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ILLINOIS PETROLEUM 72

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OIL RESOURCES AND POSSIBILITIES  
IN ILLINOIS

BY  
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# OIL RESOURCES AND POSSIBILITIES IN ILLINOIS

By

Alfred H. Bell

## ABSTRACT

The record of oil production in Illinois for the past 50 years indicates that much oil will be discovered and produced in the future. It is suggested that the state's future production may well be as much as the total to date of 1 3/4 billion barrels, making an ultimate total of 3 1/2 billion barrels. Geology, aided by geophysics, will continue to have a major part in guiding exploratory drilling.

## INTRODUCTION

Illinois ranks sixth in the United States in total production of oil to date and eighth in present rate of oil production. Illinois is first among the states east of the Mississippi River, both in total oil production and present rate of production. During the year of peak production - 1940 - Illinois ranked fourth, exceeded only by Texas, California, and Oklahoma. Except for a slight rise in 1946 (0.11 percent), production declined every year from 1940 until 1954. The total production in 1954 was approximately 66.9 million barrels, 13.4 percent above the production in 1953. The causes of this reversal in the trend of the previous 13 years are discussed below.

The year 1955 is the fiftieth anniversary of the beginning of major oil production in Illinois and also of the establishment of the Illinois State Geological Survey. In view of the close cooperative relationship of the oil industry and the Survey throughout this half century, it seems appropriate to observe this double anniversary with a brief discussion of the development of the Illinois oil industry, its present status, and future prospects.

## PERIODS OF MAJOR DEVELOPMENT

Illinois has had two major periods of oil activity, one from 1905 to about 1912, with a production peak of 33.6 million barrels in 1908, the other from 1937 to about 1941, with a production peak of 147 million barrels in 1940 (see fig. 1). Until 1936, about 98 percent of the State's total oil production of 410 million barrels came from one major field - the Southeastern Illinois Oil Field (Blatchley, 1906; Blatchley, 1910; Mylius, 1927) - located on the LaSalle anticlinal belt in Clark, Crawford, Lawrence, and adjacent counties (fig. 2). The remaining 2 percent came from scattered small fields in western Illinois (Blatchley, 1913).

Little exploratory drilling was done before 1936 in the deep part of the structural basin that underlies southern Illinois and adjacent parts of Indiana and Kentucky. One reason was that the salt water in the productive sandstones

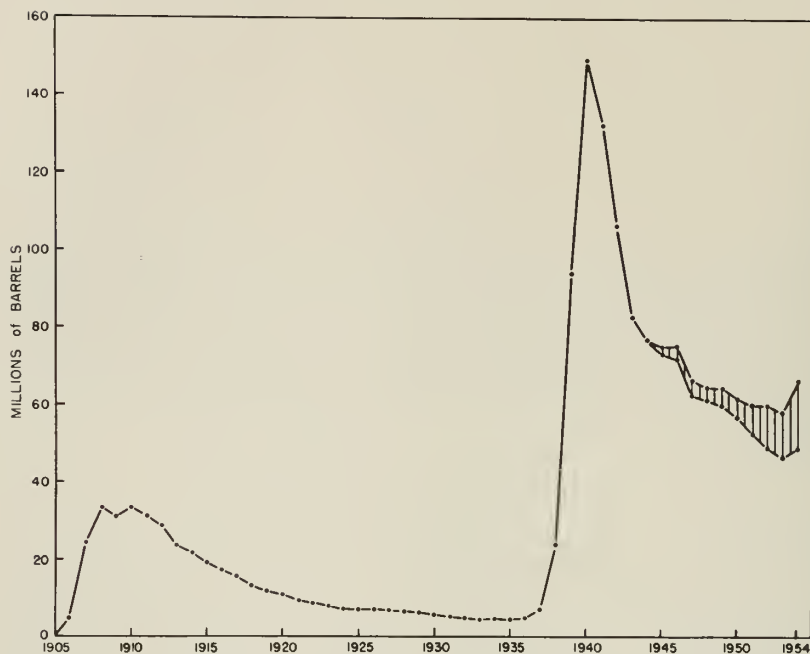


Fig. 1. - Oil production in Illinois by years, 1905-1954. Shaded area represents oil produced by water flooding, 1944-1954.

