hole bored 100 feet to the north. In this oil was struck at about the same depth. The well was shot with eighty quarts, collapsing the casing and allowing the hole to fill up with salt water, after which it was abandoned. A third bore, 250 feet south, resulted in a five barrel well.

In September, 1905, a bore was sunk on the John Richie farm, in the southwest quarter of section 25, one and a half miles northeast of Palestine, its record showing:

	Feet.
10 inch drive pipe	103
8 inch casing	415
6¼ inch casing	880
Top of oil sand	896
Through oil sand	959
Total depth	1050

Only a showing of oil was found, but a vein of salt water which flowed 100 barrels an hour over the top of the casing was developed.

On the Trimble lease, in the northwest quarter of section 18 (7 N., 11 W.) a bore was sunk in which the supposed productive sand of Hutsonville township was struck at 1020 feet, but proved barren. Salt water in abundance was found at 1961 feet and the well was abandoned.

A bore on the Goodwin lease, in the section 11 (7 N., 11 W.), four miles east of Trimble, was also dry, its partial record showing:*

	Feet.
Gas in white lime	505
Top of oil sand	936
Total depth	998

A large gas producer was drilled on the James Richie farm, two miles south of Palestine, in the northeast quarter of section 11 (6 N., 11 E.), a record of which shows:

		Feet.
1	10 inch drive pipe	44
2	8 inch casing	505
3	6¼ inch casing	840
4	Gas sand	485
5	Top of "oil sand"	936
6	Total depth	998

The gas found in No. 4 threw sand and rock over the top of the derrick for thirty-two days. There was but a showing of oil in the lower sand, and salt water was struck just before reaching the bottom. As the operating company was in search of oil, not gas, the well was plugged and abandoned.

On the Dickinson lease, three quarters of a mile southwest, on the northeast quarter of section 14, another bore was sunk in which the top of the "oil sand" was found at 946 feet. It was barren of oil, but developed salt water in quantity, and the well was abandoned at 1027 feet. No signs of gas was found at the level where it had been developed in the Richie well.

* Data by Lewis.

Robinson township—This township lies east of LaMotte and south of Hutsonville and Prairie townships, and embraces most of congressional township 7 north 12 west, and the north half of 6 north 12 west. A brief account of the first bores sunk near the town of Robinson has already been given.*

Oil in commercial quantities has as yet been found only in the southwestern portion of the township. A gas well which supplies in part the town of Robinson with fuel is located on the Price farm, near the northeast corner of sectson 7 (7 N., 12 W.) In it the gas producing sand was found at 1011 feet, the total depth being 1030 feet. The capacity of the well is about 2,000,000 cubic feet per day. It was bored in August, 1905 and gas was first piped to Robinson in January, 1906. About 200 meters are in use, the charge being 20 cents per 1,000 cubic feet.

In the southwest part of the township several bores have been sunk for oil since developments began in the Oblong township field to the southwest. The first of these was on the Walters lease, in the southwest quarter of section 36, three and a half miles west of Robinson. In it the top of the pay sand was struck at 902 and the first oil found at 904 feet. The well filled up and made several flows. At the time visited it had just been put to pumping and produced twenty-five barrels in twenty hours.

A bore on the Wm. Weirich lease, in the northwest quarter of section 24, resulted in a twenty barrel well.

A bore on the north half of section 29, Montgomery township, Crawford county, five miles east and four miles south of Robinson, developed a big supply of gas at 870 feet, and another at 910 feet. At 920 feet quite a spray of oil was blown out by the escaping gas, but not sufficient to justify pumping.

A dry hole was bored on the southwest quarter of section 5, near the station of Flatrock, and three miles south of the gas well above mentioned.

Oblong township.—This township, lying south of Prairie and west of Robinson townships, is the principal oil producing center of Crawford county. The first bore within its bounds came in as a good producer on Feb. 2, 1906, and since that date the work of the drill has been unceasing. The oil is found in a coarse grained, whitish sandstone at depths ranging from 885 to 920 feet below the surface.

A 10-inch drive pipe is used in the Oblong field to shut off gravel, sand and fresh water of the drift. It rests on the first rock, either shale or sandstone. An 8-inch casing shuts off all fresh water found in the layers of sandstone or limestone. A 6¼-inch casing is used to shut off salt water and caves in the shale above the oil sand. It usually reaches to within 50 or 75 feet of the oil sand and in some wells to its top.

During the year 1905, Anchor and Seybert, a Pennsylvania firm of operators, had secured leases on 20,000 acres of territory in southern Crawford county. In order to have some test wells put down for as little expense as possible, they granted the Minnetonka Oil Company the first half of each lease, for testing the field. This company sub-

* See p. 11

granted to Hughes and Finley 2,800 acres, provided they would sink two test wells, one on the Shire lease, in the northwest quarter of section 15 (6 N., 13 W.), six miles southwest of Robinson; the other on the A. M. Brown lease, in the northeast quarter of section 25 (7 N., 14 W.), one and a half miles north of Oblong. The Shire well was the first one drilled, its record showing:

	Feet.
10-inch drive pipe	26
8-inch casing	487
6¼-inch casing	800
Gas sand	830
Top of oil sand	885
Total depth	896

The oil began to flow as soon as the producing sand had been pierced two feet, and the well filled seven 250 barrel tanks by April 20th, without shooting or pumping.

A large amount of gas was also produced at 830 to 850 feet, the output being estimated at 1,000,000 or more cubic feet per day. This and gas from the No. 1 Birch well to the east, operated by the same company, is sold for drilling purposes in the field, a charge of $5.00 for each twenty-four hours' drilling being made.

This strike, like all others of importance in a new field, created much excitement among the oil fraternity. Scores of operators and lease brokers flocked to the field, and leases which had gone begging at one-eigth royalty a month before were soon commanding $30.00 to $40.00 an acre bonus, and one-sixth royalty.

Some difficulty was experienced in drilling the Brown well in section 25, and it was not completed until about April 20, though oil sand was reached in March. Its record showed:

	Feet.
10-inch drive pipe	119
8-inch casing	520
6¼-inch casing	910
Top of sand	1,004
Total depth	1,014

The well was first reported to have filled up and run over with oil, and this only added to the demand for leases. When finally finished and put to pumping it was only a three or four barrel producer.

Although the roads were in very bad condition, within less than a fortnight after the strike in the Shire well, a dozen rigs were building, and by April 1 the wells began to come in. As usual, some were dry, or nearly so, but the majority ranked from fair to good producers. As the depth to oil is over twice as great as in the Casey field, the time and money necessary to complete a well is correspondingly great. Instead of machines, as in the Casey field, Standard rigs are used, which adds much to the cost.

A bore on the York farm, in the southwest quarter of section 33, about half way between the stations of Oblong and Stoy, came in as a small producer on April 11th. A partial record of the strata passed through and the iron used is as follows:

		Feet.
1	Soil, clay and gravel	130
2	10-inch drive pipe	135
3	Water sand	300
4	Water sand	360
5	8-inch casing	400
6	Coal	420 to 425
7	Shale gas	600
8	Coal	670 to 676
9	Gray slate	775
10	Slate and shale	800
11	Brown sandstone	819
12	Oil and gas sand	816 to 835
13	Brown sandstone	855
14	Brown shale	864
15	Black slate	882
16	Gray sandstone	898
17	Black slate	926
18	6¼-inch casting	930
19	Oil and sand at	932
20	Salt water	945
21	Total depth	952

The upper sand, No. 12, made about two barrels of oil and quite a quantity of gas, but this was cased off. The well was not shot, and started to pumping 15 to 20 barrels of oil and as much or more salt water per day.

A bore on the Cornell lease, near the station of Stoy, near the northeast corner of section 3 (6 N., 13 W.), showed as follows:

	Feet.
10-inch drive pipe	89
8-inch casing	328
6¼-inch casing	750
First gas	865
First oil (showing only)	900
Second oil (showing only)	945
Total depth	1,008

Drilling was stopped when a big flow of salt water was encountered. The usual producing oil sand, found at 945 feet, was only seven feet thick.

On the A. Boa lease, one-half mile east of Stoy, a fair producing oil well, with a big supply of gas, was completed about May 10. A light producer was also drilled on the Dennis lease in the southwest corner of the same township.

In section 11, to the south, the only drilling that has been done is in the southwest corner on the Newlin lease, where a good well was finished about May 5, its record showing:

	Feet.
Drive pipe	41
8-inch casing	369
Coal—4 foot vein	465
6¼-inch casing	829
Top of sand	885
First oil	890
Bottom of pay sand	913
Total depth	942

The well, when shot, started to flow and yielded 100 barrels the first 24 hours. It is located less than one-half mile northeast of the Shire well.

In section 10, to the west, three bores were sunk previous to May 10. One of these, on the J. H. Lackey farm, in the southwest quarter, had the following record:

	Feet.
10-inch drive pipe	55–½
8-inch casing	436
Coal, 6 feet thick	460
6¼-inch casing	837
Limestone shell, 2 feet thick	862
Black slate up to	900
Top of oil sand	921
Gas	924
Oil	932
Bottom of oil sand	960

Samples of drillings from the producing rock show it to be a white coarse grained sandstone, with an occasional small piece of iron pyrites intermingled. The well filled up in 86 hours, and when shut in made several flows. About 15 feet of good pay sand was present.

A bore on the William Lackey lease in the northeast quarter was light, as was also one on the Imboden farm in the southwest quarter. The record of the latter shows:

	Feet.
Drive pipe	79
8-inch casing	408
6¼-inch casing	809
Top of oil sand	847
Bottom of oil sand	868
Total depth	951

No wells had been completed in the sections west of the Imboden up to May 10, but to the south and southwest there were a number. Of these the farthest southwest was on the Baldwin lease in the southwest quarter of section 17 (6 N., 13 W). Here the record showed:

	Feet.
Drive pipe	96
8-inch casing	390
6¼-inch casing	843
Top of sand	900
Oil to	914
Bottom of sand	925

The sand was overlain with a black, bituminous shale, and the well is said to be good for about forty barrels per day.

On section 16, to the east, a bore on the Mitchell lease, northeast corner, came in as a fair producer, the top of sand being found at 842 feet, and the best oil pay at about 888 feet. A shale lies between the gas pay and the oil pay in this part of the field.

Section 15 has proven the best in the Oblong field. A bore on the Riker farm in the northeast corner shows for a good well, while just to the east on the Walker lease is also a good one. In the northeastern corner is the Shire, the pioneer of the field. In No. 1 Walker, the top of sand was struck at 901 feet, and was 15 feet thick. The well flowed, without shooting, 90 to 105 barrels a day until two tanks were filled, and was then shut in. A good producer has also been completed on the Mann lease in the southwest quarter, but No. 1 Wakefield, just east, was dry at 1,040 feet.

The Birch farm in the northwest quarter of 14, one-eighth of a mile east of the Shire wells, has yielded two good producers, No. 2, one of the best in Crawford county, starting at 200 barrels. The record of No. 1 showed:

	Feet.
10-inch drive pipe	81
8-inch casing	450
6¼-inch casing	830
Gas sand	865
Shale	873-890
Top of oil sand	890

The top of oil sand was only penetrated a few feet when the well began flowing 23 to 30 barrels a day. It filled two tanks and was then shut in until pipe lines were available. A vein of coal "nine feet thick" was reported at 640 feet in the bore. No. 2, which was completed May 12, spouted every 25 minutes after shooting, each time throwing oil higher than the derrick. A dam was thrown up to retain the oil which soon filled the tanks and overflowed. The well was finally shut off to await additional tankage.

A gas sand was found in the Birch wells, as well as in the Shire and Walker wells, about 20 feet above the oil sand, with shale intervening.

The J. H. Taylor well, one-half mile south, was light, yielding but ten to fifteen barrels per day after shooting. Its record showed:

	Feet.
10-inch drive pipe	49
8-inch casing	424
6¼-inch casing	843
First oil showing	889
Top of oil sand	902
Oil at	912
Bottom of hole	970

Drillings of the producing rock from this well appear to have come from a sandy shale rather than a sandstone proper. Numerous particles of iron pyrites, which appears to be a constituent of the producing rock in this field, were present.

To the southeast one-half mile, a bore on the Chas. Martin lease came in as a fair producer, its record being:

	Feet.
Drive pipe	85
8-inch casing	402
6¼-inch casing	833
Top of oil sand	872
Shale	889-894
Oil sand	894-920

This well also flowed natural from 40 to 60 barrels per day.

This completes the records of wells finished in Oblong township to May 10. The results show that oil in quantity undoubtedly exists in south Oblong and southwestern Robinson townships in one of the Lower Coal Measure sandstones, at a depth of 870 to 940 feet below the surface. The difference in depth is due to the dip of the oil bearing rock, or the difference in surface elevations of the wells, or both. Until the wells are put to pumping regularly, no one can say what the production will be, nor can any one at this time intelligently prophesy to the size of the future field or its length of life. It is not yet a field but a prospect, though a good one.

