State of Illinois
Henry Horner, Governor
Department of Registration and Education
John J. Hallihan, Director
Division of the
STATE GEOLOGICAL SURVEY
M. M. Leighton, Chief

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FOURTH ANNUAL MINERAL INDUSTRIES CONFERENCE OF ILLINOIS

"Research on the State's Mineral Resources and Their Utilization"

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O I L A N D G A S S E S S I O N S

ABSTRACT REPORTS OF

GENERAL SESSION, FORUM ON RESEARCHES IN PROGRESS,

AND SYMPOSIUM ON NEEDED RESEARCHES

Sponsored by
The Illinois State Geological Survey Division of the Department of Registration and Education
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CONTENTS

Friday Forenoon, April 24, 1936

GENERAL SESSION

The general session was under the chairmanship of Dean M. L. Enger of the Engineering Experiment Station of the University of Illinois. After welcoming the guests he introduced Dr. M. M. Leighton, Chief of the State Geological Survey, who outlined the objectives of the conference.

Dr. Leighton pointed out that prosperity in our early history rested upon the exploration and development of the country's untouched resources, whereas now it rests upon scientific discoveries and technologic developments of new and improved uses of these same basic resources. The new viewpoint given us by science is that we should make a complete inventory of our many types of resources by thoroughgoing investigations and then show that their constitution, composition, and properties are such that they can be transformed in various ways into ever increasingly useful products. The commonwealth that will make available this kind of information will make more profitable use of its resources, will be better able to meet competitive conditions, will create more industrial opportunities, will provide more widespread employment and will lay the soundest of foundations for prosperity and happiness of its people.

He stated that this conference was thus planned to discuss the importance of research as applied to the State's mineral resources and their utilization, to acquaint the industries with the research now in progress and the value of the results, to permit us all to catch a larger vision of the possibilities of well planned comprehensive research, to receive suggestions of additional researches needed from the standpoint of industrial experience, and to develop a joint interest in pursuing a research program with proper facilities and qualified personnel that will make for greater industrial activity and greater public welfare within our commonwealth.

The main address was given by Mr. Fred Wesley Sargent, President of the Chicago and North Western Railway Company, who was introduced by Dr. A. C. Willard, President of the University of Illinois. Mr. Sargent's subject was

"Research and the Immediate Future"

Mr. Sargent set forth the thesis that economic conditions will be improved by the production of new forms of wealth. Intensive research is producing new and improved means of production, and

is creating new industries and enormous demand for changes and improvement in old industries. The chemical industry illustrates the tremendous and rapid advances of scientific research. Many things are being done with chemistry that it was thought, heretofore, could only be done with machinery and muscle. Changes are coming so rapidly that frequently plants become obsolete long before they are worn out.

The intensive developments in science make it imperative that producers of raw materials ever be alert to scientific research. Pure research working in cooperation with honest business are forces that will move us into an era of unprecedented prosperity.

By enlarging the wants of men and women in diverse directions and by the consequent new demands arising for new additional services, scientific discoveries enlarge the field of human activity thereby creating new types of employment.

The Illinois coal industry, which in quantity and total value of product, is Illinois' largest mineral industry, ought also to be one of the greatest in concentrated value. Coal must not be looked upon only as a fuel to be destroyed by burning. Coal as coal only to burn may not long be able to hold its modern place of power, but through the aid of research it has limitless possibilities not only as a source of power but as a basis for vast new industries. Railroads are now burning dyes, medicines, perfumes and innumerable valuable chemicals along with their coal, all of which are wasted, and all of which ought to be captured for the service of mankind. New forms of competition are forcing the railroads to herculean efforts to hold their place in the field of transportation. Since some of these efforts are directed to producing power at lower cost, the coal industry must avail itself of research and more research to meet the competition of other fuels.

The possibilities of coal as a chemical raw material are illustrated by analogy to the rapid modern development in the products obtained from corn. In recent weeks the daily press has reported the discovery whereby a powerful explosive can be extracted from corn.