of the LaSalle belt on the western flank of that structure was thought to indicate that the sands would probably contain salt water all the way across southern Illinois. Another reason was the apparent failure to recognize the presence of a major structural basin (see figs. 3 and 4). As the known production at that time was practically all at shallower depths, many people believed that a drilling depth of 2,000 feet was enough to test the probable oil-bearing sands anywhere in Illinois. The fact that the rock formations reached in 2,000-foot wells in the LaSalle belt might be as much as 2,000 feet deeper (or at depths up to 4,000 feet) was hardly suspected by many of the oil operators. In spite of scattered wildcat drilling and the discovery of a number of pools in western Illinois, the state's annual production declined almost every year from 1910 to 1936, and the rate of exploratory drilling reached a low ebb.

#### THE 1930 CLASSIFICATION MAP

In May 1930, the Illinois State Geological Survey observed its 25th anniversary with a special program of meetings and an exhibit reviewing the mineral resources and mineral industries of the State. At the same time, the Illinois State Academy of Science held its twenty-third annual meeting at the University of Illinois. One of the papers in the Geology Section cited the recent discoveries of oil in the deep parts of major structural basins in Michigan and west Texas, and called attention to the untested possibilities of oil in the deep parts of the Illinois Basin (Bell, 1931). The mineral resources and industries exhibit included a map (fig. 5) dividing the state into areas according to the relative likelihood of the discovery of new oil and gas fields. This map was



Fig. 2. - Index map of counties in Illinois.

based on data accumulated on the surface and subsurface geology of the State and on the tendency of oil and gas to occur in greater quantities in some parts of the rock column than in others.

The northern boundary of area 1 is the approximate northern boundary of the Chester series as well as that of the Ste. Genevieve limestone of the Lower Mississippian series. This area contains all the known producing formations of Illinois.