In the months of May and June development work in Oblong township made rapid progres, On June 11th the following additional borings had been completed:

Abbott and Newland—(S. W., S. W., Sec. 11.) Top sand 885-910 feet; shale 910-915; oil sand 915-942, bottom; shot with 80 quarts; flowing 40 barrels.

J. W. Imboden—(N. W., S. W., Sec. 10.) Top sand 847-865; lower sand absent, bottom 651; shot with 60 quarts; flowing 10 barrels,

Baldwin—(N. E., S. W., Sec. 11.) Oil 903-918; shale 10 feet; oil sand to bottom, 930 feet; not shot; flows 60 barrels.

J. W. Demin—(S. W., S. W., Sec. 2.) Top sand, 883; pay 888-900; bottom 956; shot with 80 quarts; pumped 25 barrels first day, then about eight barrels; not being pumped.

W. J. Stephenson—(N. W., N. E., Sec. 2.) Gas, about 5,000,00 cu. feet, at 920-937; bottom of hole, 992 feet.

Lawrence County.

Many leases have been taken over a strip ten miles wide, extending from Oblong, forty miles to the southeast through Lawrence and Wabash counties, but up to the first of may no wells had been completed, though a number were reported drilling. On the Captain Lewis farm, five miles north of Bridgeport, Lawrence county, gas was struck at 600 feet, and the bore is being drilled deeper for oil.

On the 10th of June wells were reported from the following points in Lawrence county:

Lewis well—(S. W., S. W., Sec. 20, Petty township.) Oil at 885 feet; not shot; said to be pumping 15 barrels.

Josiah Pepple—(S. W., S. W., Sec. 23, Petty township.) Now drilling.

S. Mathias—(N. E.. N. E., Sec. 10, Christian township.) Now drilling.

Lathrop farm—(S. W., Sec. 20, Petty township.)

	Feet.
10 inch casing	20
8¼ inch casing	60
6¼ inch casing	675
Salt sand	590-660
Oil sand	805-820
Second oil sand	867-880

The hole was stopped in sand. Coal was found at 360-365 and at 540-546 feet. The first seemed to be of good quality. The second bed was poor,

Edgar County.

In this county, which lies north of Clark and next to the Indiana line, a number of bores have been sunk, but the resulting wells have, for the most part, proven barren.

On section 9, Grandview township, four miles north and eight miles east of Westfield, a bore showed the following partial record:

	Feet.
Top of rock	80
Top of first sand	380
Bottom of first sand	405
Top of second sand	425
Gas at	427
Total depth	435

The well was capped in and the volume of gas which it would supply is not known.

About one mile southeast of Barton, a small oil producer has been drilled, the top of the pay sand being found at 360 feet. As there is no other production in the neighborhood, the well has never been thoroughly tested.

A bore on the J. E. Pinnell farm, one-half mile south of the station of Kansas, passed through three veins of coal in going down 410 feet. No oil or gas was found.

Coles County.

This county lies west of Edgar and Clark and north of Cumberland counties. Several bores in Hutton township, west and north of the Casey field have proved barren. One of these, in section 5, found the "top of sand" at 318 feet. In another in the southwest quarter of section 17, (12 N., 10 E.), the sand was struck at 485 feet. A third in the northeast quarter of section 22, was bored to a depth of 605 feet before striking sand, at which point a big flow of salt water was developed. Near Hanley Ford, section 10, (T. 11 N., R. 9 E.) a little oil is said to have been found, as also near Oakland and Trilla. On June 29 it was reported that a considerable number of pumping wells had been developed in this county.

Jasper County.

In this county, which lies west of Crawford, and south of Cumberland counties, several barren or salt wells have been drilled. One of these, on the Joseph Harris farm, section 2, Hunt City township, developed "oil sand" at 900 feet, and a heavy vein of salt water at 1,200 feet. Another test well on the southeast corner of the S. S. Leggett farm, section 4, Willow Hill township, two miles east of Willow Hill, found no sand to the depth of 1196 feet.

Clay County.

Near Iola in section 25 (T. 5 N., R. 5 E.) a well was put down in 1905 on the farm of E. W. Morgan. Oil was found at a depth of 252 feet, and a small sample examined for the survey by J. W. Gill, showed a specific gravity of .8741, corresponding to 30.1 deg. Baumé. Further drilling is in progress to determine the extent of the field.

Williamson County.

A dry hole was bored near Bainbridge in the central western part of this county, a record of which shows:

	Feet.
10 inch drive pipe	53
8¼ inch casing	265
6¼ inch casing	745
Salt water sand	1,030
Total depth	1,082

No indications of either oil or gas were encountered.

Saline County.

[By F. F. Grout.]

It is reported that throughout much of the county small amounts of oil are occasionally found in prospecting for coal. In a few places the oil has been skimmed off the water and proven to be combustible. Recently Mr. J. H. Wallen, of Chicago, while drilling on the John Small farm (N. W. of N. W. Sec. 25, T. 8 S., R. 5 E.)

noticed that the drillings were quite saturated with oil and collected as much as a bushel of the oil sand. A little gas also occurred. The oil sand was found at a depth of 444 feet; lower than the Harrisburg coal. From the quantity of drillings collected the producing sand must be of fairly good thickness.

Options are now being taken on land from Galatia to the northwest corner of Saline county, and careful prospecting is to be expected. Gas has been found in several wells, notably in section 1, Eldorado township, on the farm of Willard Overton, where two horizons produced gas, one at 219 feet, and one near the coal at 600 feet. The gas pressure was as high as 60 pounds per square inch, and brought out considerable salt water as it came. This well still produces.

In the northeast corner of the northwest quarter of Sec. 22, T. 8 S., R. 63, on the land of Mr. Burkhart, is a gas well with much the same history as the last described. Gas was found in the rock at a depth of 410 to 415 feet. The Harrisburg coal was 5 or 6 feet lower.

A good gas well also occurs on the land of John Heffman, near New Hope.

Indications of oil were good in a well on the farm of Pully Bros. near Stone Fort. Oil oozes from the side of a bluff at this point. The rocks which outcrop here are probably the same as those 500 or 600 feet deep in the northern part of the county.

Randolph County.

[By F. F. Grout.]

As already stated, gas was sound at Sparta some time since, and was for several years quite extensively used. For a time, as the supply of the existing wells gave out, new ones were drilled, but a number of dry holes being struck, efforts to enlarge the field gradually ceased. In connection with the recent development of oil fields in the eastern part of the State, attention has been again attracted to Randolph county and considerable prospecting is now being carried on. When the field was visited in June two holes had been drilled, each of which showed some oil. From these a few barrels of oil have been bailed, but no pumps have been set up and the wells have not been shot.

One well was sunk on the farm of Mr. Preston at the eastern edge of town. (Sec. 4, T. 5 S., R. 5 W.) Oil was struck at 875 feet in a sandy formation 5 feet thick, with an overlying clay or shale. Below there were 10 feet of shale and 15 feet more of oil bearing rock.

The other well was drilled in the northeastern corner of Sparta. Oil was struck at about the same horizon. The shale separating the two parts of the oil producing rock was only three feet thick, and the whole thickness of oil bearing rock is so great that it is thought that the well on Mr. Preston's farm did not go completely through it. Drilling is now being carried on one mile and three miles south of town.

Companies are being organized to develop other parts of the field. The oil bearing rock is sandy in part and apparently a porous limestone in part. A little salt water enters the wells with the oil. Oil and water now fill the holes about half way up. A sample from the Preston well was analyzed and the results are given on a later page (p. 103).

Montgomery County.

According to Mr. David Davis, of Litchfield, oil was first found about forty years ago in prospecting for coal in the bottom of the mines. The drill hole was carried down and got into salt water, which threatened to flood the mine. The well was plugged, and later an oil well was drilled near by. Oil from this well leaked into the old workings of the mine, and was for years skimmed off the water and sold. About 1886 a number of wells were drilled in this territory, and both oil and gas was found. In all something like $150,000 was expended in prospecting, with a net result that an area, approximately, one mile long and a quarter of a mile wide was developed. In this area several wells were put down as shown upon the accompanying map, (fig. 1), and from them oil was produced up to two years ago

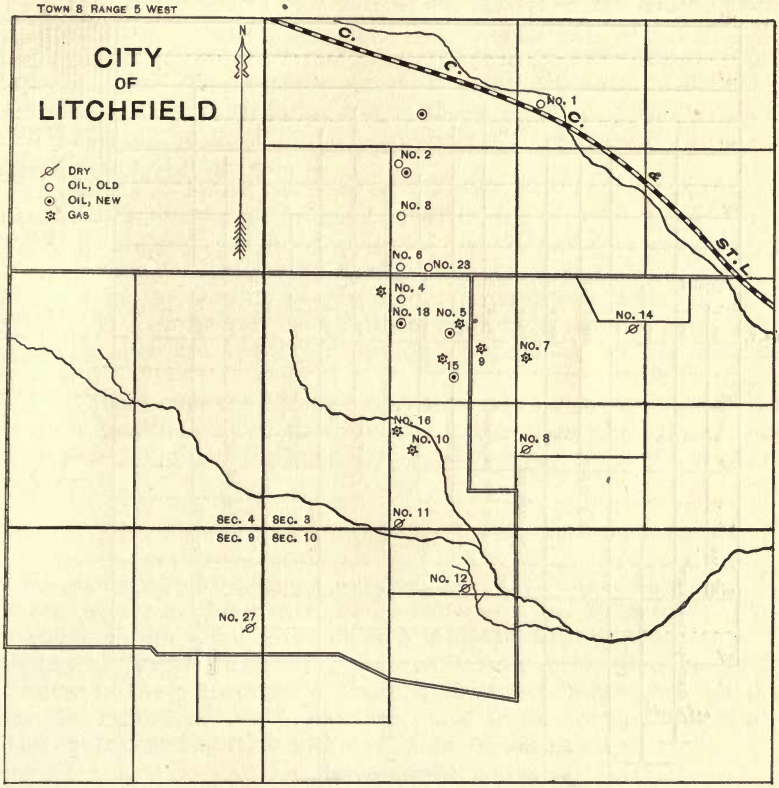


FIG. 1. SKETCH MAP SHOWING LOCATION OF OIL AND GAS WELLS NEAR LITCHFIELD, ILL.

Two of these wells are still in condition, but have not been pumped recently, owing to the low price of the oil. For some time this sold at 12½ cents a gallon, and it was very largely used as a lubricationg oil throughout this portion of the State. Competition eventually forced the price down to 6 cents, at which price it became impossible to pump at a profit. The wells still available for production are

numbers 4 and 13, on the accompanying map. This year some new prospecting has been carried on. New wells, as indicated, were put down; in both cases very near the old wells and within the already known limits of the productive territory. These wells are now capped over and the drilling rig has been moved to another territory.

A considerable amount of high pressure gas was found in connection with the oil, and was used for some years for lighting the town. It was wasted, as is usual in gas regions, and for several years now it has been necessary to manufacture gas to supply the local demand. The oil is found not far below the coal, which is mined in this territory, and which is supposed to be the number 2 seam of the Illinois Coal Measures. The different borings with their altitude and the depth and thickness of the gas and oil sand are shown in figure 2.

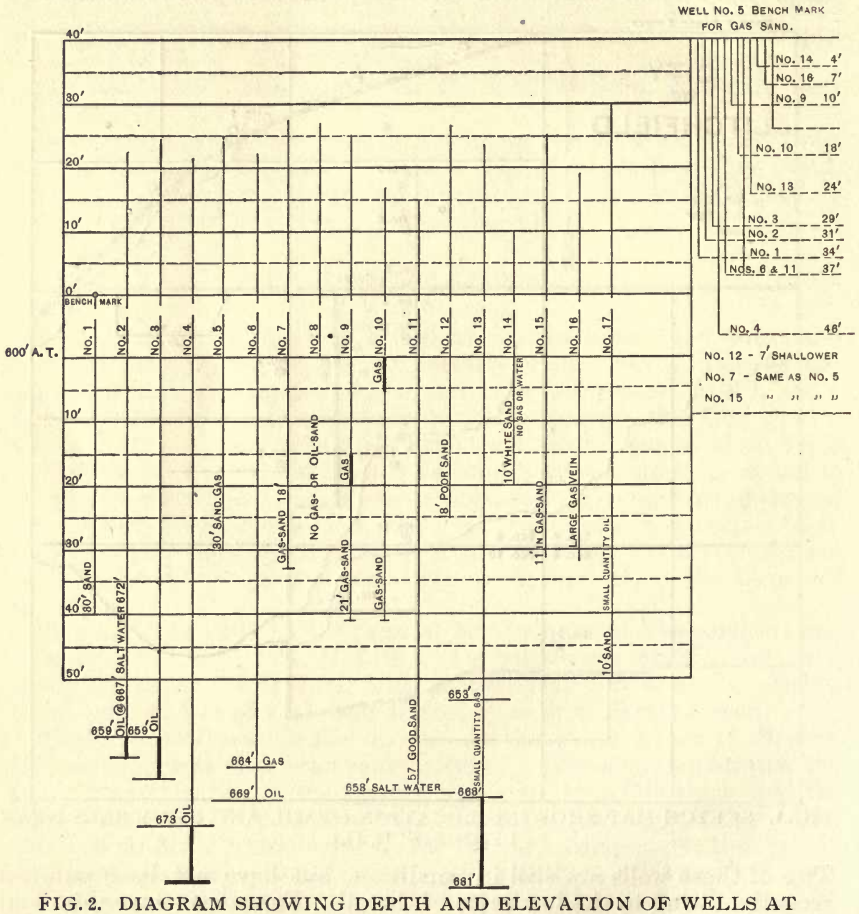


FIG. 2. DIAGRAM SHOWING DEPTH AND ELEVATION OF WELLS AT LITCHFIELD, ILL.