The railroads stand indicted because of their failure to take full advantage of scientific research possibilities. None of the major contributions to railroad development during the nineteenth century came from the railroads themselves. The telegraph was invented by Wheatstone, an English professor of philosophy, and Morse, an American artist; the Pullman sleeping car by a street contractor; the automatic coupler by Janney, a dry goods clerk; the automatic block signal system by Hall, a retired textile manufacturer; etc.

The railroads recently created the Association of American Railroads, and this organization created a Department of Research. This is a most important branch of this organization for

it should lead to things of permanent value - safety, greater efficiency and lower costs in producing and delivery transportation service.

It is no longer possible to stand by, trusting to luck, that some school teacher, artist, street contractor, or dry goods clerk will save the transportation industry in the future as they have in the past. The tempo of the times will not tolerate it. Progress through research is the order of the day. It is ridiculous to haul a ton and a half of dead weight per ton of freight and several tons of Pullman per passenger; to haul two to three thousand pounds of engine tender with load in order to have coal and water next to the power plant; and to use steam only once and then allow it to escape into the air.

New scientific achievements are eagerly recorded in the daily press. The most promising field of achievement is in the full use of all the riches wrapped up in our mineral resources, the development of transportation to the end that goods and persons will move freely and within the purchasing power of all. The true idols of the future will be the "Microbe Hunters," the "Hunger Fighters," the engineers, and the great students in pure scientific research.

"We are in the midst of a real, practical, scientific revolution that holds promise of a marvelous future for the raw products of our State, providing we have the vision and the courage to organize for research and thereby convert to useful purposes the riches now wasted, and through new and better processes make our minerals more valuable in all uses to which they may be applied to the end of a greater abundance for men and women everywhere."

Friday Afternoon, April 24

FORUM ON OIL AND GAS

RESEARCHES IN PROGRESS

Following are abstracts of the papers presented at this forum which was one of four on Researches in Progress by the State Geological Survey and the Engineering Experiment Station of the University of Illinois, on the mineral resources of the State and their utilization. These forums covered four major fields - Coal, Oil and Gas, Clay and Clay Products, and Rock and Rock Products - and were held separately and concurrently on Friday afternoon.

Researches on the Underground Geology of Illinois, by L. E. Workman, Associate Geologist and H. X Bay, Assistant Geologist, Illinois State Geological Survey. Because the discovery of new oil pools and the further development of old ones depends upon the correct interpretation of the records of wells already drilled, it is the purpose of the Subsurface Division to provide accurate fundamental subsurface data. Key wells are those represented by sample cuttings, of which there are now 108,000 on file from 1775 wells. The value of the study of these samples is so well appreciated by the operators that the preservation of samples is now a regular procedure in almost every oil well drilling in the State.

Numerous cross-sections were shown and various problems of subsurface stratigraphy were pointed out. Probably the most important current study is that of the subsurface correlation of the Chester series, in which the "Kirkwood," "Tracy," "Gas," "Stein," "Benoist", "Carlyle," and other producing "sands" occur, all of which can now be assigned to a definite position in the series. It was pointed out how the discovery that production which was formerly thought to be coming from the Silurian in the Colmar-Plymouth and Decatur areas actually comes from the Devonian gives increased importance to prospecting for other Devonian production. An isopach map of the Devonian-Silurian systems, which will greatly assist in estimating depths to the "Trenton" in southern Illinois, was shown.

Studies of Outcropping Strata in the Illinois Basin, by J. Marvin Weller, Geologist, Illinois State Geological Survey. Determination of structure in the central part of Illinois has in the past been almost wholly dependent upon drill records because

of a thick covering of glacial drift and inability to correlate outcrops of the Pennsylvanian or "Coal Measures" rocks. A new method of correlation, however, has been developed by the Geological Survey as a result of a comprehensive investigation of the Pennsylvanian rocks that has been in progress for ten years and is now nearing completion. This study has shown that the different kinds of Pennsylvanian rocks normally occur with certain definite relations to one another and that a certain sequence or cycle of beds is more or less incompletely repeated about forth times. Studies of outcrops and drill records have proved that most of these cycles are persistent throughout the Illinois basin. They furnish a new means of correlation because a key horizon, such as a particular coal or limestone, need not be present as its exact position may be determined from the association of other rocks. These studies have attracted considerable attention among geologists and two of the large Mid-Continent oil companies have employed men experienced in this type of work to undertake surface studies for them. Some of the leasing that has taken place in the Illinois basin during recent months was based upon such studies carried on independently by one of these companies.

