# KANSAS GEOLOGICAL SURVEY
# OPEN-FILE REPORT 48-3

## PETROLEUM RESEARCH IN KANSAS

by

**John C. Frye**

*Disclaimer*

The Kansas Geological Survey does not guarantee this document to be free from errors or inaccuracies and disclaims any responsibility or liability for interpretations based on data used in the production of this document or decisions based thereon. This report is intended to make results of research available at the earliest possible date, but is not intended to constitute final or formal publications.

Kansas Geological Survey
1930 Constant Avenue
University of Kansas
Lawrence, KS 66047-3726

# PETROLEUM RESEARCH IN KANSAS

by John C. Frye

State Geological Survey of Kansas

University of Kansas

Raw products of the petroleum industry during 1948 were valued at 6-2/3 billion dollars which placed petroleum well in the lead among the nation's mineral industries. This pre-eminence has been due, at least in part, to the intimate association of the industry, thoughout its development, with the progress of scientific research and technology.

For the past three-fourths of a century, geology and geologists have played increasingly important roles in the development of the industry. Starting with the anticlinal theory of oil accumulation one discovery after another has contributed new concepts to the science. In some cases new facts have changed older theories and in other cases they have introduced new principles that could be used in the further search for oil.

In the early stages of the industry the application of geology to oil finding was largely by surface methods, — that is, the structure of the rocks at the surface was mapped, the structure of the producing rocks at depth being inferred from these maps. As early as 1914 the discovery of the El Dorado pool and others on the Nemaha granite ridge clearly indicated that dip and strike of outcropping rocks were not always the key to oil pools at depth. As a result, the idea that rocks have different structures at different depths was demonstrated, hitherto unlikely territory was re-examined, and new oil was found. Nevertheless in 1923 the concept of anticlinal accumulation of oil used by a surface geologist in an untested area resulted in the discovery of the Fairport pool in Russell County. The intricate thickening and thinning of some reservoir rocks, changes in porosity (size of rock openings), and buried faults and sink holes presented problems which petroleum geologists have been called upon to solve.

The first subsurface information actually put to use was logs of wells prepared by the operator during drilling of the test. With the increasing complexity of oil finding and the introduction of rotary drilling, drillers logs failed to furnish sufficient detail. It became common practice to save cuttings or chips of the rocks through which the drill passed. These could then be studied microscopically to learn many details concerning the various rocks layers below the surface. By determining elevations of the wells and by correlating the same layer from well to well it was then possible to prepare structure maps of rock layers several hundred feet below the surface to show the shape of the actual reservoir rock. Electric logs — they measure the resistance of each layer to an electric current — and radioactivity logs have more recently been used for the same purpose.

Geophysical methods now have been developed to an extent that the shape and sequence of deeply buried rocks can be predicted before any drilling is done. Some of these systems measure the rebound or reflection of shock waves that travel through the rocks. Other methods measure differences in magnetic attraction, force of gravity, or even rate of flow of electric currents. The objective is essentially the same — determination of the shape and character of rock layers at depth.

In addition to exploration research and technology, comparable developments have taken place in production engineering and refining. Recent advances have been made in chemical utilization of oil and gas as raw materials and in the development of liquid and gaseous fuels from oil shale and coal. The petroleum industry clearly is both the child and the parent of a large realm of research and technology.

Our present concern is with petroleum research in Kansas, in particular with services available for general use through public agencies in the State. The various oil companies and operators in Kansas employ more than 300 geologists and

a somewhat smaller number of petroleum engineers. Many of these men are conducting research of a special nature which, with few exceptions, is available only to their employers.

At the University of Kansas three agencies conducting research having a direct bearing on the petroleum industry make the results of their studies available to the public. These are: (1) the State Geological Survey of Kansas, (2) the University of Kansas Research Foundation, and (3) academic departments of the University, including chemical engineering, chemistry, geology, and petroleum engineering.