Recently drilling has been begun at other points within the county, notably near Walshville. It is reported that evidence of considerable

deformation has been found, though public information is not sufficient to determine the course of the lines of disturbance.

The oil found at Litchfield is a natural, lubricating oil, and has a specific gravity of .9236, corresponding to 21. 6° B, as determined by J. W. Gill on samples collected in June, but which had been standing for some time. A partial analysis is given on a later page (page 103.)

Pike County Gas Field.

(By T. E. Savage.)

INTRODUCTION.

Pike county is located on the western border of the State between the Illinois and Mississippi rivers. The topography of the county is quite broken, the present forms having been largely developed through stream erosion. The surface relief is about 450 feet. Like that of most areas adjacent to large rivers, the surface over the uplands is much dissected, so that interstream areas of level prairie are neither numerous nor of large extent.

The elevations above sea level of the following railway stations are taken from Gannett's Dictionary of Altitudes in the United States: On the west, along the flood plain of the Mississippi, are Seehorn, 479 feet; New Canton, 468; Rockport, 471; Pike, 455. Across the north side of the county are Hull, 467; Kinderhook, 480; Barry, 672; Baylis, 871; New Salem, 780; Pittsfield, 760; Griggsville, 687. Along the south side are Quincy Junction, 465; Nebo, 488; Strout, 690; Pearl, 447.

The Wabash and the Chicago & Alton railways furnish good transportation facilities in an east and west direction, while the Chicago, Burlington & Quincy Railroad connects with points to the north and south.

GEOLOGY.

The geological formations exposed in Pike county belong to four different systems, Quaternary or Pleistocene, Coal Measures or Pennsylvanian, Lower Carboniferous or Mississippian, and Silurian. The relations of the different strata, and the character, distribution and thickness of the respective formations described below, were obtained from the report of A. H. Worthen* and from a study of the rocks of the central and northwestern portions of the county.

* Worthen: Geological Survey of Illinois, Vol. 4, pp. 24-42, 1870.

Geological Formations.

FORMATIONS.		Thickness—feet.
Pleistocene Deposits.	(Loess and Drift).....	00–100
Coal Measures (Pennsylvanian).		20–60
Lower Carboniferous (Mississippian).....	St. Louis limestone	00- 30
	Keokuk group	100–125
	Burlington limestone	150–200
	Kinderhook group	100–120
Niagara limestone.....	.....	00–50

Pleistocene—The Pleistocene deposits consist of glacial drift and beds of alluvium, loess and sand, none of which particularly concern the object of the present report.

Coal Measures—Strata belonging to the Coal Measures outcrop over but a limited area in the central and northern portions of the county. They underlie the surficial materials over the whole of township 4 south, range 4 west, and a portion only of the four surrounding townships. The materials consist of shales and shaly sandstones with a narrow seam of coal in the lower part. The entire thickness of the formation in Pike county does not exceed sixty feet.

A single seam of coal sixteen to twenty-four inches in thickness, with occasional local thickenings, was worked several years ago at a number of points, in townships 4 south, ranges 111, 4 and 5 west, and further south in the township of Pittsfield. In the western portion of the area the Coal Measure strata rest unconformably upon the Burlington limestone. Towards the north and east they are spread upon the eroded surface of the Keokuk beds.

Mississippian—Of the Mississippian rocks in Pike county there are represented strata belonging to the St. Louis, Keokuk, Burlington and Kinderhook groups. The St. Louis limestones are exposed over a small area in the extreme northeast portion of the county. The beds here consist of brown, magnesian limestone and shale. They range from twenty to thirty feet in thickness.

The Keokuk beds are present over a considerable area in the northern and northeastern portions of the county where they are frequently found immediately beneath the Coal Measures; the St. Louis strata, which should properly intervene, having been removed by denudation prior to the deposition of the Coal Measure materials. The Keokuk beds consist of light gray and bluish-gray limestones, which in places are crinoidal. Towards the base there is present considerable chert. The upper division of the group consists of thin-bedded limestones, beds of calcareo-argillaceous shales, which contain numerous geodes.

The Burlington limestone immediately underlies the drift over more than one-half the upland surface in the county. Worthen describes the distribution of this limestone as follows:

"Commencing on the western side of the north line of the county it forms a belt from five to ten miles in width, the western border of which is defined by the river bluffs, and extending thence to the southern line of the county lying west of Pittsfield, and from that point northward to Griggsville Landing, and south to the Calhoun county line, underlying all the highlands in that portion of the county south of Pittsfield, except a very limited area in the vicinity of Pleasant Hill, where the Niagara forms the surface rock."

Over the gas field area, in Pittsfield and Derry townships, outcrops of the Burlington limestone expose a thickness of only fifteen to twenty feet of the lower layers, overlying the Kinderhook shales. For some miles southwest of this area, along the channel of Dutch creek. the strata dips nearly with the fall of the stream, so that the depth of the Kinderhook shale that appears above the water level remains almost constant. The Burlington beds increase in thickness in the banks of this creek, until in the vicinity of the old Packer quarry, ten miles southwest of Pittsfield, they form cliffs fifty to seventy feet in height. This rock is a rather coarse-grained, gray limestone, with intercalations of buff or brown layers. It is largely composed of shells of brachipods and fragments of joints and plates of crinoids, which swarmed in countless myriads in that old Carboniferous sea.

In the upper part there are present large quantities of chert in the form of lens-shaped nodular masses, which are often segregated along the planes of bedding so as to form distinct bands. In many places over the north-central portion of the county the undisturbed lower layers of the Burlington beds are succeeded by a bed of chert fragments three to ten or more feet in thickness, the interstices of which are filled with gray shale. These fragments carry Burlington fossils and are irregular in shape and size, varying from a few inches to two or three feet in diameter. They lie at all angles with respect to one another, and appear to have been concentrated along this zone through the action of weathering and erosion prior to the deposition of the protecting mantle of Coal Measure strata or Pleistocene materials.

The Kinderhook group consists principally of shales, with some sandstones and arenaceous shales, and one or two narrow zones of calcareous material in the upper part. The beds are well exposed beneath the Burlington limestone in the vicinty of Kinderhook. They outcrop almost continuously in the scarp that bounds the Mississippi river along the west side of the county. They appear in the banks of the tributaries of the Mississippi for some miles back from its channel. They are also exposed in the lower portion of the bluff that borders the Illinois river from the town of Bedford south to Calhoun county.

The Kinderhook beds have a maximum thickness in the county of about 160 feet. In the most of the natural exposures they are overlaid and protected by the more obdurate ledges of Burlington limestone.

Niagara limestone—The Niagara limestone which belongs to the Silurian system outcrops only over a limited area in the southwest

portion of the county. According to Worthen* it appears at the base of the bluffs between Rockport and the Pike-Calhoun county line. It may be seen for some distance up the channel of Six Mile creek. It is the prevailing rock at Pleasant Hill where a thickness of thirty feet is exposed. Two miles north of Pleasant Hill it outcrops to a height of six feet, and is overlaid by Kinderhook shales. About two miles below Atlas there are fifteen feet of Niagara limestone underlying beds of Kinderhook age.

Where the rock first appears the upper portion is a rather thin bedded, rough, gray limestone becoming more massive below. On Six Mile creek it is partly a regular bedded, buff or brown dolomite and presents the usual characters of the formation in other localities. The maximum thickness of the Niagara in the county does not exceed fifty feet.

DEFORMATION OF STRATA.

A line of deformation passes across the southern section of Calhoun county.† When it intersects the Mississippi scarp at the Cap-au-Grés bluff there is a fault which involves almost the entire series of Paleozoic strata. To the north of this fault line there is an up-throw of the beds to the extent of 1,000 feet, bringing the St. Peter sandstone in juxtaposition to the rocks of the Mississippian series. On the south of the fault line the strata have been but slightly dislocated and dip gently towards the northeast.

In the eastern portion of the county the fault has changed to an anticlinal fold which, to the northward, becomes lost in the valley of the Mississippi. It is probable that this disturbance affected the strata for some distance toward the north, in Pike county.

Worthen describes another axis which probably changed the level of the Mississippian limestones over nearly the whole extent of Pike county and resulted in the subsequent denundation of the strata.§ It occurs in the vicinity of Six Mile creek, and its effects are most apparent in the northwest quarter of section 7, township 7 south, range 4 west. At this place the Niagara limestone rises abruptly from beneath the surface of the bottom lands at the foot of the bluffs and dipping north 20 degrees west, at an angle of 7 degrees, rises so as to form a perpendicular cliff from forty to fifty feet in height within a distance of scarcely 100 yards.

The presence of an arch in the strata underlying the gas producing area will be shown under the description of individual wells.

DESCRIPTION OF THE GAS FIELD.

So far as at present exploited, the gas field of Pike county embraces an area about seven miles in length and four miles in width. It extends in a northwest-southeast direction across the central and northwestern portions of Pittsfield township and the northeast

* Worthen: Geol. Surv. of Ill., Vol. 4, p. 26.
†Worthen, A. H., Geol. Surv. of Ill., vol. 4, p. 2. See also Weller, p. 21 of the present report.
§Worthen, A. H., Geol. Surv. of Ill., vol. 4, p. 25.

quarter of Derry, with one well further north in section 36 of township 4 south, range 5 west. The location of the borings is shown on the accompaning map. The wells are numbered later in the order in which they were drilled and on the map dry holes are distinguished from productive wells by a diffierent symbol. It will be noticed that a line drawn across the field from the center of the north side of

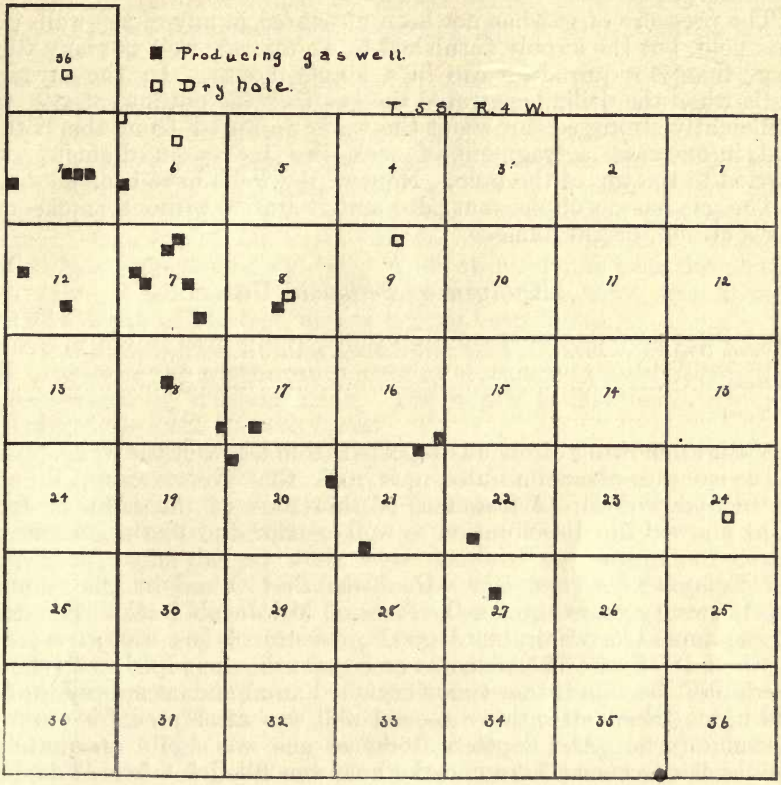


FIG. 3—SKETCH SHOWING LOCATION OF GAS WELLS NEAR PITTSFIELD, ILL.

section 1 of Derry township to the northeast corner of section 36 of Pittsfield will practically separate the area of productive wells from the non-productive portion of the field.

The wells are all shallow, the gas being reached at a depth of 75 to 350 feet, depending largely upon the inequalities of the surface. There is evidence, too, that the beds dip strongly towards the east, along the east side of the area. An inclination of the strata towards the west is also shown along Dutch creek, beyond the western border of the field.