Studies of Repressuring and Water Flooding, by Alfred H. Bell, Geologist, Illinois Geological Survey. Although the use of repressuring to recover oil in Illinois began in 1922 only about 4 per cent of the total area of Illinois oil fields had been affected by repressuring up to 1932, and since that time, owing to economic conditions, few new installations have been made. A study of repressuring in Illinois was undertaken by the State Geological Survey in 1931 and a preliminary report was published in 1932. At the same time evidence for natural water drives was found in certain areas and a study of water-flooding, both of the natural and accidental type, was undertaken. The influence of natural and accidental water-floods on the rate of oil production from wells in various areas suggested that artificial water-flooding like that in use in the Bradford field, Pennsylvania, might be a practicable method of recovering oil in Illinois.

In June 1933, the Illinois statutes were amended to permit artificial flooding under controlled pressure and some field experiments using this method have been begun. Results to date are encouraging but further investigation is needed.

The measurement of fluid levels in wells which have been allowed to stand unpumped for a time long enough for the fluid level to approach equilibrium is providing comparative data on reservoir pressures in various areas. Contour maps of fluid levels provide an effective means for studying the direction of fluid movements through the oil sands and serve to distinguish between different types of water-flooding.

The data obtained in studies of natural and accidental water-floods are useful to the operator in connection with production problems for each locality, but should be supplemented by data obtained from laboratory tests of oil sand cores.

Flow of Fluid through "Oil Sands," by R. J. Piersol, Physicist, State Geological Survey. This paper presents (1) a detailed study of permeability and porosity of a Plymouth-Colmar core, (2) a preliminary study of porosity and saturation of four Dupo cores, and (3) a comparison of permeability of the Plymouth-Colmar core with that of other oil sands.

The Plymouth-Colmar core has an average permeability in the direction of bedding of 610 milli-darcys, with a mean deviation of 68 per cent. There is a rough linear relationship between porosity and the logarithm of permeability.

The permeability of the Plymouth-Colmar core (610 milli-darcys) is very high as compared with that of the Bradford sand (6 milli-darcys) where water flooding has proved successful. The Plymouth-Colmar pool is being repressured with success, thereby indicating that high permeability sands are amenable to improved recovery, contrary to previous opinion. This success is believed to be due to the uniformity rather than the degree of permeability. Delayed repressuring is suggested for use in sands of non-uniform permeability.

Education in Petroleum Engineering, by R. F. Larson, Associate in Mechanical Engineering, University of Illinois. This paper describes the history of petroleum engineering as a college course since it was first offered in 1912, the contributions made by the industry in the early twenties when the value of trained engineers began to be appreciated, and the basic training and prerequisites as set forth by a committee of the A.I.M.E. in 1926 and as expanded in later years.

The Petroleum Production Engineering curriculum at the University of Illinois is offered by the Department of Mechanical Engineering, and is a modification of that taken by the mechanical engineering student. It provides in the senior year special courses to give familiarity with the machinery, methods, and equipment used in the oil industry, and covers oil field development from prospecting to finishing the well, followed with production methods, secondary recovery methods, transportation and storage. Engineering problems typical of those encountered in the industry are given. Specialized courses in Petroleum Geology are given in the Department of Geology. The curriculum is necessarily in a period of development because the industry itself is making great strides. Its success will be tested by the demand for the trained engineers.

Saturday Forenoon, April 25

SYMPOSIUM ON

OIL AND GAS RESEARCHES NEEDED

On Saturday forenoon symposia on Needed Researches from the industrial viewpoint were held separately and concurrently for Coal, Oil and Gas, Clay and Clay Products, and Rock and Rock Products. These meetings were planned in order to provide industries with a special opportunity to offer their suggestions of needed researches. Following are abstracts of the papers presented at the Oil and Gas symposium.

