

REPORT OF THE DIVISION OF GEOLOGY

(Sixty-fourth Annual Report of the State Geologist)

RALPH E. ESAREY, State Geologist.
G. F. FIX, Supervisor of Natural Gas.
JOHN R. HARRIS, Assistant Geologist.
J. B. PATTON, Assistant Geologist.
VERNE PATTY, Curator of Museum.

Faculty members of the Geology Department at Indiana University, who, in accordance with the plan of cooperation with the Department of Conservation, acted in an official, technical, or advisory capacity during the year were: Ralph E. Esarey, State Geologist; E. R. Cumings, stratigraphic geology; C. A. Malott, physiographic and stratigraphic geology; J. J. Galloway, paleontology; J. E. Switzer, geography; S. S. Visser, geography; W. D. Thornbury, glaciology and climatology; Wallace Buckley, geography; Chauncey Harris, geography; and H. W. Legge, preparator. These men receive no salary from the Department of Conservation.

OIL AND GAS SUPERVISION

The State Gas Supervisor, with the Assistant Supervisor and nine deputy gas inspectors, procure the enforcement of laws and regulations pertaining to the search for, development, and production of petroleum and natural gas, supervise the plugging of dry or abandoned wells, and inspect field and pipe-line equipment to eliminate wastage of oil and gas and prevent pollution of water courses by oil or salt water. In addition, this staff collects and compiles geological and production data which are made available to the public through several publications.

During the fiscal year 1939-1940, the natural gas inspection force consisted of G. F. Fix, Supervisor; John R. Harris, Assistant Supervisor; Marion Brown, Loogootee; Herman Chanley, Laconia; William Connors, Vincennes; L. W. Edmundson, Pennville; Fred Harrer, Tell City; J. P. Horton, Montpelier; O. H. Hughes, Sharpville; H. W. Legge, Bloomington, and James Wyman, Sullivan. Deputy gas inspectors receive no salary from the Department of Conservation, but are reimbursed for their work through a percentage of the fee collected for supervising the methods and materials used in plugging wells in their respective districts.

The Division of Geology, in addition to, and in conjunction with its supervisory work, collects information on the progress of wells in the state. This information, together with additional data obtained from members of the oil fraternity and interested observers is constantly kept up to date in card file. Each month the *Indiana Oil and Gas News*, incorporating the latest available information on all drilling wells in the state, is mimeographed and mailed to a large number of subscribers all over the country. There is no charge for this publication, and it is of great value to interested parties, in that it covers the entire state, showing where the active areas are located, new discoveries, and other pertinent information. Through this bulletin, drillers and operators are able also to locate one another.

The collection of samples from drilling wells continued during the fiscal year, with more complete sets of cuttings obtained than in all previous years combined. Approximately 300 sets of samples are now on file at the state laboratory in the Department of Geology at Indiana University. These samples are available for microscopic study by any interested person. The study of drill cuttings furnishes an invaluable aid to the better knowledge of the sub-surface conditions in the state. Drillers and operators have cooperated to the fullest extent to assure the Division of Geology a good set of samples on practically every wildcat well, as well as key wells in proven fields, in the state.

Mr. J. B. Patton, appointed Assistant Geologist in May, 1939, continued his supervision of field operations in the southwest part of the state, where drilling activity has been most pronounced.

Under the supervision of the Division of Geology and the deputy gas inspectors, two hundred and eleven (211) abandoned oil or gas wells and dry holes were plugged, netting fees totalling \$2,110.00.

OFFICE WORK

Routine office work consisted chiefly in answering correspondence, identifying rocks and minerals brought or sent in by owners and finders, furnishing information and publications to many hundreds of geologists and oil and gas operators interested in Indiana oil and gas possibilities, and the compilation and publication of several reports and maps, dealing chiefly with the petroleum industry. Such maps, reports, and requests for information usually require a great amount of research, since records for many years back must be consulted and checked. Many hundreds of rock and mineral specimens are checked and identified by members of the Division during the year. Most of these are samples which the owner believes to contain gold, diamonds, or other valuable minerals. Samples of calcite, quartz, iron ore, pyrite, marcasite, gypsum, magnetite, sand, fossils, garnet, et cetera, are the most common brought in for identification. Perhaps the most common mineral identified during the fiscal year was a gold-colored biotite mica contained in a weathered mica-gneiss. Many dozens of mineral specimens proved to be this same mica. To the naked eye the mineral has much the appearance of small flakes of gold, but it can be readily identified by simple tests and is of no value commercially.

The Division welcomes such requests and members are always glad to help in any way possible. Many requests are received each year from individuals and companies interested in developing or in the possibilities of development of the various non-metallic mineral resources of Indiana, such as stone, sand and gravel, coal, petroleum and natural gas, iron, marl, peat, ground water, mineral wool rock, molding sands, clays and kaolins, et cetera. In many instances, the Division is called upon for information concerning the status of already established mineral industries in the state. Other requests require information on state parks and forests, caves, fossils, rock garden materials, physiography, topography, and almost all phases of geology.