Occurrence of the Gas—The origin of natural gas and the conditions of its accumulation have been discussed in the preceding pages. In the Pike county field the gas occurs along an arch or anti-

cline of strata, the eastern limb of which is closly determined by the line separating the productive from the dry wells. The porus stratum forming the reservoir is a bed of yellowish brown, more or less vesicular magnesian limestone which probably belongs to the Niagara. The thick bed of Kinderhook shales, that immediately overlies the Niagara limestone in this region, provides the impervious cover to the reservoir.

The pressure of gas has not been measured in any of the wells over this field, but the supply furnished by an average well is many times more than is required for use in a single house. In the stronger wells when the drills penetrated the gas rock the outflow of gas was sufficiently strong so throw out the water and mud from the bottom and, in one case, a fragment of rock two inches in diameter was carried to the top of the hole. None of the wells have been shot.

The gas has no unpleasant odor and it burns without smoke, giving a strong, bright flame.

Analysis of Pittsfield Gas.

	Per cent.
Carbon Dioxide, (CO_2)	.81
Oxygen, (O_2)	3.46
Marsh Gas, (CH_4)	73.81
Nitrogen, (N)	21.92
Total	100.00

A slight showing of oil was reported from a few of the wells. Some of the samples of comminuted gas rock that were examined had a distinct odor of oil. A fragment of this rock at the home of Jerry Mink showed the discoloration as well as odor due to the presence of oil.

Development of the field.—Gas was first found in Pike county nearly twenty years ago, on the farm of Mr. Jacob Irick. The drilling was made for water, but a good pressure of gas was struck at a depth of 186 feet The well was cased and the gas piped to the house to which it has since that time furnished an abundant supply for fuel and light. Soon after this a second well was attempted for water on the same farm. At a depth of 168 feet gas was again encountered. This well was near a barn and the hole was filled for fear of damage by fire. During the next fifteen years no effort was made to discover or utilize gas, although it was found in drilling a number of water wells over the area.

In 1905 a well was put down on the farm of William Irick in which a strong flow of gas was found. Mr. Irick recognized its value and at once piped the gas over his premises. Gradually the neighbors came to realize the advantages of using gas, and one after another put down wells in the hopes of obtaining supplies for their homes.

Some weeks ago the gas rights on a tract of a few hundred acres of land in the northwest portion of Pittsfield township was leased for a nominal sum, but no effort has been made to exploit the field in a commercial way, or to determine the limits of the gas bearing strata. Down to the present time the development of the field has been wholly by the owners of the land for local uses. Two drillers have

been employed pretty constantly for the past few months. Up to June 9, 1906, thirty wells have been put down in this field, all but six of which furnish a supply of gas.

Description of wells.—Well No. 1 was drilled for water nearly twenty years ago on the farm of Jacob Irick. It is located in the northwest quarter of the southeast quarter of section 1 of Derry township, on land now owned by Albert Gray. The well is 186 feet deep, and it has furnished abundance of gas to the premises since that time.

No. 2 was put down for water a short time after No. 1, on the same farm. Gas was struck at a depth of 168 feet, but it was never utilized. The well was not cased and later the hole was filled.

Less than two years ago a well was put down on land of Andrew Irick in the northwest quarter of the southwest quarter of section 6 in Pittsfield township. The drilling was discontinued at a depth of 760 feet. Gas was encountered, but no effort was made to utilize it.

Well No. 4 was drilled by Jerry Mink at his home near the northwest corner of section 6, Pittsfield township. The work was abandoned at a depth of 460 feet, no gas having been found.

No. 5 is a good well, located one mile west of No. 3, in the northwest quarter of the southwest quarter of section 1 in Derry township; on land owned by William Irick. The depth is 203 feet. Abundance of gas for local use was found.

Well No. 6 was put down for Albert Troy on a hill only a short distance east of well No. 1. A good pressure of gas was struck at a depth of 312 feet. Inasmuch as the first well furnished abundance of gas, No. 6 was cased and plugged.

Up to this time the gas wells were confined to section 1 of Derry township and section 6 of Pittsfield. During the year 1905 well No. 7 was drilled for Mr. John Reed, in the southwest quarter of the northwest quarter of section 7 of Pittsfield township. Abundance of gas for use in the home was found at a depth of 150 feet.

Well No. 8 was put down a short distance southeast of No. 7, on the farm of Mary McSorley. This ranks among the strongest wells in the county. It is also one of the shallowest, being only 76 feet in depth. This was on low land near a branch of Kiser creek, which accounts for the shallow depth.

Number 9 is located about one mile southwest of the last, on bottom land owned by Jesse Irick. It was drilled near the middle of the south half of section 12, Derry township. An abundance of gas for local use was found at a depth of 115 feet. The log of this well was furnished by the driller, Mr. George Mink, as follows:

		Feet.
1	Gray silt	3
2	Yellow clay	12
3	Blue soapstone	20
4	Brown soapstone	10
5	Brown shale	60
6	Limestone	4
7	Cave in limestone filled with gas causing a gusher	6

Nos. 1 and 2 above belong to the Pleistocene deposits. Nos. 3 to 5 inclusive represent the Kinderhook shales; limestones 6 and 7 prob-

ably are the Niagara, as the Devonian strata do not appear in Pike county. In one other well a cavity four feet in depth was reported, but such caverns are not generally found.

Well No. 10 was put down for I. N. Winans, near the middle of section 10, Pittsfield township. The depth was 242 feet. There is a strong pressure of gas which is utilized on the premises.

No. 11 is located near the middle of the west half of section 12 of Derry, about one-half mile southwest of well No. 9. This is on the farm of Clel. Harshman. The well is 155 feet in depth and furnishes an abundance of gas for the home.

Well No. 12 was drilled about one mile north of No. 2, on land belonging to Jacob Irick. The following record of the well was furnished by the driller, Mr. Mink:

		Feet.
1	Soil	3
2	Yellow clay	14
3	Gravel	8
4	Sand containing water	23
5	Dark soapstone	4
6	Coal	1
7	Gray fire clay	6
8	Flint and clay	48
9	Blue limestone,	8
10	White limestone	41
11	Blue soapstone	103
12	Brown shale	52
13	Light gray shale	7
14	Whitish limestone	27
15	Gas rock, (yellowish-brown limestone)	27
	Total depth	372

In this section Nos. 1 to 4 are surface materials; 8, 9 and 10 represent the Burlington limestone; 11, 12 and 13 are Kinderhook shale; and 14 and 15 are Niagara limestone.

Number 13 is a dry well on the farm of Noah Harshman, near the middle of the north half of section 6, Pittsfield township. Work was discontinued at a depth of 690 feet.

Well No. 14 was put down during the early part of 1906 on land of John McSorley. It is one mile south of No. 13. A good supply of gas was found at a depth of 185 feet.

Number 15 is on the farm of Mrs. Maggie O'Connell, near the middle of the southeast quarter of section 7, Pittsfield township. Gas was struck at 164 feet.

Well No. 16 is a short distance north and across the wagon road from No. 14, on land of Thomas Austin. The well is 219 feet deep. It furnishes sufficient gas for use on this farm, but the well is not so strong as the average.

Number 17 supplies abundance of gas to the premises of F. P. Wackerman and W. S. Lloyd. It was drilled on land of the former near the southeast corner of section 18 of Pittsfield township. The depth is 273.

Well No. 18 is on the farm of Mary J. Smith, near the northwest corner of section 20, a short distance southeast of No. 17. An ample supply of gas was struck at a depth of 231 feet. Mr. Mink furnished a log of this well as follows:

		Feet.
1	Soil	3
2	Brown clay	12
3	Blue clay	1
4	Sand and clay	8
5	Sand and gravel, with water	14
6	Flint and sand rock mixed	7
7	Blue soapstone	102
8	Brown shale	58
9	Limestone	14
10	Gas rock (brown magnesian limestone)	12

Of the above numbers 1 to 5 inclusive, belong to the Pleistocene; 6 probably represents the residual materials of the Burlington limestone mingled with sand of the Kinderhook; 7 and 8 are Kinderhook beds; 9 and 10 represent the Niagara limestone.

Number 19 is considered one of the strongest gas wells in the field. It is 167 feet in depth, and is located near the southeast corner of section 16, Pittsfield township, on land owned by Mrs. J. H. Helm.

Number 20 is a dry well put down in the northwest quarter of the northeast quarter of section 9 of Pittsfield, on the farm of Benjamin West. The depth is 501 feet.

Well Number 21 is near the middle of the south half of section 8, at the home of Capt. Davis. Gas was struck at 276 feet. The pressure is below the average, but supply is sufficient for farm use.

Number 22 is a good well, less than one-half mile southwest of Number 19. It is on the farm of John Dorcey, in the notthwest quarter of the northeast quarter of section 21. Gas was struck April 9, 1906, at a depth of 185 feet.

Number 23 was drilled for Messrs. Higgins and Strauss, in the southwest quarter of the southwest quarter of section 17 of Pittsfield. An abundance of gas was found at 251 feet. The well was completed April 19, 1906.

Number 24 is on the farm of Joseph Haney, across the road, east of the Davis well. The driller, G. M. Mink, reports that the gas rock in Number 14 was found at an elevation fifty feet lower than in the Davis well, which is located 600 feet further west. This would indicate an eastward dip of the strata of fifty feet in a distance of 200 yards. The drilling was discontinued at a depth of 313 feet. No gas was found.

Number 25 is a strong well on land of Michael Nash, one-fourth of a mile east of the center of section 7. Gas was struck on April 26th, at a depth of 123 feet.

Well number 26 is 333 feet deep. It is on the farm of Charles L. Wilsey two and one-half miles west of Pittsfield and about one-fourth mile east of the southwest corner section 22. A strong pressure of gas was found on May 7th. Following is a section of the well furnished by the owner, Mr. Wilsey:

		Feet.
1	Soil	1
2	Yellow clay	17
3	Gravel and clay	1
4	Sand and clay, with water	36
5	Joint clay	27
6	Black slate	10
7	Gray shale	6
8	Flint rock and gray shale	12
9	Flint rock and blue clay	15
10	Blue sand rock	3
11	Blue soapstone	100

12	Brown shale	57
13	Blue soapstone	5
14	Limestone	25
15	Gas rock	18

Numbers 1 to 5 inclusive probably represent deposits of the Pleistocene; 6 and 7 are the Coal Measures; 8 and 9 are remnants of the Burlington limestone; 10 to 13 inclusive are Kinderhook beds; and 14 and 15 belong to the Niagara.

Well number 27 ranks among the best. It is on the farm of W. R. Wills, in the southeast quarter of the northeast quarter of section 20, in Pittsfield township. Gas was struck on May 15th at a depth of 220 feet. Mr. Wills furnished the following approximate section of the well:

		Feet.
1	Clay	23
2	Blue soapstone	90
3	Brown soapstone	13
4	Brown shale	65
5	Limestone (cap rock)	14
6	Gas rock (brown limestone)	14

Number 28 is a good well, It is located about three-fourths of a mile southeast of Number 27, on the farm of A. V. Wills. It was completed on May 14th at a depth of 293 feet.

Number 29 was put down in the city of Pittsfield for C. H. Doss and Co. The depth was 352 feet. No gas was found. The record of the well kept by the driller, Mr. Clark, is given below:

		Feet.	Inches
1	Soil	2	
2	Clay	41	
3	Sand and gravel	13	
4	Rotten limestone	19	6
5	Fire clay	2	6
6	White limestone	34	
7	Light soapstone	76	
8	Dark slate	8	
9	Soapstone	21	
10	Brown shale	58	
11	Soapstone	10	
12	Hard limestone	14	
13	Soft limestone	2	
14	Hard limestone	14	
15	Gas rock (full of water)	27	
16	Hard limestone	2	
17	Light soapstone	8	6

In the above, numbers 1, 2 and 3 belong to the Pleistocene; 4, 5 and 6 probably represent the Burlington limestone, much softened and decayed in the upper part; 7 to 11 inclusive are members of the Kinderhook, and 12 to 16 inclusive are Niagara limestones. The soapstone or shale, number 17, probably represents the Maquoketa or Cincinnati shale. Professor Worthen reports a thickness of but a little more than fifty feet for the Niagara further southward in Calhoun county.

The cap rock or limestone immediately overlying the gas rock, is usually eighteen to thirty feet in thickness, and Mr. G. M. Mink reports that in the two wells in which the drill penetrated the entire depth of the gas rock its thickness was respectively thirty-seven and twenty-eight feet. This would indicate a thickness of about sixty feet for the Niagara at those points.

Worthen, A. H.; Geol. Surv. of Ill. Vol. 4, p. 7.

