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PETROLEUM POTENTIALITIES THROUGH RESEARCH, 1945

By

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PETROLEUM POTENTIALITIES THROUGH RESEARCH

Petroleum, along with the other mineral fuels -- gas and coal, -- furnishes the power for industry, heats our homes, moves our transport, and furnishes basic raw materials for manufacture. The present war has emphasized again that the nation or area that possesses an abundance of these sources of energy is potentially strong, and the one that lacks them is vulnerable. Our capacity to produce petroleum now exceeds that of the rest of the world but the outlook for the future should be viewed sanely and soberly without assuming that this situation will continue to be the case if we do nothing about it.

The potentialities of petroleum are of two general classes: (1) the availability of supplies, now and in the future, and (2) the possible uses of petroleum as a raw material for a wide diversity of chemical products. The second of these two general subjects will be left to others and this discussion will be confined to the question of petroleum supplies available in this region.

Before speculating about the future and the research needs of petroleum, we might briefly survey the region with which we are concerned. Kansas City is located in the northeastern part of the area known to the oil industry as the Northern Mid-Continent. It includes the oil-producing states of Oklahoma, Kansas, Nebraska, and Missouri, to which Iowa may some day be added. The Northern Mid-Continent in general coincides with the area which the Midwest Research Institute proposes to serve. Geologically, it constitutes a fairly well-unified province. Oil and gas are produced from rocks of Paleozoic age which are much older but not necessarily deeper than most oil reservoirs of other areas. These oil reservoirs occur above a basement of non-productive crystalline rocks.

The entire Mid-Continent region is unique in that its reservoirs have yielded more oil than all other rocks of similar age throughout the world. The relative importance of the Northern Mid-Continent is shown by the fact that during 1944

it yielded more than 13 percent of the oil produced in the United States, ~~and~~ it also accounted for 10 percent of the estimated world production in 1943, and it contains more than 8 percent of the nation's proved reserves. Russia's production in 1943 is estimated by J. P. O'Donnell in the Oil and Gas Journal (January 27, 1944) at 237,250,000 barrels, and the estimated production of the Rumanian fields for the same year was 36,500,000 barrels, compared to 229,505,000 barrels for the Northern Mid-Continent. Although Missouri has produced small quantities of oil for many years and Nebraska has produced ~~a~~ significant quantity in recent years, it is Oklahoma and Kansas, the states in the nation that rank fourth and fifth in production, which have accounted for nearly all the oil of this region. The history of production does not show a steady uniform rise, as can be seen from the chart (Fig. 1), but rather it has been characterized by abrupt fluctuations, caused not only by discovery and depletion of pools but also by economic and other factors. In spite of these wide variations in yearly production, the proved reserves of the region as estimated by the American Petroleum Institute have remained surprisingly constant for the past two decades -- that is, the estimated proved oil reserves have ranged from one and a quarter billion barrels to a little less than two billion barrels. However, the fact that for the last few years these reserves have declined slightly each year should not be overlooked. Their relative importance with respect to the reserves of the nation as a whole has also steadily declined, from 28 percent of all proved reserves in 1925, to 13 percent in 1935, to 8 percent at the end of last year. Although Oklahoma has produced nearly four times as much oil as Kansas, her production has also been much more erratic, and it is now estimated that Kansas contains 41 percent of the proved reserves of the region. The effect of a few major pools on production history has been profound. The chart (Fig. 1) quite clearly reflects such discoveries as the Augusta-El Dorado and Seminole districts. Last year ten of the more than 700 pools in Kansas produced more than one-fourth of

the state's oil. This great dependence of total production on a few major pools is somewhat disconcerting when we consider that major pool discoveries with the exception of the West Edmond pool north of Oklahoma City have been almost nonexistent during the past ten years.

For the purpose of this discussion the region can be subdivided on the basis of geologic structure, or attitude of the rocks. The colored map (Fig. 2) shows in a very general way the areas in which the rocks have been bowed upward to produce structurally high features (shown by red) and where they are bent downward and thus form basins (shown in blue). Oil is found in minor structural features or stratigraphic traps of various kinds within these large structural provinces. Many different rock layers, or formations, yield oil in this region, and some of them are found throughout the several states.

In comparison to North America as a whole, this region may be considered well-explored, but nevertheless large areas remain that have been inadequately tested, or not tested at all. Kansas City is located within the Forest City Basin, which attracted a great deal of attention a half dozen years ago. Three significant discoveries have been made in this basin -- the McLouth field in Kansas, the Falls City field in Nebraska, and the Tarkio field in northwestern Missouri. Fifteen oil tests and a number of slim holes have been drilled in the Iowa part of the basin, but have not as yet been rewarded with oil production. Although it would probably be unduly optimistic to expect another Burrton or Oklahoma City in this basin it seems quite reasonable to expect that continued exploration may result in more McLouths, Falls Cities, and Tarkios.

The Nemaha Anticline extends from western Iowa and eastern Nebraska across Kansas into Oklahoma. Along part of this structure, granite is so near the surface that there is little chance of major oil production; the significance of this great structural feature at other places is attested by many large oil pools, typified by El Dorado. The importance of the Central Kansas Uplift, the

Central Oklahoma Arch, the Sedgwick Basin, and the Cherokee Basin are adequately demonstrated by the oil pools in these areas. The Ozarks, Arbuckles, and Ouachitas are areas where the rocks are arched upward to such an extent that the potentially important oil-bearing rocks have partly been stripped away by erosion so that these mountainous areas present poor possibilities for petroleum prospecting. The McAlester-Ouachita Basin in eastern Oklahoma and the Dodge City-Anadarko-Ardmore Basin of southwestern Kansas and Oklahoma are areas where the pre-Cambrian ~~basement~~ is deeply buried beneath Paleozoic rocks and many thousand feet of possible oil-producing strata occur below the surface. Much of the area of these basins is unexplored and from the present inadequate subsurface data their future potentialities -- whether great or small -- can only be guessed. Two other large areas so far inadequately explored are the Salina Basin of Kansas and Nebraska and the so-called Julesburg Basin of Kansas, Nebraska, and Colorado.