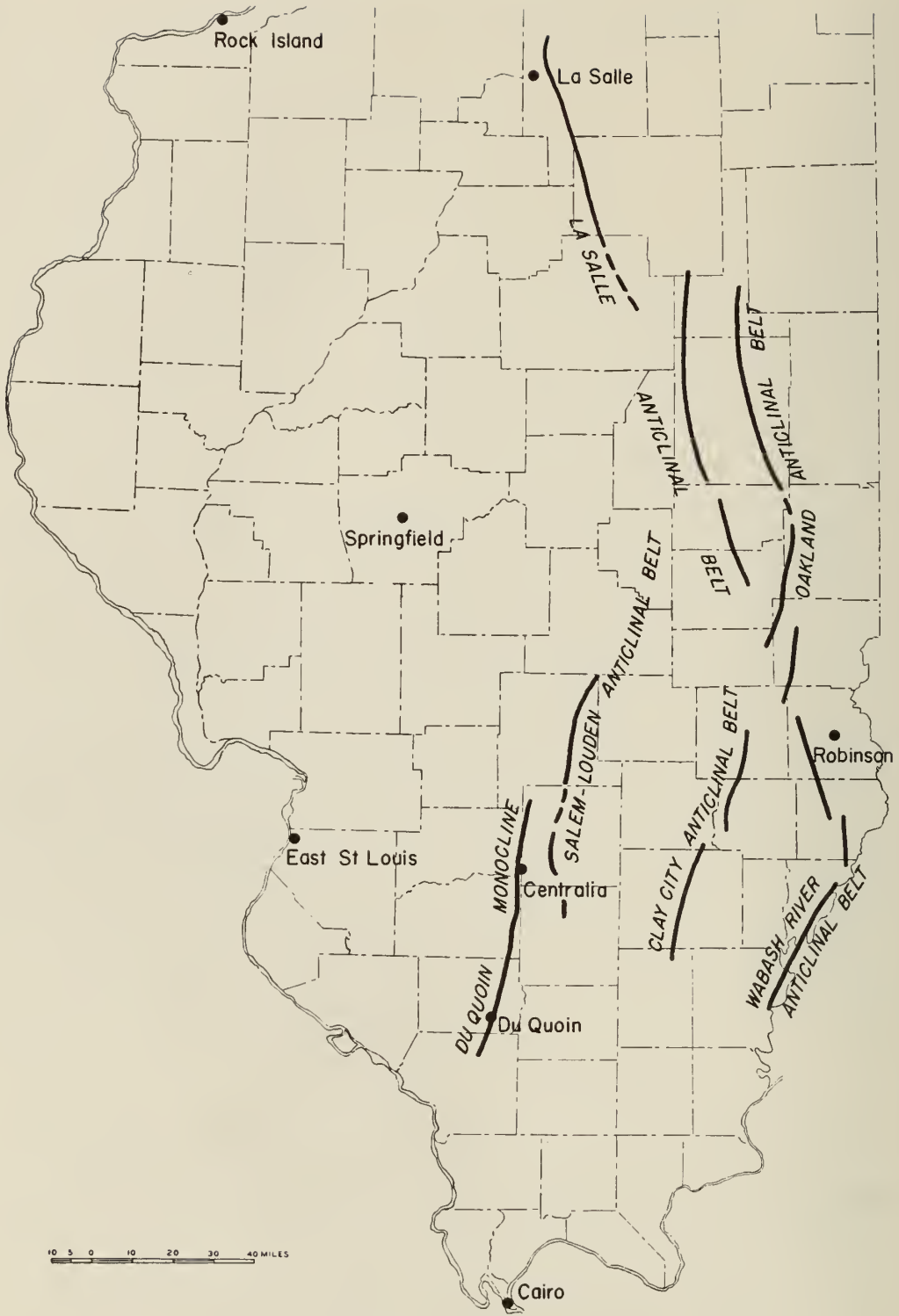


Fig. 3. - Principal anticlinal axes and the Du Quoin monocline.