The city of Pittsfield is in a valley above which the uplands rise on the west more than 125 feet. The surface where the Pittsfield well, No. 29, was drilled is more than 100 feet lower than the curb of Mr. Chas. L. Wilsey's well, two and one-half miles due west of Pittsfield. From a comparison of the sections of these two wells it will be seen that the top of the Niagara limestone was reached in the Pittsfield well only five and one-half feet nearer the surface than in the well of Mr. Wilsey. This would indicate an eastward dipping of the strata between these points of at least 100 feet. This fact, together with the dip of the beds between the Davis and the Haney wells above described, would determine the eastern slope of the anticline, the west side of which is in part seen in the dipping of the beds down the channel of Dutch creek.

Number 30 was the last well put down for gas in this area to June 9, 1906. It is on the farm of Mr. Riley Wilsey, in the southeast half of the northeast ¼ of section 27 of Pittsfield township, At the time of the writer's visit on June 6th the drill was down 200 feet. It has since been reported that gas was struck on June 7th, but complete data on the well was not obtained.

On June 7th the drilling was begun on a second well in the city of Pittsfield, in the hope of obtaining a supply of gas for the town.

The drillers report the succession of strata penetrated in the different wells as quite constant and the thickness of the respective beds as fairly uniform over this field.

Outlook for the Pike County Field—The pressure of gas in the wells of this district is not sufficiently strong to warrant the expectation of any great development of the field in a commercial way. However, the supply from an average drilling is ample for use in one or two, or even a number, of the farm houses adjacent to the well. An abundant and constant source of excellent light and fuel, with no expense after the small outlay of putting down a well, is a very fortunate and happy circumstance to the farmers in this field. The fact that well number 1 has furnished gas for more than eighteen years with no signs of weakening lends assurance as to the durable nature of the supply when utilized in this way.

There seems no reason why other wells should not be put down further to the northwest and to the southeast of the producing area with a good expectation of finding gas.

It seems probable that, in case gas is not found in wells at Pittsfield, an abundant supply could be obtained by putting down a few wells in the productive area a short distance west of town, connecting them with pipes, and pumping the gas into the city under pressure.

Some years ago gas is reported to have been found in a water well on the farm of Captain B B. Hopkins, in Griggsville township. There is a possibility that a parallel anticline may lie to the east of the known gas bearing arch and that another gas field may be found to the east of Pittsfield. This can be determined only by the putting down of a few wells over that area. Since, as is well known, gas and oil are frequently and closely associated, the presence of the gas here gives strong probability of the finding of petroleum.

PRODUCTION OF PETROLEUM IN SOUTHEASTERN ILLINOIS.

The raising of petroleum from the porous stratum or reservoir in the depths of the rocks, where it has lain for thousands of years, to storage tanks upon the surface of the earth, where it can be utilized by man, is termed the *Production.*

The evolution of the processes involved in the present advanced methods of production from the primitive ones used by the first oil producers in the United States has been a wonderful one, and would prove a story of surpassing interest to the practical operator of today.

The different steps necessary to the successful development of a good oil property are many, and the tyro who enters the field against operators who had spent a lifetime in mastering the details of producing oil at a minimum cost often finds himself handicapped before he has completed his first well.

Choosing a locality for operating—The first step necessary in the production of oil is the choosing of the locality in which the operations will be carried on. In this step it will be found that the old operator, who has watched the growth of a field from the beginning, is usually wise enough to locate his future wells within the limits of the known productive territory, provided he can procure the necessary leases. The beginner more often betakes himself to "promising" territory just outside the limits and puts down a "wild-cat" bore. Any one who makes a special study of the oil business will soon note that the Standard Oil Company and other large operators do little "wild-catting," but profit by the experience of the small operators who do it. "Wild-catting" must, however, be done by somebody, as there is no known method of fixing the limits of a field except by test bores put down by speculative individuals.

Usual terms of a lease—After deciding on a piece of territory it must either be bought outright or leased from the owner for a term of years. In most cases it is leased, usually for a period of five years or as much longer as production continues. If the adjoining territory is untested, the farmer usually receives from one-eighth to one-sixth royalty on the future production, with a stipulation that drilling is to begin within one or two years, or that a stated rental per acre shall be paid until the first well is drilled. The landowner retains all rights over the surface of the land with the exception of the portion necessarily occupied by the derricks, power houses and storage tanks. Of a farm of 80 acres not more than five need necessarily be kept from cultivation, even though it contain, in time, its full quota of wells. If a good well has been put down on adjoining territory, the farmer in the Illinois field often receives a bonus of from $30 to $100 an acre, or even more, in addition to the royalty and rental. In many instances the supposed rich strike in time proves of little value. The lease expires without being drilled and the farmer is ahead a sum equal to the bonus advanced.

If, on the area leased, some good wells are developed, the lease, like the franchise of a street railway, becomes the most valuable part

of the so-called "oil-property"; and with the wells already in operation is often sold for large amounts. Even though no wells are drilled on a leased farm, the lease often changes ownership a number of times before it expires. The following is a form of lease in common use in the Illinois field:

THIS AGREEMENT, Made this.....day of.....A. D. 190..
WITNESSETH, That.....
.....Lessors
In consideration of One dollar in hand duly paid by John Doe, of Lima, O., lessee, do hereby grant, demise, and let unto the lessee all the oil and gas in and under the following described tract of land; also the said tract of land for the purpose of operating thereon for said oil and gas with the right to use water, oil and gas therefrom, except water from wells now on said premises and all rights convenient for such operations; also the right at any time to remove a part or all of the property, machinery or fixtures placed thereon by lessee. Said land being situated in the.....of.....
County of.....State of.....described as follows:
.....
.....
.....
.....
Containing.....acres more or less hereby releasing and waiving all rights under and by virtue of the homestead exemption laws of this State. To have and to hold unto the lessee for the term of five years from the date hereof, and as much longer thereafter as oil and gas are found in paying quantities thereon. The lessee shall deliver into tanks or pipe lines to the lessor's credit, the one eighth part of all the oil produced, and saved from the premises; and shall pay at the rate of One hundred dollars per year for each gas well during the time gas is sold or marketed therefrom.

The lessors may have gas free of cost from any gas well on said premises for use in the dwelling house thereon at their own risk so long as the lessee continues to operate such well, the lessors making connections for gas at such point or place as may be designated by the lessee.

No wells are to be drilled within two hundred feet of the dwelling house now on the premises without the lessors consent; whenever the lessors shall request it the lessee shall bury all oil and gas lines which are laid over tillable ground and shall pay all damage to growing crops caused by burying or removing said pipe lines.

It is provided, that this lease shall become null and void if a well is not completed on the premises within two years from the date hereof, unavoidable delay excepted, unless the lessees thereafter pay at the rate of 25 cents per acre per year (payable quarterly) until a well is completed, which payments maybe made direct to the lessor..or deposited to their credit in the.....
.....
.....

All the provisions hereof shall extend to the heirs, successors, and assigns of the respective parties hereunto, upon the payment of One dollar, at any time, by the lessee his successors or assigns, to the lessors their heirs or assigns; said lessees his successors or assigns shall have the right to surrender this lease for cancellation; after which all payments and liabilities thereafter to accrue under and by virtue of its terms shall cease and determine, and this lease becomes absolutely null and void.

Witness the following signatures and seals:
Witness.—

....(SEAL)
....(SEAL)
....(SEAL)
....(SEAL)

STATE OF ILLINOIS. }
COUNTY OF..... } ss

I,.....in and for said County in the State aforesaid, do hereby certify that.....
.....
.....
personally known to me to be the same person....whose name..... subscribed to the foregoing instrument, appeared before me this day in person, and acknowledged that ...he... signed, sealed and delivered the said instrument as ..... free and voluntary act, for the uses and purposes therein set forth, including the release and the waiver of the right of homestead.

Given under my hand.....Seal, this..... ...day of..... A. D. 190..

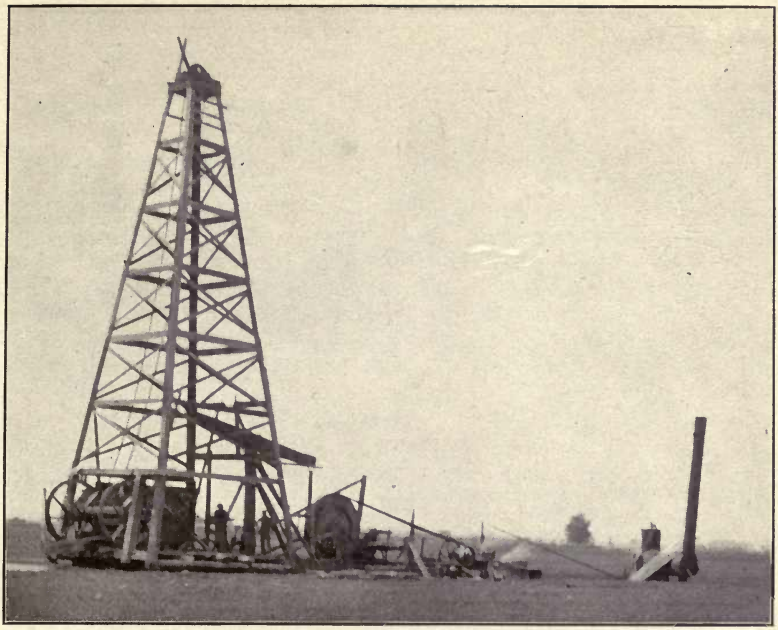
....
.....

Locating the wells—Aster securing a lease, the operator must choose the site for his first well. It is usually the custom to drill at some point about 200 feet from the property line in order to first obtain the oil which might otherwise be raised by operators of adjoining leases. Various circumstances, such as the dip of the oil bearing rock, variations in the surface level of the tract leased, the location of a permanent power house, etc., are to be considered in determining the site of the well. If wells are down on adjoining leases, the production of the first well, as compared with that of the older ones, can be used to gauge the location of future bores. If a well holds up to 10 or 15 barrels a day for three months or more the chances are that it is close to or connected with a large area of porous rock, and that better wells may be located somewhere in the immediate vicinity. The wells are usually put down 400 to 600 feet apart; that distance, in the language of the oil field, being termed a "location."

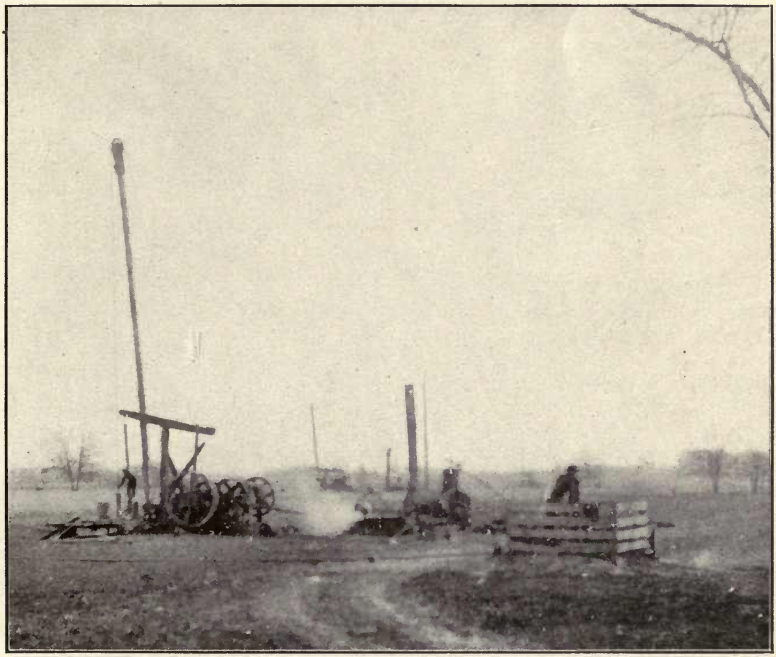
An unwritten law exists among operators that the lessee of a tract of land shall immediately put down wells when producing wells are drilled on adjoining territories. This is done to offset and protect property lines and prevent the oil underlying one tract from being drained off through another.

As to the amount of acreage to be assigned to an oil well, opinion varies greatly. On the larger leases ten acres are often given to the well. On the smaller leases one to every five acres is often drilled. One common and very good method of locating the wells on an 80 acre lease is to have them 200 feet back from the outside line and 460 feet apart. This leaves a distance of 920 feet clear in the center, on which the power house can be erected. By this method 14 wells can be placed on each 80 acre tract, and have the center to draw on.

Drilling rig—Having selected a site for his first well, the operator next contracts for the drilling. If this be done with a drilling machine, as is the custom in the shallow territory of the Casey field, he does not have to build a rig and the process is much simplified. In that field the machines in use are principally the "Star" and a Parkersburg, W. Va. machine. The entire drilling outfit, machine, engine, boiler and tools, costs about $2,200. A number of contracting drillers, some of them owning a half dozen or more outfits, soon flock to a new field which promises much work. Oftentimes the operators



A. STANDARD DRILLING RIG.



B. DRILLING MACHINE USED IN NORTHERN PART OF THE FIELD.

own their own machines and do their own drilling. The price for drilling in the Casey field in May, 1906, was $1.00 per foot. The operator furnishes all drive pipe, casing, tubing, etc. The contractor pulls and resets the casing for shooting, cleans out the well and puts in tubing and rods for pumping. If his fuel and water is furnished, he received but 90 cents per foot. If a standard rig is used in drilling, as is the custom in the deeper territory of the Crawford county field, the operator must first contract for it and have it erected before the drilling begins. This rig consists of four strong uprights held in position by ties and braces and resting on strong wooden sills, which are preferred as a foundation to masonry. The derrick is used as a support for the sheave called the crown pulley, which must rest at a sufficient height to swing the heavy drilling tools free from the ground. The average height of the derrick is 72 feet, and it forms the most conspicuous object which characterizes an oil field.

