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UNDISCOVERED OIL RESERVES
IN ILLINOIS

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LOWER ORDOVICIAN AND CAMBRIAN
OIL POSSIBILITIES IN ILLINOIS

By STEWART FOLK

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Undiscovered Oil Reserves In Illinois

Chances for finding substantial amounts of new oil by no means exhausted, especially in stratigraphic type traps

By M. M. LEIGHTON

ILLINOIS has had two great periods of oil development, one beginning in 1905, the other in 1937. Of the total of 1,022,000,000 barrels produced, 566,000,000 barrels, or half, came from fields discovered since 1936.

All but a fraction of one percent of this latter quantity came from fields located in the area of "best possibilities," as recommended by the Illinois State Geological Survey in a map classifying oil and gas possibilities in Illinois which was prepared and exhibited in 1930. This classification was based on a review by Dr. A. H. Bell of the many well logs and other geologic data which the survey had accumulated over a period of 25 years. The discovery of oil in the central part of the Michigan Basin in 1928 led to recognition of the oil possibilities of the Illinois Basin, and accordingly the deep basin area was included with the area of "best possibilities" in the 1930 classification map.

The same organization that prepared the classification map has been studying and aiding in the oil developments and has recently taken stock of the Illinois situation. It is convinced that the chances for finding substantial amounts of new oil are by no means exhausted.

Although no major pools have been discovered for several years, many small pools have been found and continue to be found every month. In the past, major attention has been given to the finding of structural traps. When the reflection seismograph method began to be used, it was natural that the largest structures should be prospected first. That is why large pools like Clay City, Salem, and Loudon were brought in early during the play. It may be that no large pools of the structural-trap type remain to be discovered. However, some of the world's largest oil accumulations, such as East Texas, are of the stratigraphic type, and these are not discoverable by the reflection seismograph method now in use. There is

good geological reason to believe that oil accumulations in stratigraphic traps exist in Illinois. The discovery of oil pools of this type will depend upon geologic studies combined with large-scale systematic drilling programs.

Very probably more oil remains to be discovered in additional producing formations, both above and below those now productive. There have been several instances where pay zones have been passed up and later brought in. Also there are many pools producing in the McClosky or shallower formations in which no tests have been drilled below the Mississippian strata.

In January, 1942, under a special appropriation for work connected with the war effort, the Illinois State Geological Survey undertook studies of Pennsylvanian strata encountered in drilling oil wells, for the dual purpose of obtaining information on the oil and coal resources of the Pennsylvanian system. The old fields of Illinois produced some hundreds of millions of barrels of oil from Pennsylvanian sandstones, but the amount so far produced from Pennsylvanian strata in the new fields has been comparatively small, in spite of the fact that nearly all the wells were drilled completely through the Pennsylvanian system. For several years following the new discoveries in 1937 most wells were drilled rapidly through the Pennsylvanian without saving samples or obtaining an adequate log of the formations drilled, and it is probable that pay zones were sometimes passed up. Electric logs have proved to be of considerable help in stratigraphic studies but alone they are inadequate to detect oil zones or to determine thicknesses of coal beds not previously known. To remedy this situation the survey has obtained a portable laboratory which makes it possible for staff geologists to sit on key wells during the drilling of the Pennsylvanian strata in order to make detailed drilling-time logs, to collect and examine samples taken at