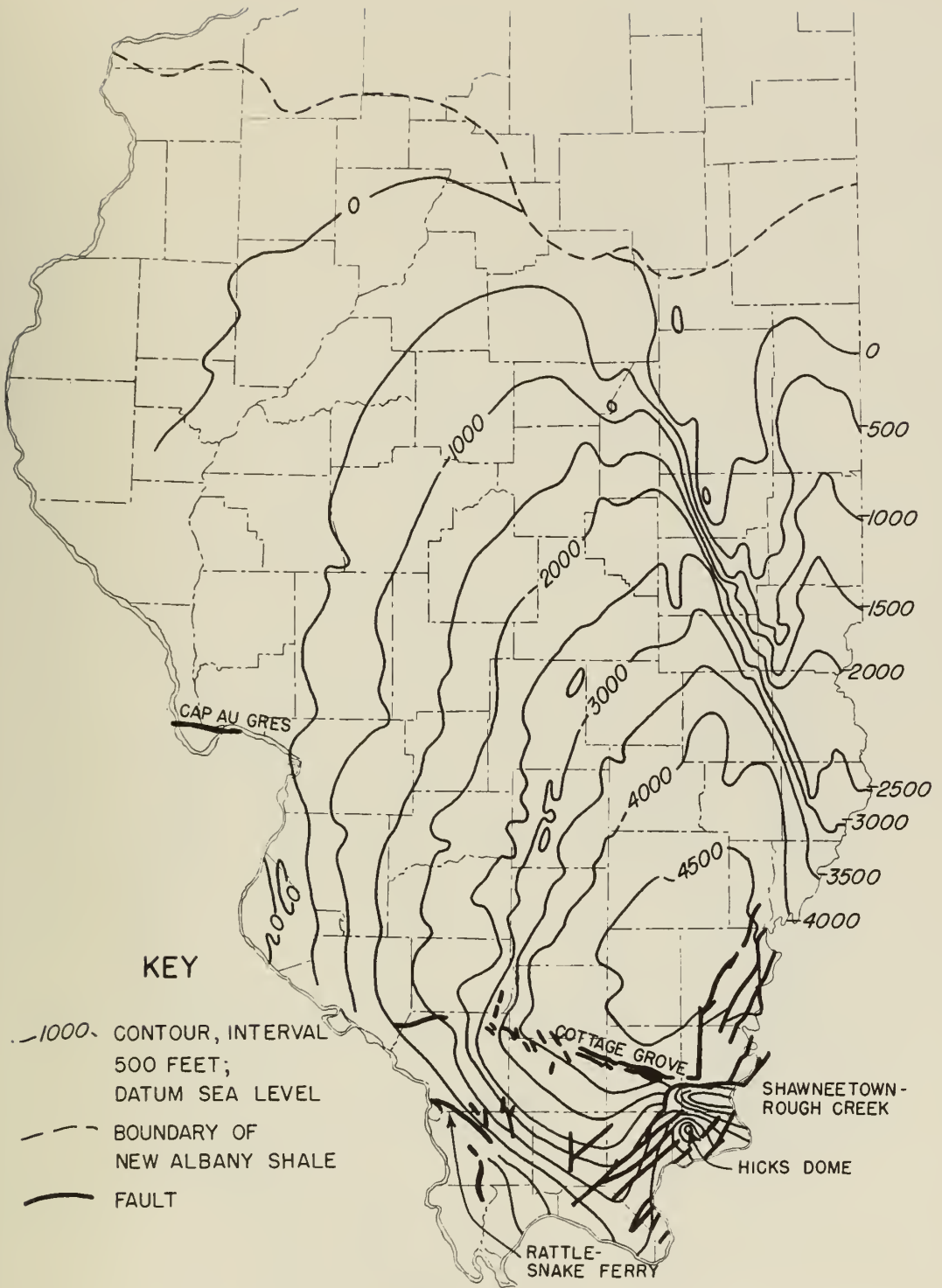


Fig. 4. - Structure of the base of the New Albany shale in central and southern Illinois.