The State Geological Survey is a State service and research organization charged with investigating the geology and mineral resources of Kansas and making the results of these findings available to the public. An important part of the Survey's program is devoted to study of the geology of the State's oil and gas producing rocks and the maintenance of service facilities for the industry, operators, and land owners. The Research Foundation conducts specific projects, primarily of a chemical and chemical engineering nature, financed by grants from the Kansas Industrial Development Commission and other groups. The Departments of Petroleum and Chemical Engineering are undertaking several research projects dealing with oil production and utilization.

Outstanding among the service facilities operated by the Geological Survey are files of drillers logs, electric and radioactivity logs, and bench mark elevations and libraries of well cuttings both in Lawrence and in Wichita. Well logs have been gathered by the Survey for more than 20 years, in recent years partly in cooperation with the Kansas Well Log Bureau of the Kansas Geological Society of Wichita. The nearly 70,000 logs now on file are available for use by anyone who comes to the Survey offices. Electric and radioactivity logs of 5,000 wells are filed in the same office. Maintenance of libraries of well cuttings is an ever-increasing task. Cuttings now on file include those from 14,000 wells in Lawrence and from nearly 5,000 wells in a sub-library in Wichita.

It is impossible to know how many discoveries have been aided by these State-maintained facilities. They are tools of exploration research by companies, operators, and consulting geologists. Weekly many of these "tools" are used by various persons in the industry.

A service less apparent to the nonprofessional is the Geological Survey's file of stratigraphic data. The value of this file has been demonstrated during the past six months. Field parties mapping structure from surface rocks in Wabaunsee and near-by counties have been visiting this file regularly to get identifications of outcropping rock layers and the local succession of rock layers as starting points for plane-table mapping.

Another long-range Geological Survey service is the annual compilation and publication of statistics on oil and gas developments and production. These data were published intermittently for many years, but since 1937 there has been an annual bulletin summarizing the preceding year's activities. These reports have proved useful not only to the petroleum industry but also to land owners, investment companies, and individuals needing details of the status of the industry. A year ago a large map showing the present extent of the petroleum industry in the State — oil and gas pools, pipelines, refineries, and other facilities — was prepared.

Services so far described are the tools of research. Specific studies that are clearly basic research in petroleum geology have been and are being carried on by the Geological Survey. Perhaps the most important in this category is the work that for 20 years has been carried on cooperatively by the State Geological Survey and the U. S. Geological Survey.

This program, headed by Wallace Lee, has in recent years resulted in reports on the Forest City basin of northeastern Kansas, the Salina basin of north-central Kansas, and a series of detailed cross sections in the southwestern and west-central parts of the State. These reports reveal the character, thickness, shape, and

geologic history of the various producing rocks. Microscopic examination of well cuttings is the main basis of the studies, but electric, radioactivity, and drillers logs and any other data available are used also.

A few weeks ago a well-known consulting geologist in Wichita commented that, by use of this work, the companies, particularly the smaller operators, had saved enormously in both time and money in the stepped-up exploration program in Wabaunsee and adjacent counties. He pointed out that if these general reports had not been available many concerns would have had to start at the beginning to develop the general picture of petroleum geology in that region before undertaking detailed testing.

These research projects are orthodox in that they are of the same basic type that has been carried on for years. In addition the Geological Survey is initiating several research projects keyed particularly to the new and changing needs of the industry. Chief among these is a study of the detailed character, or petrology, of the oil sands suitable for secondary recovery operations. Many pools that have been abandoned or are at the point of abandonment are known to contain much more oil than has so far been produced. New methods, such as water flooding, are being devised to recover this oil. These specialized secondary recovery methods, in order to be successful, require a much more detailed knowledge of the nature of the producing rocks than was formerly necessary.

Petroleum industry research in recent years has even expanded beyond the fields of liquid and gaseous hydrocarbons. The recent war brought into rather clear focus the need for research along diversified lines.