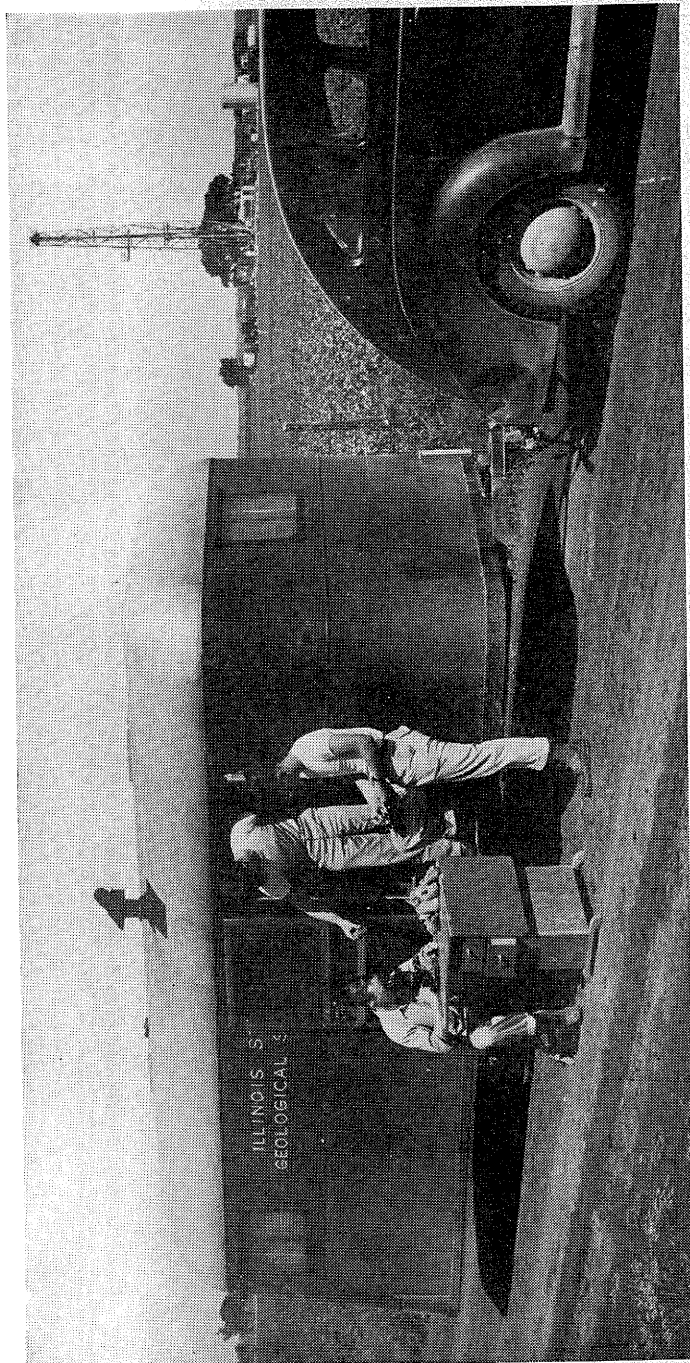


FIGURE 1
Trailer laboratory used by the Illinois State Geological Survey in oil well studies.

frequent intervals and then to correlate in the laboratory all the information from a well, including the electric log. Up to date some 180 wells have been logged in this manner, and the results are being studied for the benefit of both the oil and coal industries.

The new data from the key wells are being assembled in structure maps and cross-sections. It is planned that subsurface studies of pre-Pennsylvanian strata will be made in the areas of the new Pennsylvanian structure maps. These will be based on sample studies, electric logs, and drilling-time logs where available. The relation of pre-Pennsylvanian to Pennsylvanian structure will be given special attention.

Deeper Possibilities

Because the oldest formation that has yielded commercial production of oil in Illinois is the Kimmswick ("Trenton") limestone of Ordovician age it has been customary in much of the past test-drilling in Illinois to stop with the first porous zone in the "Trenton." A few test wells have reached the St. Peter sandstone. There remains, however, a sedimentary section estimated to be about 4000 feet thick below the St. Peter which has not been tested in the Illinois Basin. The lithologic character and the structure of the pre-St. Peter strata in the basin is therefore unknown. The fact that large oil production is

obtained from older Ordovician and Cambrian strata in the Mid-Continent area raises the question as to the oil possibilities of rocks of the same age in Illinois.

In view of the present need for oil and especially for supplies geographically near areas of large consumption, there is now a strong incentive to explore these deeper strata in Illinois.

Detailed studies of reservoir conditions and production conditions in individual pools are in progress. These have a two-fold use, first to help solve production problems, especially in connection with secondary recovery by repressuring or water-flooding, and second to aid in the interpretation of regional geology. This work involves the collection and testing of cores, the collection and analysis of oil, gas, and brine samples, the measurement of reservoir pressures, and the measurement of the rates of withdrawal of the reservoir fluids.