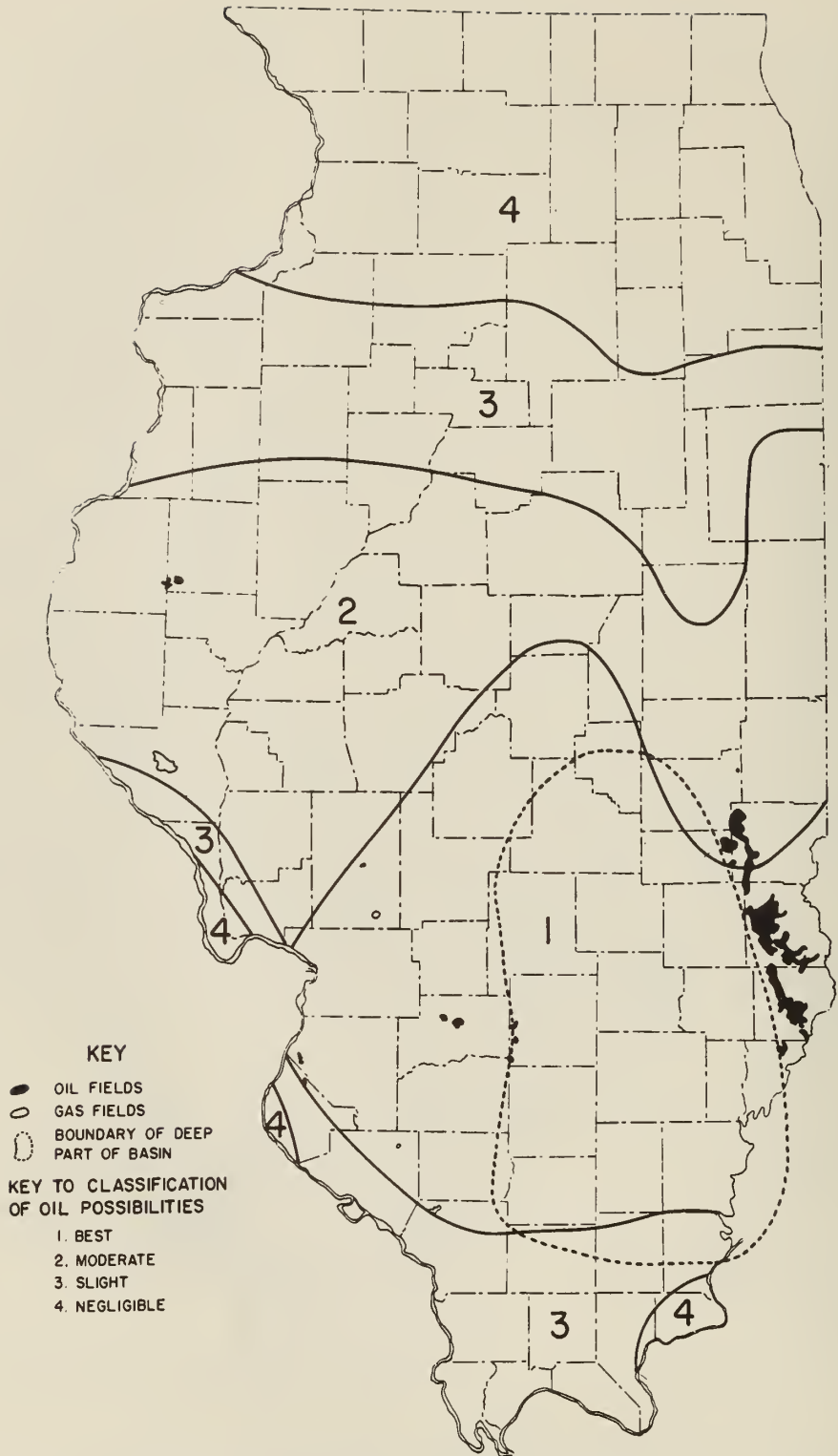


Fig. 5. - Oil and gas possibilities of Illinois classified by areas, 1930.