A Comprehensive Survey of Reserves and Underground Conditions in Illinois Oil Fields, by William Bell, President, Illinois-Indiana Petroleum Association, Robinson, Illinois. To date about 25,000 wells have been drilled in Illinois, of which more than 14,000 still survive. Total production amounts to more than 400,000,000 barrels for which more than $500,000,000 was paid at the wells.

It is estimated that as much more oil, or another 400,000,000 barrels, can be recovered, if economic conditions are favorable and if the expected progress in improvement of recovery methods is realized. The field has doubtless been injured by the use of vacuum on the producing formation, resulting in depletion of the natural gas available to move the oil to the well, in deterioration of the oil remaining, and in scarcity of fuel for surface operations. New methods of improved recovery seek to restore the internal energy by pumping into the oil-producing formations air, gas, or water. To this end it is important that oil producers cooperate with each other and with the State Geological Survey in order to develop the most suitable methods for the different pools and to avoid the mistakes that cause loss and injury.

Problems in Improved Oil Recovery, by Millard Flood, Engineer, Ohio Oil Company, Marshall, Illinois. In Illinois only about 3.6 per cent of the State's total productive area has been affected by repressuring methods. Of the acreage affected by repressuring, 73 per cent obtained increases in production; of pumping wells affected, 75 per cent yielded increased production.

Problems in repressuring and water-flooding operations include: (1) study of underground conditions including geology, petrography, and structure of the oil-bearing formations; studies

of grain size, porosity, permeability, and saturation of the oil-bearing rocks, based on analyses of cores; and chemical composition of the rocks and of their waters, oil, and gases; (2) mechanical engineering problems of well drilling, coring of oil sands, design of well equipment and machinery including that for repressuring by gas, air, or water; metering of injected medium, measurement of rate of production of gas, oil, and water, study of oil-gas ratios or volume-rate per barrel of oil; back pressures and increased load on powers and prime movers; (3) treatment of oil, including demulsification; (4) study of corrosion, its effects, corrosion-resistant equipment, and methods of combatting it; (5) disposal of oil-field wastes to avoid stream pollution and property damage; (6) economics, including underground reserves, production costs, prices and markets. Actual existing conditions, which can best be determined in cooperation with the State Geological Survey, provide the basis on which each operator must analyze his own problems.

The Permeability of Oil Sands in Relation to Increased Recovery, by W. S. Corwin, Manager, Tide Water Oil Company, Robinson, Illinois. A standard procedure for determining permeability of oil sands was adopted by the American Petroleum Institute in May 1935, the unit of measurement being called "darcy." Permeability, or the ability of a solid to permit liquids to move through it, depends on grain size and shape, and on the type of the cementing material; solids of the same porosity may have different permeabilities. This was demonstrated near Bradford, Pennsylvania, where porosity tests of two wells showed 11.50 and 12.10 per cent respectively. Repressuring based on these tests was successful in only one area, whereupon permeability tests were run on the cores with results showing 2.72 and 28.5 millidarcys. Other properties in Pennsylvania whose problems involved loose and tight streaks have yielded profits from repressuring operations based on permeability tests of the sand cores. Delayed drilling programs, where the sand was put under pressure for some time before the production wells were drilled, have been successful in the Bradford field. Records of permeability tests and the input of cored wells have permitted accurate forecasts of results in adjacent areas.

Daily production in the Bradford field (95,000 acres) was 4,000 barrels in 1910 and 35,000 barrels in 1935. In the Illinois field (98,000 acres) it was 33,000 barrels in 1910 and 12,000 barrels in 1935. Water-flooding of oil sands has been legalized in Illinois but not much advantage has been taken of it. Natural and accidental water floods have been studied, but lack of cores and permeability tests are a handicap. Test-drilling and coring is needed badly, with engineering and laboratory data made available promptly, if scientific research is to bring back the production of crude oil to its former prominence in Illinois' industries.