The planning and execution of a program to explore for oil in stratigraphic traps, in the deeper formations, and in undeveloped shallow pay zones should make use of all available scientific data, both geological and geophysical. The Illinois State Geological Survey with its staff of technical experts, its laboratories, and its extensive files of data, is contributing its resources in research to such a program.

Lower Ordovician and Cambrian Oil Possibilities in Illinois

Production of large volumes from these formations in other states suggest commercial possibilities in southern two-thirds of state, where they constitute almost unexplored geological "layer"

By STEWART FOLK

BELOW the St. Peter formation in Illinois are many hundreds of feet of Lower Ordovician and Cambrian sedimentary rocks—dolomites, shales, and sandstones—of marine origin. The folding and partial erosion of these older strata before the St. Peter sands were deposited produced the most marked unconformity in the Lower Paleozoic succession of Illinois and adjoining states (see Figure 1). Some of the subsurface dolomites and sandstones are porous and permeable. Traces of oil have been reported in them in Illinois, and oil is produced from equivalent strata in Texas (Ellenburger limestone), Oklahoma and Kansas (Arbuckle or "Siliceous" lime and the Reagan or Lamotte or "Basal" sand), and in Tennessee (the Knox dolomite). Such conditions suggest that commercially valuable quantities of oil may occur in the Lower Ordovician and Cambrian formations in the southern two thirds of Illinois, where they constitute an almost unexplored geological "layer." Only a few tests have been drilled to them and none has been drilled through them in this area. The present discussion is a preliminary report of a study being conducted by the Illinois Geological Survey and is based largely on data from Northern Illinois.

The Northern Illinois correlatives of the Ellenburger, Arbuckle, and Knox strata are, in descending order, the Shakopee, New Richmond, and Oneota formations of the Prairie du Chien group of Lower Ordovician age and the Trempealeau formation of Upper

Cambrian age. Equivalent strata in Southwestern Illinois are designated by names used in the Ozark region (see Figure 2). Oil shows have been reported in beds of Prairie du Chien and Trempealeau age in tests drilled in West-Central and Southwestern Illinois (see Table 1). No oil shows have been reported in them in the Illinois Basin, but only four tests in the basin have been drilled into pre-St. Peter strata, and of these none has gone deep enough to test even all of the Prairie du Chien.

The Cambrian formations below the Trempealeau are the Franconia, Galesville, Eau Claire, and Mt. Simon, in descending order. They have been correlated with the Wilberns, Cap Mountain, and Hickory formations of Texas, with the basal portion of the Arbuckle and the Honey Creek, Cap Mountain, and Reagan formations of Oklahoma, and the Doe Run, Derby, Davis, Bonnetterre, and Lamotte formations of Missouri. They are not known to have been penetrated in Southern Illinois, but a well in St. Louis, Missouri, was drilled through them and into the pre-Cambrian granite.

The Shakopee and Oneota formations in Northern Illinois consist largely of dolomite with some interbedded thin sandstones. There are subsurface openings or "crevices" in the dolomite beds in places. The New Richmond formation consists chiefly of sandstone with lenses and interbeds of dolomite and thin beds of shale. In LaSalle County, in North-Central Illinois, the permeability of the New Richmond