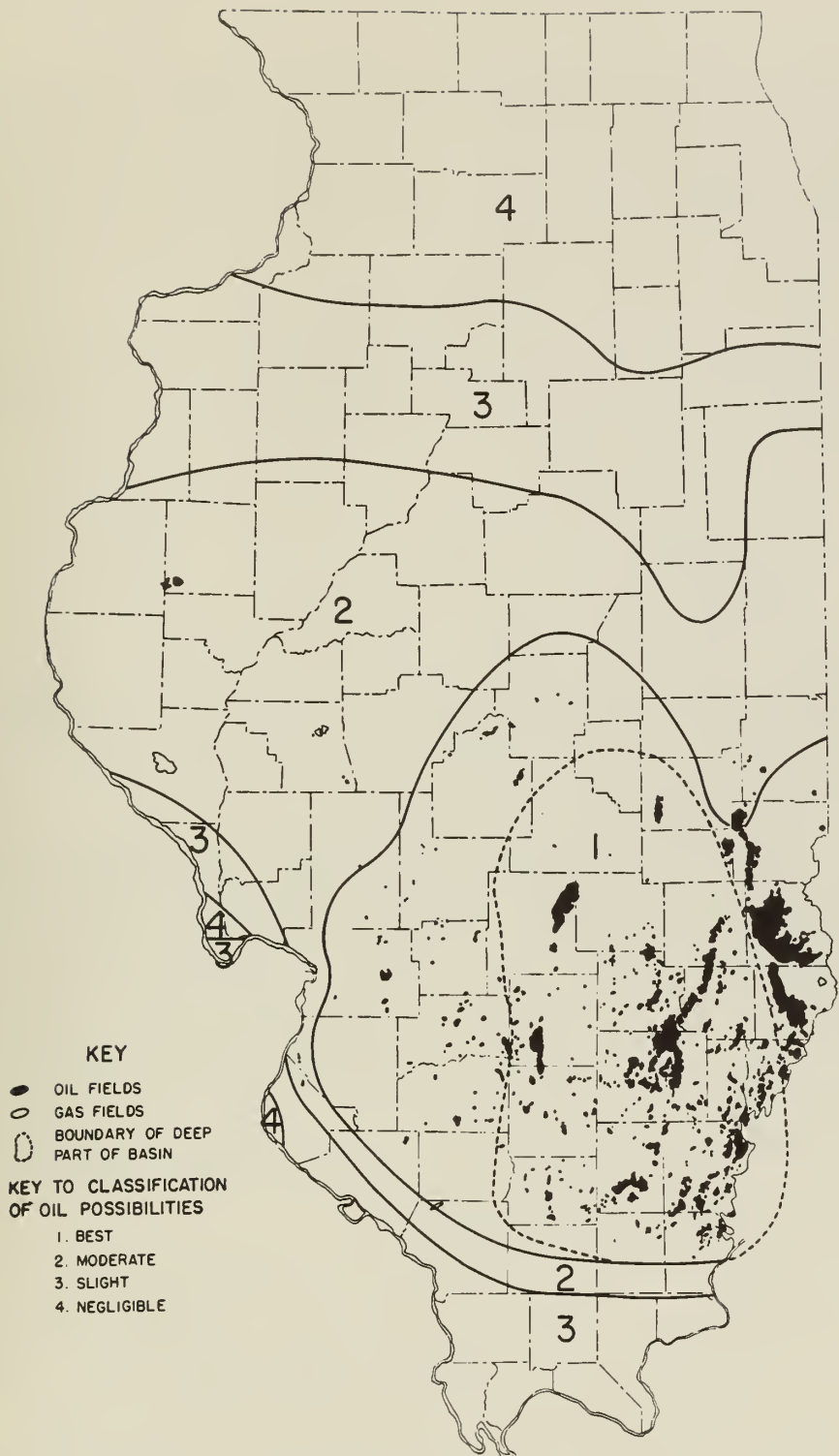


Fig. 6. - Oil and gas possibilities of Illinois classified by areas, 1954.

The boundary between areas 3 and 4 in northern Illinois is approximately the northern limit of the Pennsylvanian system. The boundary between area 3 and area 2 to the south is a line intermediate between the northern boundary of area 3 and the northern boundary of area 1. Although this line was not intended to represent a stratigraphic boundary, it does coincide roughly with the northern boundary of the New Albany shale, which is considered to be partly Mississippian and partly Devonian.

The marginal areas to the west and south of areas 1 and 2 are classified 3 and 4 because of the character of the structural disturbances - faulting, folding, and in some districts igneous intrusions. Ordovician rocks crop out in the two small areas of No. 4 along the Mississippi River.

Following is an approximate division by geologic systems of the oil production of Illinois up to 1930:

Geologic system	Percent of total
Pennsylvanian	± 60
Mississippian	± 39
Devonian and Ordovician	- 1
Silurian	0

There is considerable uncertainty in the figures given above for Pennsylvanian and Mississippian oil production because of the lack of separate production figures by pays in multiple-pay areas and because of doubt as to the correct geologic age of some prolific sandstone pays near the Pennsylvanian-Mississippian contact.

At the request of the Western Society of Engineers, the Survey's exhibit of Illinois mineral resources and mineral industries was taken to Chicago in September 1930. The Survey's classification map of oil possibilities attracted considerable interest among oil company representatives. The economic depression of the early 1930's made the financing of oil exploration unusually difficult, but interest in the oil possibilities of the Illinois Basin built up steadily. Studies of the surface geology by the State Geological Survey indicated the presence of structural irregularities in the basin which might serve as oil traps. The results of one such study were published in May 1936 (Weller and Bell, 1936). One major company began surface studies in 1934, and at least three companies began subsurface studies of the basin by 1935. In the fall of 1935, the first areal seismograph surveys began. Leasing on a large scale followed, and soon there was active competition for leases in an area covering about 20 counties in southern Illinois.