With the derrick are included under the term "rig" all the woodwork and its necessary iron fittings so put together that when boiler and engine are in place drilling can at once begin. The bull wheel and shaft on which the cable supporting the drilling tools is wound; the walking beam to give vertical motion to the tools, and the band wheels for transmitting power from the engines to the movable parts are, next to the derrick, the most important parts of the rig.

The construction of the rig is usually undertaken by a contractor known as a "rig builder", for a certain specified sum. In the Crawford county field in 1906 the price paid for the rig complete was $525. After the well is completed the rig is, in most cases, left standing, though small operators often take it down and use it for another well. A considerable saving of outlay for lumber and rig irons is thus effected, but if the well stops flowing or needs cleaning out, a new rig, usually smaller and less expensive, must be built.

Drilling the well—The drilling crew consists of four men, two drillers and two tool dressers, who work in pairs, 12 hours each. It is the duty of the driller to stay close to the mouth of the bore and attend to the drilling proper, turning the cable and the temper screw when necessary and controlling the machinery by cords and lever when changing the tools and sand pumping. The tool dresser is the helper to each driller. He fires the boiler, attends to the engine and machinery and dresses or sharpens the bits as each in turn becomes worn.

The wages paid to drillers in the Illinois field in 1906 were $5.00 and the tool dressers $4.00 each per day. The contractor is responsible for accidents and failure to complete a well. The time necessary to put down a bore in the Casey field was four to five days. The shooting, tubing and connecting with power requires about two days longer. The operator connects the well with the power as soon as it is tubed by the driller. In the Crawford county field from 12 to 14 days are required for drilling.

Shooting the Well.—As soon as the porous stratum is passed through, if there is a fair showing of oil the well is torpedoed or "shot" in order to open up fissures in the porous rock and form a cavity

therein into which the oil may flow. In the Illinois field it is now the custom to drill to the bottom of the oil bearing rock, and then, if possible, gauge the shooting so that the rock will be shattered from the bottom of the drill hole to the top of, but not far above, the porous stratum. This prevents the explosion affecting the shale or other formation overlying the oil bearing stratum and so filling up the cavity with loose debris and rendering the well worthless. Nitro-glycerine is the explosive used, and the amount depends largely upon the texture of the porous rock or so-called "sand." If it is hard and close pored, more explosive is necessary than where coarse and friable. In the latter case a large shot shatters too great a quantity and causes too much trouble in cleaning out after the shooting. An average shot in the Casey field is 85 quarts, though some operators persist in drilling deep and using 120 to 150 quarts in all wells. "The bigger the shot the better the well" is the motto of some of the operators in the Siggins pool.

The shooting is done by a contractor who follows it as a vocation. He is usually an agent of the company who manufactures the explosive, and often works on the percentage system, receiving from the company a stipulated sum per quart for the explosive sold.

The nitro-glycerine is hauled overland from the factory in square tin cans holding eight to ten quarts each, and stored in quantity in buildings erected in some out of the way place at various points in the oil field. When a well is ready to be shot, the agent who does the shooting transports, in a light buckboard buggy, padded and fitted for the purpose, a number of these cans to the well. There the glycerine is poured into cylindrical tin cans, called "shells," about five inches in diameter and long enough to hold 20 quarts of the explosive. The average shell is five feet, five inches in length. Each shell is conical at the lower end, and slightly concave at the upper. As soon as the first shell is filled, it is lowered into the bore. When it reaches the bottom the lowering line, by a special device, becomes detached and is drawn up. The second shell is then filled, and, when lowered its conical end fits into the cavity at the top of the first. In this manner, each of the shells, after being lowered, rests in close connection with the one preceding. The last or top shell is fitted in a special manner with a waterproof percussion cap so arranged that it can be readily set off with an electric spark, communicated to it by a wire which is connected with a hand battery.

It is the custom in the Illinois field to remove the casing section by section after the nitro-glycerine has been placed in the bore and then reset it as soon as the shooting is over. The removal takes but an hour or two, and danger of collapsing or breaking the casing is thereby obviated.

When the nitro-glycerine is exploded, a person 100 yards away will, after an interval of 30 to 50 seconds, experience a slight jarring of the earth, accompanied by a muffled report somewhat louder than a pistol shot. A minute or so thereafter a roaring sound is heard and a solid column of oil and water is seen issuing from the mouth of the bore. This rises higher and higher until it finally reaches far above the derrick and there breaks into spray. Blown up with it are many frag-

ments of stone and the remains of the tin canisters, shattered into a thousand particles. Pieces of porous rock blown up from a depth of a thousand feet often weigh six to eight pounds.

The flow of oil resulting from the explosion usually soon subsides and, as soon as possible after resetting the casing, tubing two to two and a half inches in diameter and reaching to the bottom of the bore, is put in and connected with a tank which has been erected near by. These tanks are cylindrical, are constructed of wooden staves, and are usually gauged to hold 250 barrels each. In such a tank each inch in depth equals two and a half barrels of oil; therefore, in oil field vernacular, a yield of "ten inches a day" means twenty-five barrels. The cost of such tanks in the Casey field in 1906 was $95.00 and in the Crawford county field, $100.00.

Pumping the oil—After tubing the well and connecting it with the tank, the necessary pumping apparatus must be attached. If a number of wells are to be drilled a power house is located near the center of the lease and a small gas or steam engine placed therein. Each well is supplied with a jack and balance weight, to which the necessary pumping or sucker rods which ply up and down inside the tubing are attached. When a number of wells are pumped by one engine the power is transmitted to the pumping jack of each by means of steel pull rods or wire ropes provided with suitable angle knees to change the direction of the pull. In the Casey field where the surface is level the rods run about two feet above the ground and rest in notches cut in the top of short posts or props. Where the surface is broken or uneven the rods are suspended above the ground by ropes attached to poles or posts which are set in a row between the power house and well. The engine in the power house runs an oscillating pull-wheel which gives horizontal movement to the rods radiating from it to the different wells. The pull-wheel draws the rods in one direction, and on the return the weight of the sucker rod, hanging from the jack, draws them back. In this way wells have been pumped one mile from the power house, and often as many as twenty wells, and sometimes as many as forty, are pumped by a single engine. More than twenty-five or thirty are, however, too many, for if the power should happen to break down all the wells are stopped. Again, a pumper (the man in charge of the engines and wells) cannot look after more than that number and do it right. The fuel used for pumping is usually gas, the wells on the lease often furnishing enough; though in many instances it is piped in from a distance. The material pumped is run first into a salt water barrel to settle out the water. The oil is drawn off from this into storage tanks.

But little trouble is experienced with salt water in the Casey field, provided sufficient care is taken in drilling to stop before the water-bearing stratum is reached. In the Casey-Westfield pool, this lies some distance below the oil bearing limestone; while in the Siggins pool it is usually just below the eight to fifteen feet of black shale which immediately underlies the productive sandstone. On account of the scarcity of fresh water to operate the engines and for use in drilling, the salt water from the producing rock is used on a number of the leases. This is usually pumped in small quantity with the oil

into a barrel tank. From this the oil flows into the near by storage tank, while the water is allowed to escape from the lower part of the barrel tank, into ditches and drains, or into pipes which lead to a storage reservoir.

Cost of producing well in the Illinois field—The average cost of the *first well* on a lease in the Clark and Crawford county fields in the spring of 1906 was about as follows:

	Clark.	Crawford.
Rig	....	$ 525
Drilling	$400	1,000
Drive pipe	70	80
Casting	250	700
Shooting	100	120
Tubing and pumping outfit	150	200
Power house and power	500	500
Two tanks	190	200
Belting and lead lines	100	100
Incidentals	100	100
Totals	$1,860	$3,525

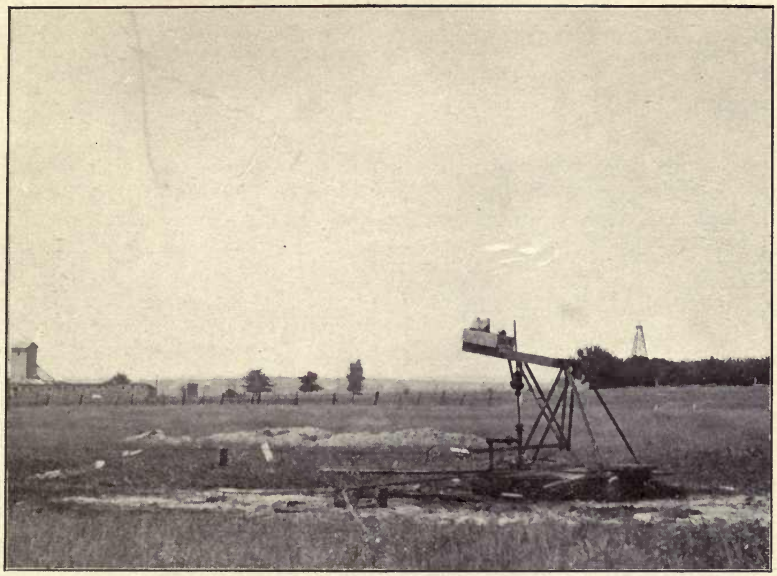
The incidentals include the cost of necessary teaming and the expenses (livery hire, board, etc.) of the operator or field manager while overseeing the work. The second and succeeding wells on the lease will each cost, in the Casey field, about $800 less, and in the Crawford county field, $1,400 less, as the rigs, where used, tanks, power house and power can be used for future wells, though there will be a loss of of $125 in tearing down and rebuilding the derrick, and the number of tanks will soon have to be increased. The cost of the lead lines and surface rods on a lease will increase proportionately to the number of producing wells.

After a tank has been filled with oil the latter must be steamed to reduce the impurites of sediment to a minimum. This is done by connecting pipes from the engine with the bottom of the tank and forcing steam through the oil. From three to four hours is usually necessary to steam a 250 barrel tank. The process of "production" is then complete and the oil is ready for the market.

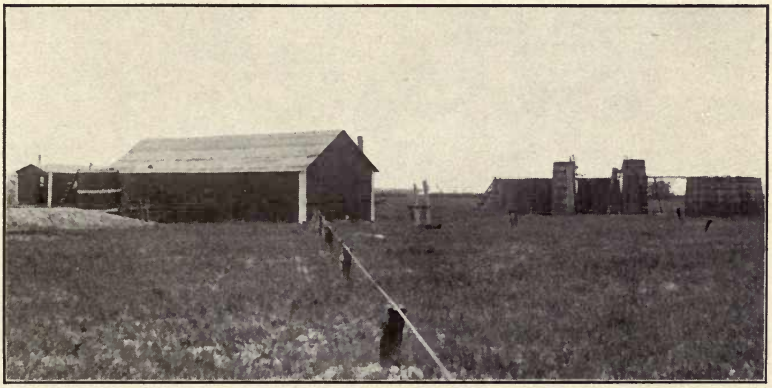
Cost of operating a lease—The cost of operating an oil lease in the Illinois field after the production has been established need not be more than $100 per month, the salary of the pumper being $60 and the cost of fuel about $40. A dozen or even 20 wells can, however, be operated almost as cheaply as one after they have been connected with the power. An extra pumper may have to be employed, but otherwise no additional expense is entailed.

Where the plant has been established, it will pay to pump as low as three or four wells, even if the yield is only four barrels each per day, provided the price of oil is as high as it was on May 10, viz., 81 cents per barrel.

The estimate of expense and income from three four-barrel wells or four three-barrel wells, after deducting the royalty of one-sixth, is as follows:



A. JACK USED IN PUMPING OIL.



B. POWER STATION TANKS AND PUMPING RODS.

Income per month—		
300 barrels of oil at 81 cents		$243 00
Salary of pumper	$60 00	
Cost of fuel	40 00	
		100 00
Net income		$143 00

With six two-barrel wells on the lease, the income would be the same.

From what has been written, it will be seen that the cost of drilling and operating a lease in the Casey, Illinois, field is lower than elsewhere in the eastern United States for the following reasons: (a) The wells are very shallow, the producing rock in most instances being struck at less than 400 feet. (b) It is seldom that more than 100 feet of drive pipe and 320 feet of casing are necessary. (c) On account of a comparatively level surface a large number of wells can be connected to and pumped with one power. (d) Gas for fuel or for running gas engines is available in many parts of the field, and if not present, coal is as cheap as in any other locality. (e) Transportation facilities are good, a system of pipe lines permeating all parts of the main pools.