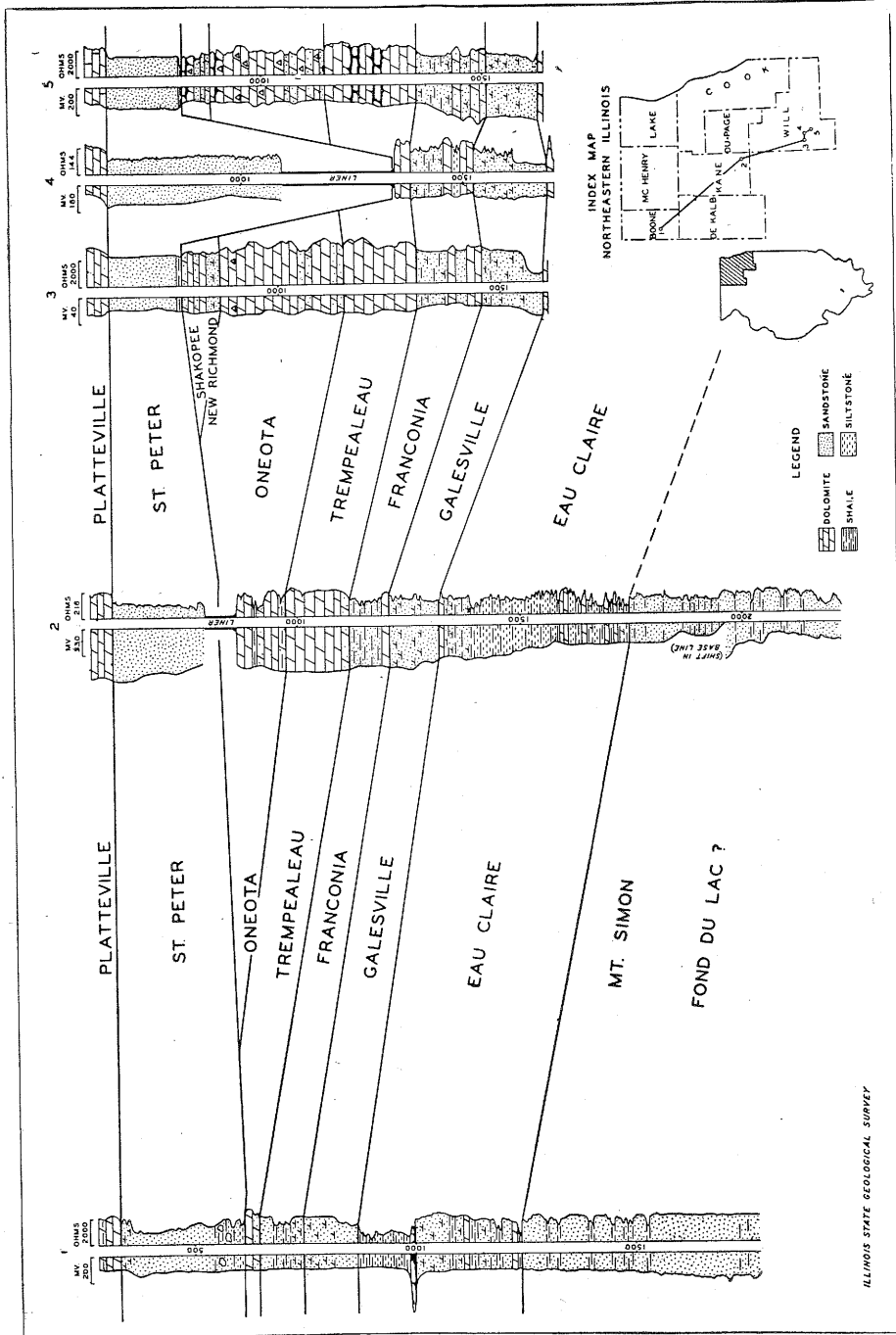


FIGURE 1

Graphic cross-section of Lower Ordovician and Cambrian strata in Northeastern Illinois, based on electric logs and sample studies.

TABLE 1
Oil Shows in Lower Ordovician and Cambrian Formations, Reported by Driller

COUNTY	Sec., T., R., Operator, Farm and Well No.	OIL SHOWS		Total Depth (feet)	Date Drilled
		Formation	Depth (feet)		
Jersey.....	32-7n-11w, A. W. Gerson, Knight 1....	Jefferson City.....	1765-70	2235	1939
McDonough....	33-5n-4w, Curry & Rolleston, Hardy 1.	Jordan?.....	1822?	2306	1930
Monroe.....	20-2s-9w, E. H. Gorse, Hergenroeder 1..	Jefferson City.....	1700-12	2248	1909
St. Clair.....	26-1n-10w, S. G. Lockwood, Dyroff 1...	Jefferson City.....	2054-61	2904	1924
		Gasconade.....	2300-07		
		Van Buren (gas)....	2320-47		
		Eminence.....	2540-47		
		Eminence.....	2580-90		
		Eminence.....	2710-14		
		Potosi.....	2812-28		
		Potosi.....	2836-50		
		Potosi.....	2900-04		
St. Clair.....	28-1n-10w, Tarlton & Sklar, Dyroff 1-A.	Powell.....	1075-90*	1800	1943

* Reported by scout.

sandstone in outcrops ranges to more than 5,000 millidarcies, and its thickness in the subsurface approaches 200 feet. Elsewhere it is much thinner. To the east it either grades laterally into dolomite or wedges out so that the Shakopee overlaps it and lies directly on the Oneota. Oolitic chert and siliceous oolites occur in both dolomites and sandstones and serve to distinguish the Prairie du Chien formations from overlying and underlying formations.