Test drilling began in the fall of 1936, and it was rewarded by eight new pool discoveries during 1937. The most famous was the Pure Oil Company's discovery well of McClosky production in the Clay City field, B. Travis No. 1, NW 1/4 SW 1/4 NE 1/4 sec. 33, T. 3 N., R. 8 E., Clay County, completed May 15, 1937. Total depth 2960 feet, producing formation McClosky oolitic limestone, top 2950 feet, initial production 2565 barrels per day. This discovery initiated a period of intense activity in drilling and leasing (Bell, 1941).

Out of about 330 new oil and gas pools discovered in Illinois between 1930 and 1955 and now producing, all but 23 are located in area 1 of the 1930 classification map. Seventeen of the 23 are in Saline and Gallatin counties just south

of the southern boundary of area 1. Up to the end of 1954, these 17 pools had produced about 1.5 percent of the total oil production of all oil pools discovered between 1930 and the end of 1954. The remaining 6 pools not in area 1 are located in area 2, to the north of area 1, and their total production is only two-tenths of one percent of the total for pools discovered in the period 1930-1954. Thus it appears that later developments have in great measure confirmed the opinions expressed in the 1930 classification map.

#### REVISED CLASSIFICATION MAP, 1955

In the light of later developments, the question arises as to how the boundaries of the areas should be modified. A revised classification map has been prepared (fig. 6), making use of new data from wells drilled in the period 1930-1955. About 45,000 wells were drilled for oil and gas in Illinois during that period, and a great many of these were located in southern Illinois in area 1 of the 1930 classification map. The new information seems to require only minor changes in the boundary lines which are based on the extent of the Chester series and Pennsylvanian system as noted above. The new pool discoveries to the south, mentioned above, necessitate revision of the southern boundary of area 1 and, accordingly, it has been extended southward to include parts of Williamson, Saline, and Gallatin counties. An area 2 of intermediate possibilities is shown between areas 1 and 3 in extreme southern Illinois. This is because the possibility of commercially significant oil accumulations south of the Cottage Grove-Shawneetown-Rough Creek fault zone (fig. 4) seems more likely since discovery of the Slaughters pool in Webster County, Kentucky, in 1947. The Slaughters pool is located just south of the Shawneetown-Rough Creek fault zone about 30 miles from the Illinois-Kentucky boundary.

The basis of area 4 in the 1930 map in Hardin County and adjacent parts of Pope and Gallatin counties was the idea that the fluorspar district, where faulting is abundant and igneous intrusions are present, would be unfavorable for oil. However, the other No. 4 areas, in northern and western Illinois, contain outcrops of Ordovician rocks, the oldest rock to produce oil in the region, whereas the oldest rock at the surface in Hardin County is Devonian limestone which crops out in a small area on top of Hicks dome. For this reason, the Hardin County area 4 is eliminated in the revised map and its rank raised to No. 3.

Following is an approximate division of the oil production of Illinois by geologic systems through 1954:

Rock system	Total oil produced 1889 through 1954 (millions of bbl.)	Percent
Pennsylvanian	305	17.3
Mississippian	1332	76.0
Upper (Chester series)	962	55
Lower (Iowa series)	370	21
Devonian	94	5.3
Silurian	13	0.7
Ordovician	13	0.7
Cambrian	0	0.0
	<hr/> 1757	<hr/> 100.0

Because separate oil production figures by formations are not recorded for most of the producing area of Illinois, the above figures are only approximations, but still they give a good idea of the relative oil productivity of the various rock systems. A considerable change is evident from the estimated division by systems through 1930 given above. The Mississippian is the predominant oil-producing system, having yielded more than three-fourths of the total.