I have used most of my allotted time for an introduction to the few brief comments I wish to make on my assigned subject -- Petroleum Potentialities Through Research. There are three general areas of petroleum research: First, exploration and discovery; second, production; and third, refining and processing. These three general fields of research, although differing greatly among themselves, serve to expand our petroleum resources, a vital necessity at a time when the demand for oil is increasing and the discovery rate is not holding its own. The first of these three areas of research, the one with which I am personally most concerned, is a problem for the geologist and geophysicist. In addition to the work being carried on by the various oil companies, each of the State Geological Surveys in this area, together with the United States Geological Survey, is carrying on independent investigations, such as the cross sections of the Julesburg Basin being prepared by the Federal Survey and the detailed studies by the insoluble residue method being made of the Arbuckle limestone in Oklahoma by the Federal and Oklahoma Geological Surveys. A summary of the oil and gas re-

search program of the State Geological Survey of Kansas will serve as an example of this work now in progress. We maintain a general information or service department that is utilized by geologists, operators, land owners, and companies. These service facilities consist of libraries, in Lawrence and Wichita, of well cuttings and cores from more than 9,000 wells drilled in all parts of the state, drillers logs of more than 50,000 wells, insoluble residues of the limestone fragments of several thousand wells, a file of bench marks, information about the subsurface stratigraphy and outcropping rocks, and the distribution to the public of more than 50 different reports and maps dealing with oil and gas geology and development. Development reports are compiled and issued annually for western Kansas and the first of a similar series for eastern Kansas is now being prepared. A detailed investigation of the subsurface geology of the Kansas part of the Forest City Basin has been completed and published. We are now cooperating with the State Geological Surveys of Iowa, Missouri, and Nebraska and the Federal Geological Survey in a regional study of this basin. A highly detailed investigation of the McLouth field, as a type example of northeast Kansas fields, has been completed as a cooperative project with the Federal Survey, and a regional study of the Salina Basin is now under way. Research on the regional stratigraphy -- that is, the character, succession and correlation of the rock layers of the state, is constantly in progress. Stratigraphic research on our rocks, both as they are exposed at the surface and as found in oil well cuttings and cores, is fundamental and its results furnish a necessary tool for all petroleum geologists in their search for new oil. A stratigraphic study of the Arbuckle limestone in Kansas is just being completed. Our most recent work of this type was published just a month ago and shows by the presence of microscopic fossils in cores from a deep oil well in Kearny County the presence of rocks formerly unknown in the state. Much more work of this type is needed. Future plans call for an expansion of well sample libraries and regional subsurface work on

the oil and gas producing rocks, detailed reports on the geology, producing rocks, and well inventories of counties -- temporarily suspended due to the press of war conditions -- and special investigations of important producing formations. In addition to the present activities of the State Geological Surveys there are many other problems in the petroleum geology of the Northern Mid-Continent. Research on such subjects as the origin, accumulation, and migration of oil, the effect of paleogeography on accumulation in limestone reservoirs, regional structure mapping, development of new and the refinement of old techniques of geophysics and geochemistry, and many others are worthy of consideration. The practical value of such research will be directly measurable by the degree of success it has in directing the drill to new pools of oil. It should be clearly understood, of course, that research can result in new oil only when it is followed by exploratory drilling.

The second area of petroleum research -- production -- is primarily a problem for the engineer although it has many geological aspects. Proper and efficient production methods and the improvement of these techniques result in the recovery of a larger percentage of the oil from a reservoir, therefore increasing the available supply. An excellent example of this type of research is to be found in the report recently issued by the University of Kansas Research Foundation on a method of decreasing the water-oil ratio in producing wells. Important subjects for production research are methods of secondary recovery, designed to recover the sizable quantity of oil left in many reservoir rocks after normal production methods have been abandoned, horizontal drilling techniques and applications, acid treatment and shooting techniques, drilling methods, oil mining, studies of porosity and permeability characteristics of various reservoir rocks, *Optimum producing rates with various reservoir conditions and oil viscosities*, and many others. The Petroleum Experiment Station of the U. S. Bureau of Mines at Bartlesville, Oklahoma has been doing important work. The Kansas Survey, in cooperation with the Department of Petroleum Engineering at Kansas University,

was carrying on research in this field, but it has been temporarily suspended due to the war.

The third area of petroleum research -- refining and processing -- is almost entirely beyond the range of the geologist and is primarily a problem for the chemist, the refining engineer, and the chemical engineer. The geologist is involved only in so far as new materials, such as oil shale, may be used as a source of petroleum products. He must then start all over again on his investigation of the source of supply of this new substance. Such research as results in a superior product from the crude, or a higher yield of the desired product, or produces liquid fuels from natural gas, shale, or coal, serves to increase the available supply of petroleum products. I am not qualified to discuss the most needed research projects in this general field of activity and for such questions refer you to your well-known chairman, Dr. Cross.

To summarize -- petroleum products are a vital ingredient of the industrial menu; the Northern Mid-Continent -- our area -- is and has been an important petroleum producing area; new discoveries are not staying as far ahead of production as we wish were the case. Research on the source of supply followed by drilling, research on methods of production, and research on refining and processing, are the procedures we must look to for maintaining and increasing our supply and further utilizing this important natural resource -- petroleum.

Talk by John C. Frye
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