Throughout large areas in Northern Illinois Prairie du Chien strata are missing and the St. Peter formation rests on Cambrian strata. Apparently these areas were unfolded and the Lower Ordovician and some of the Cambrian strata were stripped away in pre-St. Peter time. In other areas the Prairie du Chien attains a thickness of more than 400 feet, but even in these areas it is locally thin or absent owing to pre-St. Peter erosion. Its surface resembles sink-hole or karst topography like that of the Arbuckle dolomite, which is its correlative and a prolific producing zone in the Silica and Trapp pools of Kansas.^{2,3} The Prairie du Chien group thickens southward, being between 800 and 900 feet thick in Southwestern Illinois.

The Trempealeau formation, which consists chiefly of siltstone and sandstone (including the Jordan, a highly permeable sandstone) in Iowa and Wisconsin, is dominantly dolomite in Illinois. Apparently the sandstones and siltstones of adjoining states grade laterally into the dolomite, some of

which is silty and sandy. In the dolomite are numerous quartz-lined vugs and some large openings as much as 8 feet in height. The latter, termed "crevices" by the drillers, under different conditions make or take great volumes of fluid; they seemingly represent extensive cavern systems that were developed after Trempealeau and before St. Peter time. The thickness of the Trempealeau ranges from 0 to 260 feet in Northern Illinois; its normal thickness is approximately 200 feet. Local variations in thickness of the Trempealeau and the widespread occurrence of "crevices" suggest that an unconformity of some magnitude separates the Trempealeau from the overlying Prairie du Chien.

The Franconia formation comprises glauconitic sandstone, sandy shale, and sandy dolomite. Some of the sandstones are porous, others are argillaceous or dolomitic and "tight." Permeability is restricted horizontally by cross-bedding and lenticularity, vertically by shale partings and interbeds. The thickness of the Franconia ranges from less than 50 to almost 200 feet.

The Galesville formation consists of porous sandstone with interbeds of sandy dolomite. The permeability of outcrop samples from Wisconsin exceeds 5000 millidarcies. The average thickness of the Galesville in Northern Illinois is almost 200 feet.

The Eau Claire formation includes shales, siltstones, sandstones, and dolomites, many of which are glauconitic and fossiliferous. Some of the lower

	NORTHERN ILLINOIS		MISSOURI		OKLAHOMA	TEXAS
LOWER ORDOVICIAN	PRAIRIE DU CHIEN	SHAKOPEE NEW RICHMOND ONEOTA	BLACK ROCK SMITHVILLE POWELL COTTER JEFFERSON CITY ROUBIDOUX GASCONADE VAN BUREN Gunter ss. member		ARBUCKLE ("Siliceous lime")	ELLENBURGER
			Jordan ss. member	EMINENCE		
CAMBRIAN	TREMPEALEAU		POTOSI		HONEY CREEK	WILBERNS
	FRANCONIA	IRONTON ss. member	ELVINS	DOE RUN DERBY DAVIS		
	GALESVILLE			BONNETERRE		CAP MOUNTAIN
	EAU CLAIRE	REAGAN	HICKORY			
	MT SIMON	LAMOTTE				

FIGURE 2

Tentative correlation chart of Lower Ordovician and Cambrian strata. Based principally upon: (a) Bridge, Josiah, *The Correlation of the Upper Cambrian Sections of Missouri and Texas with the Section in the Upper Mississippi Valley*: U. S. Geol. Survey Prof. Paper 186—L, 1936. (b) Bridge, Josiah, *Geology of the Eminence and Cardareva Quadrangles*: Missouri Bur. Geol. and Mines, Vol. 24, second ser., 1930. (c) Dake, C. L., and Bridge, Josiah, *Faunal Correlation of the Ellenburger Limestone of Texas (with an appendix by E. O. Ulrich)*: Bull. Geol. Soc. America, Vol. 43, pp. 725-48, 1932.