In the Crawford county field the expenses are higher, running about the same as in the main Indiana Trenton rock field.

Marketing the oil—In the Casey field, where the well is inside of productive territory and promises a fair output, but little difficulty is experienced in getting a pipe line of the Standard Oil Company of Illinois laid to it. This company has loading racks at Oilfield, between Casey and Westfield, on the C. H. & D. Railway, and is erecting nine 35,000 barrel steel tanks one half mile north of Casey. Four of these were completed and filled with oil on May 10, and the remaining five were to be finished as quickly as possible. From these tanks a six inch line extends to the loading rack at Oilfield, near the center of the Casey-Westfield pool, and a four inch line to the Siggins pool.

When a tank is full or nearly so, the pumper notifies a gauger of the Standard company, who comes and measures its contents. A "donkey pump" is then connected with the tank and the oil pumped therefrom into the pipes running to the large storage tanks; about one and a half hours being necessary to empty a field tank.

After deducting 2 per cent for sediment, leakage, etc., certificates are mailed to both the producer and the party owning the land, stating the number of barrels to their credit in the lines of the Standard company, together with the market price of the same. These certificates can be cashed at the various banks in the oil field, or are payable over the counters of the company at Casey.

Output of the Casey field—As the loading rack at Oilfield was not erected until June, 1905, the output prior to that time was stored in tanks. On a number of the smaller leases, especially these in areas outside of the two main producing pools, the field tanks have not yet been connected with the loading station or large storage tanks and the wells are idle on that account. The following table shows the output up to May 1, 1906:

Crude Oil Produced in Casey Field, Clark County, Illinois, and Sold to Standard Oil Company.

Month.	Barrels 42 gals.
June, 1905	5,489.46
July, 1905	9,207.58
August, 1905	15,092.39
September, 1905	19,591.52
October, 1905	26,443.52
November, 1905	34,765.56
December, 1905	45,912.49
Total, 1905	156,502.52
January, 1906	55,680.09
February, 1906	65,208.83
March, 1906	19,352.31
April, 1906	102,861.42
Total to May, 1906	243,102.65
Grand total	399,605 17

The small production in March was due to the bad weather interfering with the operations of the railways. It was made up by the extra heavy deliveries in April.

These figures are published through the courtesy of J. N. McDonald, Auditor, Manufacturing Department, Standard Oil Company, who also advises that the shipments for the first ten days in May indicate an average monthly production per well of about 395 barrels.

In the Crawford county fields no arrangements for piping or shipping the oil had been made up to May 10. It was said, however, that a loading rack would soon be installed at Stoy, a station on the Illinois Central Railway, five miles east of Robinson.

Fake oil companies.—For some reason, not well understood, the promoter of the fake oil company has not yet begun operations in Illinois. Usually a number of such companies are organized when a good strike is made in any region. Their available assets consist of little more than a superb allowance of gall, leases on a few hundred acres of supposed oil territory and a hundred or two dollars invested in prospectuses and stock certificates. Sometimes even the leases are lacking. The company does not expect to make money by producing oil, but by selling stock, and the number of those who pay out their hard earned cash for a piece of engraved paper is usually large. Not one out of a hundred of such stock-selling companies ever pay back even a small percentage of the amount invested. Such companies reaped a harvest of millions of dollars during the Beaumont, Texas, oil excitement of 1902-'04. The highway robber who takes the money of his victim at the point of a gun is an honest man in comparison with some of these barefaced scoundrels who fleece victims of high and low degree with the glittering advertising sheets and stock certificates of their mushroom oil companies.

The *bona fide* oil operator usually has no stock to sell. If he does, he forms a company among his chosen friends and induces them to invest. The money so invested is spent for drilling and supplies. It may be lost, as the venture often results in dry holes, but it is lost legitimately in an honest search for oil. Therefore, I would say to the reader, do not invest money in the stock of any oil company unless

you are well acquainted with the promoters and know them to be honest men who are experienced oil operators. However, if the speculative tendency is too strong to be withstood, either go into the field personally, or send someone in whom you have implicit confidence, and investigate the holdings of the company whose stock you are thinking of buying. By so doing you will lessen the profits, as well as the number, of such fake companies as we have mentioned. The oil business is a big enough gamble within itself—that is, the risks of losing in the legitimate companies are great enough—without taking a thousand-to-one shot in the stock certificates of those get-rich-quick concerns whose members do not know a drive pipe from a derrick.

Need of accurate surface levels.—In order to develop any oil producing area and reduce the number of dry holes to a minimum, the trend, width and dip of the anticlines and synclines in the top of the oil producing stratum should be ascertained by an accurate determination of the surface levels between a number of wells. Where a bore for petroleum has resulted in a good producing well, the level of the surface of the oil bearing rock above or below tide should be carefully ascertained. This can be done only by running a transit level from the nearest point where the surface is known, usually on a railway to the site of the bore. By substracting the surface level of the bore from the depth at which the oil bearing stratum is first struck, the surface of the latter in terms of sea level will be obtained, provided it is below tide. Where the oil bearing rock occurs above tide, the depth of it will be less than the sea level elevation of the bore and should be subtracted accordingly,

The location of the first half-dozen or so wells in any area a mile or two square must of necessity be a matter of guess work, but if the surface level of the top of the sand in each bore, productive or dry, be carefully ascertained, the trend of the anticline and the approximate limits of the field or pool can soon be determined. Too much guess work is carried on concerning the surface level of the spot on which the well is located. In a broken country it is difficult for any man to guess approximately the relative levels of two points a quarter of a mile apart, and the new level should always be ascertained with instruments. The surface level of the bore has nothing to do with the absolute height or surface level of the productive sand, or the absence or presence of the petroleum, but it has a great deal to do with the accurate determination of the surface level of the sand, and therefore with the location of future wells. For these reasons lines of level have been recently run through the Clarke county field for the Survey by Mr. E. M. Scheflow, assisted by Mr. Loren Digby. Bench marks, consisting of a small brass tag, were put up at frequent intervals and stamped with the elevation above sea level. The location and elevation of these marks is given in the list below.

LIST OF BENCH MARKS.

By E. M. Scheflow.

From Charleston to Westfield.

No.	Observed elevation...	Elevation of bench mark	Location.
1	654.00	.....	Base of rail front of Big Four station, Charleston, Ill. (Taken from Gannett's dictionary of altitudes.)
2	667.19	.....	South end of west step, Charleston court house. (Taken from Gannett's dictionary.)
3	640.08	.....	Base of corner stone, Charleston theatre. (Taken from Gannett's dictionary.)
4	691.41	.....	Base of west column of north entrance of Normal school. (Taken from Gannett's dictionary.)
5	689.16	680	Post near Sam Turney's mail box, ½ mile south of Charleston.
6	675.64	677	Telephone post on Wrightsville and Salsbury roads, ½ mile south of Charleston.
7	648.77	651	Telephone post in middle of hill to river, north side.
8	571.87	573	Telephone post at north end of Blakeman bridge.
9	703.94	705	Telephone post at top of hill south of Blakeman bridge.
10	716.19	718	Telephone post on center of west line of N. E. qr. sec. 31, twp. 12 N., R. 10 E.
11	733.84	736	Fence post in front of Edmund Rennel's house on Salsbury road.
12	721.53	723	Northeast corner Whetstone church in center of N.W. qr., sec. 32, twp. 12 N., R. 10 E.
13	640.15	640	Stump near Edmund Rennel's well, S. W. qr., sec. 29, twp. 12 N., R. 10 E.
14	721.42	723	Fence post in lane leading to Wm. Rennel's well near center of sec. 32, twp. 12 N., R. 10 E.
15	729 72	732	Telephone post in center of east line of N. E. qr., sec. 32, twp. 12 N., R. 10 E.
16	747.27	750	Fence post in front of Johns school house, in center of north ½ sec. 33, twp. 12 N., R. 10 E.
17	742.07	743	Telephone post in center of east line of N. E. qr., sec. 33, twp. 12 N., R. 10 E.
18	747.56	748	Telephone post N. E. corner of sec. 33, twp. 12 N., R. 10 E.
19	746.63	747	Blacksmith shop (John Riggin's) south line of sec. 27, twp. 12 N., R. 10 E.
20	747.52	650	Telephone post in S. E. corner sec. 27, twp. 12 N., R 10 E.
21	749.37	751	Telephone post in S. E. corner sec. 26, twp. 12 N., R. 10 E.
22	733.00	734	Tel phone post in S. E. corner sec. 25, twp. 12 N., R. 10 E.
23	758.12	760	Telephone post where road on south line of sec. 30, twp. 12 N., R. 11 E., turns north about one mile west of Westfield.
24	758.28	760	Telephone post near west limits of Westfield.
25	752.78	755	Telephone post in S. E. corner of Westfield college campus, Westfield.
26	718.56	.....	Base of rail on South st. and C. H. & D. R. R. crossing, Westfield.
27	721.54	723	Telephone post on South st. and C. H. & D. R. R. crossing, Westfield.

From Westfield to Casey.

28	682.02	.....	Base of rail on trestle No. 55, C., H. & D. R. R.
29	683.49	685	Telephone post near trestle No. 55, C., H. & D. R. R.
30	678.41	680	Telephone post near switch one mile south of Westfield.
31	694.02	694	Telephone post near S. E. corner of sec. 32, Westfield, opposite Shuey well.
32	664.24	665	Telephone post opposite Briscoe tank on south line of sec. 32, Westfield.
32a	653.26	655	Railroad sign post ¼ mile south of Briscoe tank.
33	647.11	648	Telephone post ¾ mile south of Briscoe tank.
34	654.81	656	Telephone post one mile south of Briscoe tank.
35	659.02	660	Telephone post opposite Treat & Co.'s power house No. 1.
36	651.16	652	Telephone post at crossing of railroad and south line of sec. 8, Parker twp.
37	648.53	650	Telephone post about ½ mile north of Oilfield.
38	642.91	644	S. W. corner oil supply house, Oilfield.
39	642.29	642	Trestle No. 51, ¼ mile south of Oilfield.
40	645.94	647	Telephone post ⅞ mile south of Oilfield.
41	645.64	.....	Base of rail on trestle No. 50, one mile south of Oilfield.
42	654.16	655	Railroad sign post 1½ miles south of Oilfield.
43	651.94	652	Corner section house 1¾ miles south of Oilfield at highway crossing.
44	647.58	647	Trestle No. 49, two miles south of Oilfield.
45	648.11	650	Railroad sign post on highway crossing 2½ miles south of Oilfield.
46	651.08	652	Railroad sign post on highway crossing 3 miles south of Oilfield.
47	646.03	.....	Base of rail on trestle No. 49A.
48	642.15	642	North end-beam on trestle No. 48, 3½ miles south of Oilfield.
49	648.93	651	Railroad sign post on highway crossing 4 miles south of Oilfield.

From Westfield to Casey—Concluded.

No.	Observed elevation.	Elevation of bench mark	Location.
50	648.87	651	Railroad sign post on highway crossing 4½ miles south of Oilfield.
51	644.78	644	East guard-beam on trestle No. 47.
52	638.37	638	East guard-beam on trestle No. 46, one mile north of Casey.
53	631.90	631	East guard-beam on trestle No. 45, ¾ mile north of Casey.
54	636.86	637	Railroad sign post at crossing of North Vasper street and C., H. & D. R.R., Casey.
55	634.93	.....	Base of rail at station C., H. & D. R. R., Casey.
55	635.11	.....	Base of rail at railroad crossing Vandalia and C., H. & D. railroads.
57	638.34	639	Door post at Vandalia depot, Casey.
58	663.54	665	Telephone post on center of east line of S. W. qr., sec. 29, Parker twp.
59	648.38	650	Telephone post N. E. corner of S. W. qr., sec. 29, Parker twp.
60	651.71	654	Telephone post opposite Treat & Co.'s power house No. 4.
61	655.71	657	Telephone post on center of north line of sec. 20, Parker twp.

East from C. H. & D. R. R. on North Line of Casey Township Northwest of Casey.

62	648.33	650	Telephone post on S. E. corner sec. 32, Westfield.
63	634.95	637	Fence post on center south line of S. W. qr. sec. 33, Westfield twp.
64	629.61	631	Telephone post on S. E. corner of sec. 33, Westfield twp.
65	649.45	650	Fence post on center of west line of sec. 34, Westfield twp.
66	617.20	619	Fence post on center of east line of sec. 34, Westfield twp.
67	632.11	634	Telephone post in center of sec. 35, Westfield twp.
68	639.61	642	Fence post at about center of sec. 36, Westfield twp.

East from C. H. & D. R. R. on South Line of Westfield Township.