#### PRODUCTION RISE IN 1954

The rise in oil production in 1954 of 13.4 percent over 1953 (production is continuing to rise in 1955) is the result mainly of three factors, water flooding, fracture treatment, and new pool discoveries, in order of importance. Oil recovery by water flooding is estimated to be about 27 percent of the total production in 1954. The use of fracture treatment in completing wells has been growing in recent years and, of the producing wells completed in Illinois in 1954, 70 percent were reported to be fracture treated. Among the new pool discoveries in 1954, the following are noteworthy: Eldorado Central and Eldorado North, Saline County, and Mt. Auburn Central, Mt. Auburn East, and Edinburg West, Christian County. All of these are in areas marginal to the deep part of the basin, which contains the principal oil fields.

#### FUTURE PROSPECTS

Illinois' record of oil production and oil discoveries to date indicates that substantial reserves of oil remain to be discovered. A little over half the oil has been produced from two major anticlinal belts - the LaSalle and the Salem-Louden. The remainder has been produced from smaller anticlinal structures and from stratigraphic traps of various types, including reefs, wedge-outs, sand bars, etc. Many oil reservoirs are the result of not one but several factors. Faulting is an important factor in numerous oil reservoirs in the Edwards-White Gallatin County area.

Previous studies indicate that lateral changes in lithology - facies - are important in the accumulation of oil in much of Illinois. Facies studies are being increasingly used in oil exploration along with structural studies, which have been used for a long time. Although there is not much likelihood of finding more structures of the magnitude of Salem or Loudon, it is believed that many more stratigraphic traps, small anticlinal traps, and faulted traps remain to be found. It is probable that most of the new oil will be found in Mississippian rocks with smaller amounts in Devonian, Silurian, Ordovician, and Pennsylvanian.

A whole new geologic province, essentially unexplored for oil, underlies the St. Peter sandstone in the Middle Ordovician (Workman and Bell, 1948). The volume of sedimentary rocks from the top of the St. Peter to the top of the pre-Cambrian basement complex is believed to be about equal to the volume of rocks above, in which all the oil to date has been found. In their outcrop areas around the margin of the basin, the lower Ordovician and Cambrian rocks are largely dolomite and sandstone with minor amounts of shale, but within the basin their character is unknown because so few wells have penetrated them. The question of whether they will ever produce oil is as yet unanswered.

Illinois may confidently be expected to go on producing oil for many years (Swann et al., 1951). Future recovery from existing wells both by primary and secondary methods is estimated at one billion barrels. This, added to production to date, gives a total of 2 3/4 billion barrels. Reserves in undiscovered fields cannot be accurately estimated, but we believe it is about 1/2 to 1 billion barrels. Thus the State of Illinois may yield as much oil in the future as it has already produced, or an ultimate total of 3 1/2 billion barrels.

#### EXPLORATION METHODS

Both geological and geophysical investigations have contributed greatly to successful exploration for oil in Illinois. In recent years there has been a downward trend in the amount of geophysical exploration. Many earlier successes in the Illinois basin are attributed to the reflection seismograph method. Major structural features like the Salem and Loudon anticlines were easily found by this method, but, in general, the difficulty of finding oil-bearing structures becomes greater the smaller the structural features being sought. More refined methods of seismograph work and interpretation of results may cause the seismograph method to be used for a long time. Other geophysical methods used in Illinois include gravity, magnetic, and radioactivity surveys. Use of the scintillometer to aid in oil exploration has begun in some areas other than Illinois, but whether it will prove successful here remains to be seen.

Study of the various aspects of subsurface geology, including structure, stratigraphy, paleontology, lithology, facies, and paleogeography, is continuing in the geological departments of many oil companies and at the State Geological Survey. The Survey is the repository for the largest collections of well logs, samples, and cores from this area. These materials have been furnished by the cooperation of the industry and are available for examination by all interested persons. Whatever new and successful methods of geophysical prospecting may come into use, there will always be a need for basic geological studies to help in exploring for oil. We believe that an even more intensive application of geology to oil exploration will be well worth-while. The State Geological Survey hopes the next half century will bring as much success to the Illinois oil industry as the one just past.

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