FIELD INVESTIGATIONS

Field investigations, in connection with Department of Conservation projects, enforcement of laws and regulations, and collection of data by members of the staff, required a large amount of time during the fiscal year. Mr. Tom Dawson continued his work on the geology of new topographic quadrangles in southern Indiana during the 1939 field season. This work was begun the previous fiscal year. During the latter part of the season, however, his duties were revised to include a detailed study of the outcrop of the Devonian and Silurian formations in the southern part of the state. Field work on this project was completed during the year.

Summer field parties for the field season, 1940, are working on the geology of topographic quadrangles in southwestern Indiana. Duties consist primarily of a complete inventory of Indiana's coal resources, including stratigraphy, areas mined out, workable coal seams, estimates of the amount of coal yet available, structure of the area, et cetera. The last coal survey made in the state was conducted more than 30 years ago, so that this work has been needed for several years. Four parties, consisting of two men each, are actively engaged in this work and, in addition, other members of the Division of Geology, including members of the Department of Geology at Indiana University, act in an advisory or consultative capacity. Parties for the field season, 1940, are as follows: No. 1, Ralph E. Esarey and Hollis Fender; No. 2, John R. Harris and Everest Wible; No. 3, Tom Dawson and Preston McGrain; No. 4, Walter Spangler and Willis Smith.

Other studies included work on the sub-surface Devonian formations of the state by John R. Harris; work on the sub-surface geology of the Chester Series of Indiana, by G. F. Fix, and on the geology of the Griffin Oil Field, by J. B. Patton.

PUBLICATIONS

In March, 1940, a report entitled "Oil and Gas Developments in Indiana During 1939" was prepared to be used in the publication of the American Institute of Mining and Metallurgical Engineers, "Petroleum Development and Technology, 1940." This includes a resumé of the Petroleum Industry in Indiana during that calendar year and contains in tabulated form the area, production, wells, and producing horizons in every field now producing oil and gas in the state. Reprints of this report are available in the office of the Division of Geology.

A report entitled "Natural Gas in Indiana during 1939" was completed for publication in the "Minerals Yearbook, 1940," published by the U. S. Department of Mines, Washington, D.C. This report includes statistical and development data on natural gas in Indiana for the calendar year, 1939.

Several new maps were made to cover new producing areas in the state, older maps were periodically brought up to date, and several new county well log supplements to Publication No. 108, "The Sub-Surface Strata of Indiana," 1931, by W. N. Logan, were completed. These include Gibson County, 188 pages, September 1, 1939; Knox County, 97

pages, April 2, 1940; and Spencer County, 121 pages, May 1, 1940. The complete list of County Well Log Supplements now includes: Vigo, Sullivan, Dubois, Pike, Posey, Daviess, Dearborn, Fountain, Wabash, Henry, Gibson, Knox and Spencer counties.

Due to an increasing interest in Indiana's numerous caves a small publication entitled "A Guide to Indiana Caverns" was published late in 1939. This includes descriptions of twenty-two of Indiana's best known and most easily accessible caverns, located in seven different counties. "The Bristow Oil Field, Perry County, Indiana," by Ralph E. Esarey, State Geologist, and George Heap, was published in December, 1939. This report, accompanied by two structure maps and one cross-section, discusses the stratigraphy, development, structure, and production of a small, but interesting, field in southern Indiana which shows similar sand conditions and structural relationships to many areas where production is from formations of Chester age. A comprehensive publication entitled "The Devonian Formations," Part II, "Structural Conditions," by John R. Harris, Assistant Geologist, and Ralph E. Esarey, State Geologist, was published in February, 1940. This report, accompanied by seventeen maps and cross-sections, includes structural conditions for the entire state, with information on areas producing at present from the Devonian-Silurian formations, and future possibilities in other areas. Part I of this series, by Tom Dawson, includes the outcrop of the Devonian and Silurian formations. The field work for Part I was completed during the year and maps and data are being compiled for its early publication. A report on the Griffin Oil Field of Gibson and Posey counties, by J. B. Patton, Assistant Geologist, was completed in May, 1940, but has not as yet been published. This study covers the stratigraphic and structural conditions in this recently developed field and includes a history and development of the area. Laboratory work for the "Sub-surface Geology of the Chester Series of Indiana," by G. F. Fix, Assistant State Geologist, was completed during the latter part of the fiscal year. Maps and cross-sections have been drafted, and data are being compiled for its early publication. This report will include the stratigraphic conditions and relationships of some nineteen formations in southwestern Indiana, and is based largely on sample study logs. In addition, research work is being conducted on several other problems in Indiana geology.