Present Status and Future Possibilities of Acid Treatment in Illinois Fields, by Frederick Squires, Formerly Associate Petroleum Engineer, Illinois State Geological Survey, Urbana. Acidizing as a method of increasing oil production is of course useful only on limestone formations. Acid treatment of shallow wells has been tried in Ohio, Michigan, Indiana, Kentucky, and Illinois and has been reported generally successful.

Study is needed to determine: (1) the limits of its successful application to rocks partly sand and partly lime; (2) improvement in the technique of application; (3) other oil field uses of acid; and (4) the actual effects of acid on the oil-producing lime.

Tests of cores of the producing formation would provide much needed data on the proportion of sand to lime which would determine whether or not acid treatment would be useful, and on the porosity and permeability which would determine the pressure required. Side-wall cores could be obtained from old walls at small expense with the manufacture of a simple tool for the purpose.

Further research should study how beneficial heat would be in acid treatment and how much it would lessen the value of the inhibitor, means of mechanical agitation of the heated acid in the hole and reaming of the acid softened limestone, the softening of lime formation ahead of drilling tools, the use of acid in fishing for tools in a lime formation, the use of an acid jet through a rotary drill to accomplish horizontal or inclined drilling in the producing formation of an old well. Hydrogen chloride gas might be found to give better results than the liquid hydrochloric acid. An experiment in acid treatment at the face of a quarry in the McClosky formation would yield accurate information on underground conditions in the oil field.

Relation of Imports and Exports of Petroleum to the Domestic Industry, by W. H. Voskuil, Mineral Economist, Illinois State Geological Survey. The United States has today an ample liquid fuel supply. In addition to the domestic oil resources, large supplies are available in Venezuela, Mexico, and Columbia, and more remotely located supplies in Russia, Roumania, Persia, and the East Indies. The principal consumers outside of the United States are Great Britain, Germany, France, Italy, Russia, China, Japan, and Canada. The factors of price and production depend upon the relation of supply to demand and the domestic oil situation is affected by world conditions. California produces about 20 per cent of the nation's output. About 35 per cent of this output, or 60 to 70 million barrels annually, moves by water transportation to intercoastal, Pacific foreign, and Atlantic foreign ports. If California fails to discover 200,000,000 barrels annually to maintain its present position, water shipments will probably be curtailed. Japan, the largest foreign consumer of surplus California oil, will be the first to be affected. The price of California export oil will rise for the nearest other producer to Japan is the Dutch East Indies,

which is incapable of meeting Japan's demands. California shipments to western Europe may decline or cease altogether which will be advantageous to Mid-Continent producers, who must now compete with California shipments through the Canal Zone. Russia is becoming a less competitive factor in the Mediterranean area. The Mediterranean demand will probably be supplied by Roumania, Persia, and Iraq. Venezuela, third largest producer, is now and will continue to be the most critical competitor to the domestic industry. The effect of curtailment of Venezuelan oil shipments to the Atlantic Seaboard has been to increase refinery capacity in Venezuela, thereby increasing shipments of both crude and refined oil products directly to Europe and a decline in shipments to the United States. The apparent future trend of oil production in the United States is one of higher cost. The urge to protect the domestic industry and domestic reserves by tariffs will increase as a result, especially since Venezuela promises to be a source of low cost oil for a long time. The large surplus of stocks on hand of gasoline due to heavy demand of furnace oil last winter and prediction of same for 1936-1937 presents a serious problem to the industry. It has been suggested that an import of certain quantities of furnace oil would prevent the accumulation of an unwieldy surplus of gasoline. Certain factors must be considered in solving this problem: (1) In addition to gasoline, furnace oil has become a cash crop in the industry; (2) a normal gasoline stock may cause a rise in price of furnace oil, thereby causing a reversion to the use of coal for domestic heating; (3) an attempt to produce an adequate supply of furnace oil may weaken the gasoline price structure. The picture of world oil movements should be analyzed in detail in order to gauge their effect upon the future of the domestic market.