69	648.63	650	Telephone post on center of north line of N. E. qr. sec. 5, Casey twp.
70	634.32	636	Telephone post on center of north line of sec. 4, Casey twp
71	637.24	638	Fence post on center of north line of N. W. qr. of sec. 3, Casey twp.
72	633 90	635	Telephone post on N. E. corner of sec. 3, Casey twp.
73	626.07	628	Fence post near center of north line of sec. 2, Casey twp.
74	616.98	618	Telephone post on center of north line of N. E. qr. sec. 2, Casey twp.
75	570.67	572	Fence post near center of N. W. qr. of sec. 36, Parker twp.

Northwest of Casey.

76	636.19	637	Semaphone on Vandalia tracks, ⅜ mile from station.
77	635.80	637	Railroad sign post on highway crossing one mile from station.
78	641.12	643	Telephone post on center of east line of sec. 19, twp. 10 N., R. 11 E.
79	636.28	638	Telephone post in center of sec. 19, twp. 10 N., R. 11 E.
80	628.81	630	Telephone post on center of west line of sec. 19, twp. 10 N., R. 11 E.
81	626.18	628	Telephone post on center of west line of N. W. qr., sec. 19, twp. 10. N., R. 11 E.
82	616.43	618	Fence post on center of west line of N. E. qr. sec. 24, Union twp.
83	617.43	619	Telephone post on center of north line of sec 24, Union twp.
84	605.46	607	Telephone post on center of south line oi S. W. qr. sec. 13, Union twp.
85	590.68	.....	South end of east rail of bridge near center of N. W. qr. sec. 13, Union twp.
86	603.95	605	Fence post in center of N. W. qr. sec. 13, Union twp.
87	613.53	615	Telephone post in center of S. W. qr. sec. 12, Union twp.
88	606.52	608	Telephone post in center of sec. 12, Union twp.
89	600.35	.....	West end of north rail of bridge on center of north line of S. E. qr. sec. 12, Union twp.
90	621.70	623	Telephone post on center of east line sec. 12, Union twp.
91	620.99	623	S. W. corner of building of Goodhope Univ. church, in sec. 7, twp. 10 N., R. 11 E.
92	628.47	631	Tree stump near center of sec. 7, twp. 10 N., R. 11 E.
93	644.04	645	Telephone post near center of east line of S. E. qr. sec 7, twp. 10 N., R. 11 E.

No.....	Observed elevation...	Elevation of bench mark	Location.
94	642.08	644	Telephone post on center of west line of N. W. qr. sec. 18, Casey twp.....
95	649.42	651	Telephone post on center of west line of N. E. qr. sec. 18, Casey twp.....
96	644.31	646	Telephone post on center of east line of N. E. qr. sec. 18, Casey twp.....

South of Casey.

97	634.02	636	Telephone post on Jefferson and Vaspar streets, Casey .....
98	627.64	629	Telephone post on Jefferson and South First streets, Casey.....
99	620.78	622	Telephone post on northeast corner of Fairview Park, Casey .....
100	618.80	621	Telephone post in center of section 29, Casey twp.....
101	614.69	.....	South end of east rail bridge near center of south line of sec. 29, Casey twp..
102	620.55	622	Telephone post on center of south line of sec. 29, Casey twp .....
103	623.99	625	Telephone post in center of sec. 32, Casey twp .....
104	620.71	622	Fence post on center of south line of sec. 32, Casey twp.....
105	606.61	607	Telephone post in center of sec. 5, Johnson twp.....
106	604.07	606	Telephone post on center of south line of sec. 5, Johnson twp. .....
107	598.83	600	Telephone post on northeast corner of sec. 8, Johnson twp.....
108	580.93	580	East end of south rail of bridge, near northeast corner of sec. 8, Johnson twp.
109	595.48	596	Telephone post on center of north line of sec. 9, Johnson twp.....
110	613.02	614	Telephone post in northeast corner of sec. 9, Johnson twp.....
111	606.47	698	Telephone post on center of east line of sec. 9, Johnson twp.....
112	598.68	600	Telephone post in southeast corner sec. 9, Johnson twp .....
113	590.13	591	Telephone post on center of north line of N E. qr. sec. 15, Johnson twp....
114	587.79	589	Fence post on center of south line of N. E. qr. sec. 15, Johnson twp.....
115	585.82	587	S. W. corner of school house on center of south line of S. E. quarter sec. 15, Johnson twp. .....
116	583.60	584	Telephone post in front of store, Moriah.....
117	522.11	523	On bridge timber of S. E. pier of Peters' bridge over North Fork of Embarras river in N. W. qr. sec. 28, Johnson twp.....

QUALITY AND PROPERTIES OF ILLINOIS CRUDE PETROLEUM.

By F. F. Grout.

Three samples of the crude petroleum produced in Clark and Crawford counties were gathered and sent to the chemical laboratory of the Illinois State University, for testing. No. 1 was a sandstone oil secured from the Weaver lease in the northwest quarter of section 23, Johnson township, (T. 19 N. R. 14 W.) Clark county; No. 2 was a limestone oil taken from the Briscoe lease, operated by Bayliss & Haskel, in the southwest quarter of section 29, Parker township, (T. 11 N. R. 14 W.) Clark county; No. 3 was a sandstone oil taken from the Birch lease in the northwest quarter of section 14, Oblong township, (T. 6 R. 13 W.) Crawford county.

The crude oil as it comes from the well is a dark olive green in hue, its specific gravity being as follows:

Specific Gravity.

No. 1.	Weaver.....	.887
No. 2.	Briscoe.....	.873
No. 3.	Birch.....	.870

Crude Petroleum No. 1.

Sample No. 1 was obtained from the Weaver lease, in section 23, Johnson township. This oil had been standing in an open tank some weeks and is doubtless therefore of a higher specific quality than when first pumped.

The original oil had a specific gravity of .887. It flashed and burned at 60°C. Five hundred cubic centimeters were used for distillation. The heat was raised slowly till the first drop fell from the condenser, and was then regulated so as to distill at a regular rate of about two drops per second. The first drop came at 88°C.

Distillate.	Per cent. Volume.	Sp. Gr. at 15.5°C.	Baumé.	Flashed.	Burned.
Up to 150°C	4.4	.745	58°	Below	5°C.
150 to 200°C	11.0	.773	51°	51°C.	25°
200 to 250°C	9.1	.813	42°	58°	60°
250 to 300°C	13.1	.844	36°	70°	95°
300 to 350°C	50.0	.863	32°	45°	76°
Coke (and loss)	12.4	.....	.....	.....	.....

The first three distillates were colorless with slight opalescence. Color began to distill at 290°. Bloom of fluorescence began to be noticeable about that time. All fractions darkened in 24 hours. The first two distillates had a good sweet oily odor. The next two were very strong with H_2S, after standing a short time; and the last fraction had also a slight odor. The last fraction was brownish-red to green fluorescent. The oil seemed to "crack" readily and completely, yielding coke and oil which distilled at about 325°C. If the process was stopped before completion, the residuum was a black pitch of varying degrees of hardness depending upon the degree of distillation. When 80 per cent (by volume) of the oil had been distilled the fraction above 300° had a specific gravity of .860, and flashed at 47°C. The residuum was a little too soft and sticky to be chewed in the mouth. After about 3 per cent further distillation there was left a good firm residuum; 4 per cent more left coke. The last 7 per cent of oil to be distilled had a specific gravity of .878, and flashed at 43°. The cold test was 10°C.

The low flash test of the fifth fraction is further proof of the "cracking." 100 cubic centimeters of this was redistilled in part to see if the flash test could be improved. After 15 per cent was distilled the remainder flashed at 150°C. The sulphur in the original oil was 0.13 per cent.

Crude Petroleum No. 2.

This sample was taken from the Briscoe lease operated by Bayliss and Haskel, in the southwest quarter of section 29, Parker township, in Clark county.

The original oil had a specific gravity of .873. It flashed and burned at 38°C. It was tested in the same manner as No. 1, to which it was very similar, but was a little lighter. On distillation the first drop came at 53°C.

DISTILLATE.	Per cent. Volume.	Sp. G. at 15.5°C.	Baumé.	Flashed.	Burned.
Up to 150°C	8.6	.741	59°	Below	5°C.
150 to 200°C	10.6	.779	50°	12°C.	20°
200 to 250°C	10.7	.814	42°	50°	60°
250 to 300°C	13.5	.841	36°	74°	107°
300 to 350°C	48.0	.853	34°	37°	45°
Coke (and loss)	8.6	.....	.....	.....	.....

The distillates were of the same kind as came from sample No. 1. When 84 per cent (by volume) was distilled, the (tar) residuum was soft and sticky at ordinary temperatures. When 87 per cent was removed, it was hard and could be chewed in the mouth. These asphalt-like residues were quite odorless and nearly tasteless.

The flash test of the fifth distillate could be raised, as before, by distilling off about 15 per cent of the lighter oils which evidently resulted from "cracking" during the first distillation.

The amount of sulphur in the original oil equals 0.73 per cent.

Crude Petroleum, No. 3.

Sample No. 3 came from the Birch lease in the northwest quarter of section 14, Oblong township, Crawford county.

The original oil had a specific gravity of .870. It flashed at 43° and burned at 60°C. It was much like samples 1 and 2. The first drop of distillate came at 60°C.

DISTILLATE.	Per cent. Volume.	Sp. G. at 15.5°C.	Baumé.	Flashed.	Burned.
Up to 150°C	3.5	.749	57°	Below	5°C.
150 to 200°C	12.0	.775	51°	.....	22°
200 to 250°C	14.2	.809	43°	52°C.	70°
250 to 300°C	10.6	.837	37°	80°	92°
200 up	50.2	.849	35°	27°	45°
Coke (and loss)	9.5	.....	.....	.....	.....

At a temperature of about 90°C. the oil crackled and sputtered, and when the first distillate was examined it was found to be in two layers. Evidently a little water caused the trouble. The lower layer amounted to about 0.5 per cent of the original oil.

There was no odor of H_2S, either during the distillation or after the distillates had stood twenty-four hours in a closed flask.

Sulphur to the amount of 0.10 per cent was found in the original oil.

The examination of oils for the purpose of identifying their composition has not been carried far enough to warrant any extended

conclusions. It can be said, however, that they are chiefly made up of members of the paraffine series, and of the lighter members of that group. Paraffine proper is not of that group.

Cracking begins at 300°C. and, with the exception of the "Birch" oil, the sulphur content is high, allying them in that respect with the sulphur oils of Ohio.

Sparta Crude.

A sample collected June 9, 1906, from a can in Mr. Preston's barn gave the following results. It was said to be just as taken from the well, but since it had stood for some time, may be somewhat heavier than when fresh. It is reported to grade 38° Baumé when first pumped. The specific gravity of original oil was .842, corresponding to 36° Baumé. It flashed at 18°C, and burned at 22°C.

Distillate.	Volume—per cent.	Sp. Gr.	Flashed.	Burned.
Up to 150°C	14	.729	.....	.....
150°–200°	14	.767	20°C	20°C
200°–250°	11	.801	46°	64°
250°–300°	12	.829	92°	112°
300° up	42	.850	28°	42°
Coke and loss	7	.....	.....	.....

No odor of H_2S was observed at any time. The oil seems to be much like the other oils tested from this State, but has a little larger percentage of the light oils.

Litchfield Crude.

This sample was taken from a barrel in the stock of Mr. David Davis. It had been several months out of the ground and probably had suffered from evaporation. The specific gravity as determined by J. W. Gill was .9236. The first drop distilled at 110°C.

Distillate.	Volume per cent.	Sp. Gr.	Baumé.	Flashed.	Burned.
Up to 150°C	1.3	Too little to test.	.....	.....	.....
150° to 200°	.5	Much like the other oil.	.....	.....	.....
200° to 250°	1.2	.....	.....	.....	.....
250° to 300°	15.2	.852	34°	79°C	100°C
300° up	71.1	.863	32°	37°	57°
Coke and loss	10.7	.....	.....	.....	.....

No odor of H_2S was detected. A considerable amount of the first fraction is apparently water; probably 0.5 per cent of the total oil.

INDEX.

LIBRARY CATALOGUE SLIPS.

[Mount each slip upon a separate card, placing the subject at the top of the second slip. The name of the series should not be repeated on the Series card, but the additional numbers should be added, as received, to the first entry.]

AUTHOR.

Blatchley, W. S.

. . . The petroleum industry of southeastern Illinois, by W. S. Blatchley, Urbana, University of Illinois, 1906.

109, v. p. (3 fig. 6 pl.) (State Geological Survey. Bulletin no. 2.)

SUBJECT.

Blatchley, W. S.

. . . The petroleum industry of southeastern Illinois, by W. S. Blatchley, Urbana, University of Illinois, 1906.

109, v. p. (3 fig. 6 pl.) (State Geological Survey. Bulletin no. 2.)

SERIES.

State Geological Survey

Bulletins.

no. 2. Blatchley, W. S. The petroleum industry of southeastern Illinois. 1906.