Eau Claire sandstones possess good porosity and permeability. The Eau Claire averages between 400 and 500 feet in thickness.

The Mt. Simon formation consists almost entirely of sandstone, some of it porous and permeable. Formerly all the sedimentary strata below the Eau Claire formation and above the pre-Cambrian granite were called Mt. Simon in Illinois, but on the basis of recent studies it is now considered that the lower part of this sequence, consisting of conglomeratic and arkosic sandstones and sandy shales, prevailing red in color, is a separate formation and may be equivalent to the Fond du Lac beds of pre-Cambrian age in Minnesota. The thickness of the sedimentary section below the Eau Claire ranges from ap-

proximately 1700 feet to more than 2200 feet in Northern Illinois.

The thickness of all the Lower Ordovician and Cambrian strata below the St. Peter in the deep well at St. Louis, Missouri, was reported to be 2230 feet.

The Lower Ordovician and Cambrian formations in Illinois have experienced a number of periods of structural movement. The most important of these were (1) in the Ordovician period, after Shakopee and before St. Peter deposition, (2) during the Devonian period, (3) in the post-Mississippian, pre-Pennsylvanian interval, and (4) in post-Pennsylvanian time. Structural traps for the accumulation of oil in the formations below the St. Peter could have been formed during any or all of these and other periods of folding. There also

might be stratigraphic traps in the dolomites and sandstones below the St. Peter.

Whether or not the structure of the overlying beds can be used as a guide in exploration for oil in the Lower Ordovician and Cambrian formations is not now known, nor can it be predicted whether the formations below the St. Peter will more probably be productive in pools producing from higher formations or in areas where the higher formations produce no oil. The Lower Ordovician formations have been reached on only four producing structures in Illinois; the Cambrian on only one. On the Waterloo-Dupo anticline, the only producing structure tested to the Cambrian, an oil show was reported in the Lower Ordovician, and several shows were reported in both Lower Ordovician and Cambrian formations in a test on the flanks of the structure. The greatest thickness of pre-St. Peter strata penetrated on the other three structures that were drilled into the Lower Ordovician was only 230 feet, which is not enough for a real test.

From a structural viewpoint there are two regions in Illinois that appear to be most favorable for Lower Ordovician and Cambrian prospecting at present. They are (1) Eastern Illinois, from Ford and Iroquois Counties south to Wabash County, and (2) Western Illinois, from Henderson and Warren Counties south to Randolph County. Through Eastern Illinois extends the LaSalle anticlinal belt, the most prominent structural feature of the state; along it are several well-defined closures, none of which have been drilled below the St. Peter formation, south of Ford County.

There are a number of anticlines in Western Illinois on which the Lower Ordovician and Cambrian strata merit testing. Some of them are Pennsylvanian or later in age, some are pre-Mississippian. The fact that Western Illinois was structurally high during the Silurian and Devonian periods as well as at later times suggests that there also may have been pre-St. Peter folding in the area.

Possibilities for Lower Ordovician

and Cambrian production may be as good in the Illinois basin as in Eastern and Western Illinois, but drilling costs probably are too high to warrant much exploration there until more is known about the Lower Ordovician and Cambrian in other parts of Illinois. Depth to the top of the Lower Ordovician is less than 4000 feet throughout most of Western Illinois and along a greater part of the LaSalle anticlinal belt, but in the basin it is as much as or more than 8000 feet.

Although the pre-St. Peter sedimentary rocks of Central and Southern Illinois have been so little explored that the Lower Ordovician and Cambrian geological conditions there are little known, it may be inferred that they are similar to conditions in Northern Illinois. If so, there is no lack of porous zones and of structural traps, and possibly stratigraphic traps. Oil shows reported to occur in these rocks in Illinois and the quantity of oil produced from their equivalents in other states suggest that commercial production may be obtained from them in Illinois. All tests of them should be drilled at least through the Trempealeau formation; and to be thorough they should be drilled into the Mt. Simon formation. Structurally favorable areas in the eastern and western parts of the state are considered the best possibilities for current exploration for Lower Ordovician and Cambrian oil pools in Illinois.

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