The probability of future production of liquid and gaseous fuels from coal and lignite virtually makes the coal research program carried on by the Geological Survey for many years a part of petroleum industry research. The U. S. Bureau of Mines is conducting basic studies on methods of extraction and conversion. The Geological Survey's work on quantity, quality, and occurrence of Kansas coal and lignite deposits makes their research applicable to Kansas deposits.

Oil shale as a future large reserve of fuel has attracted much attention in recent years. Here again the U. S. Bureau of Mines is conducting basic research on the methods of mining and extracting oil. Their research, mostly centered at Rifle, Colorado, serves the entire nation. The need in Kansas is for an inventory of the quantity and quality of the State's oil shale deposits. This job, started several years ago by the State Geological Survey but temporarily put aside for more urgent studies, is again under way. Several years ago it was contended that Kansas possessed no oil shale deposits, but field work and laboratory studies by the Survey have shown that several beds occurring in the State are worthy of investigation. Analyses of some samples have yielded as much as 20 gallons of oil and 1,000 cubic feet of gas per ton of shale. Deposits containing 10 to 14 gallons of oil and about 1,000 cubic feet of gas per ton are thought to be extensive. Studies on methods of improving yields of Kansas oil shales have also been started and preliminary results indicate than an admixture of certain clays substantially increases the yield of oil.

A totally different field of petroleum research is that dealing with the chemistry and chemical utilization of oil and gas. The University of Kansas Research Foundation is carrying on several chemical projects sponsored by the Kansas Industrial Development Commission.

Research on the conversion of natural gas into useful chemical products has been under way for several years. Burning of natural gas gives the lowest possible dollar value for each cubic foot used; therefore the use of the gas as a raw material for more valuable chemical products deserves detailed study. Chemical companies are turning more and more to natural gas as a basic source of organic raw material, and the large Kansas gas reserves should prove attractive.

Laboratory studies of the reactions of the several substances in natural gas with other materials have been made. Also, the value of the products that can be

produced from natural gas has been compared with the value of the materials used in their manufacture. Only those which would greatly increase the value of the product by the manufacturing process were marked for study in the laboratory. As a result of continued laboratory work it has been found that thiophene, benzene, and toluene can be prepared by new processes from materials (called straight chain hydrocarbons) found in natural gas or crudes. All three of these chemicals which can be manufactured from Kansas gas and oil are of basic importance in the manufacture of important chemical compounds called organic aromatic chemicals or pharmaceuticals (drug products). One of the most important aspects of this research was the development of substances to promote chemical reactions — or catalysts. One such new material has been developed in the laboratory.

Studies are also under way on the action between bacteria and petroleum. There is the possibility that bacteria which live in petroleum can be used to produce new products. Extensive fundamental data must be assembled to determine just which bacteria can live on an oil diet, and a number of such bacteria have been found. The problem now is to discover if bacteria can split the hydrocarbons of petroleum into more valuable materials. This study may also give considerable help in pipeline corrosion problems where bacteria are active. Their use as a possible aid to initial oil production is also being considered.

A survey on the knowledge of Kansas crudes is in the final stages of completion. This information is of the utmost importance if a chemical industry is to be based on some of the constituents of our crudes. From this survey a plan can be adopted to supply any major deficiencies in our knowledge.

The Chemical Engineering Department at the University has initiated a study of the equilibrium data between nitrogen and light hydrocarbon gases produced in Kansas. As time goes on it will probably be necessary to remove the nitrogen from our natural gas and the data being assembled will be valuable for the design of such separation plants.

The Department of Petroleum Engineering at the University is at present making studies of the behavior of oil and water in reservoir sands, particularly in those of eastern Kansas. These studies are intended to aid in secondary recovery operations, particularly in water flooding, in the older eastern Kansas pools. In many of these pools more than 80 percent of the original oil is still in the sand after ordinary methods of production have been abandoned. By using secondary recovery methods to obtain part of this remaining oil many pools are expected to produce more oil than was produced by initial (primary) methods. Another study is aimed at developing a rapid method of determining the particular characteristics of oil in a new well, so that the development of the pool can be planned for most efficient production.