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| Free publications distributed | 900 |
| Publications and well logs sold..... | \$1,395.18 |

DEPARTMENTAL WORK

During the past fiscal year, members of the Division of Geology have continued the cooperative work with other state and federal agencies in their projects, which have required geological investigation. Geological examinations were made at the sites of "made lakes" on properties owned by both state and federal agencies. Such investigations at dam sites, included the determination of the form of the bedrock stream channel, and the amount and character of the alluvial fill material; the type and extent of the bedrock; the presence, character, direction, and

spacing of joints or laminations in the rock; the permeability of the bed-rock; the depth to which weathering has affected the rock; and the ability of the foundation material to withstand dynamic and hydraulic pressure after the dam has been completed.

The earth fill materials used in the construction of dams were selected under the supervision of members of the Division of Geology. Samples of these materials were taken and laboratory soil tests were made to ascertain the suitability for construction purposes prior to the opening of barrow pits where the earth-fill material was obtained.

Requests for geological examinations of fish hatchery and rearing pond sites have also been numerous during the past year. Materials used in the levees and bottoms of the pools were selected under the supervision of this Division. This type of work was done for many conservation clubs prior to and during the construction of hatching and rearing ponds and small bodies of water. During the past year, the Division of Geology has also cooperated with the Works Progress Administration in the geological examination of proposed lake sites and in the selection of earth materials to be used in the construction of the dam.

A cooperative research agreement with the Ground Water Division of the United States Geological Survey, instituted in 1935, with the Division of Geology was continued during the fiscal year. Observation water wells are located throughout the entire state, and water levels are checked every two weeks. These wells represent all variations of topography, altitude, and water-bearing strata, and continuation of the measurement program will give valuable information concerning the fluctuations in level of the sub-surface water supplies. Data are assembled and studied in the offices of the United States Geological Survey in Washington. Several new wells were added to the list being measured in Indianapolis during the early months of the fiscal year, and two automatic, continuous water-level recorders are now in operation.

The continuation of the ground-water program will result in a wealth of valuable information such as, the amount of ground water available, the effects of land drainage projects on the ground water table, whether and where a progressive and permanent decline of the water table is taking place, and the effect of soil erosion control methods on the ground water levels.

MAPPING

During the past fiscal year, as in three previous years, the Department of Conservation cooperated with the United States Geological Survey in a topographic mapping program, wherein each sponsor furnished \$25,000.00 for a two year period. Mapping of topographic quadrangles is done by engineers from the federal survey and data are compiled and published in the offices of that organization. The Divisions of Geology and Engineering have charge of the selection of areas to be mapped, and, also, select part of the non-technical personnel. Mapping under the new program is on the scale of 2 inches to the mile, approximately, and each quadrangle is 7½ minutes of arc square. The new larger scale of these maps, and the accuracy of work done by the United

States Geological Survey, makes these maps very valuable. They are, by far, the most accurate maps in the world, and their utility in highway, flood control, and many other types of endeavor cannot be overestimated.

During the year, mapping progressed along the Ohio River, in the extreme northeast part of the state and in four central western counties. At the end of the fiscal year, maps had been received for seventeen $7\frac{1}{2}$ minute quadrangles, and mapping was in progress on approximately 45 other quadrangles of similar size. Many of the latter have been completed in so far as field work is concerned and are now in Washington for inking and photolithing. Indiana is far behind practically all other states east of the Mississippi River in total area mapped, and this program should be carried to completion.

OIL AND GAS OPERATIONS

During the fiscal year 1939-40 drilling for oil and gas increased approximately 60 per cent over the previous fiscal year. Much of this increase was due to inside drilling in some of the new fields of southwestern Indiana, but a large percentage was due to wildcat drilling in search for new production. Production of oil increased considerably although pipe-line proration, limiting wells to two-thirds of their potential daily production, continued on some of the older fields. Oil production for the calendar year 1939 was 1,729,564 barrels. Gas production continued to decline up to the end of the calendar year 1939 to a total of 871,586,000 cubic feet for that period. The new Rockport Gas Field, in Spencer County, discovered in April, 1939, did not have pipeline connections until January, 1940. This field, at the end of the fiscal year 1939-40, had a total of 31 producing gas wells, with a total cumulative initial production of approximately 200,000,000 cubic feet of gas a day. Several new wells, in addition, were being drilled at the end of the year. The Griffin Oil Field, Gibson County, discovered December, 1938, had 150 producing wells, and the New Harmony Oil Field, Posey County, discovered May, 1939, had 25 producing wells at the end of the fiscal year. Several new oil and gas producing areas were discovered during the fiscal year in southwestern Indiana. None had been drilled sufficiently at the end of the fiscal year to indicate whether or not they would assume any proportions.

Drilling was most active in southwestern Indiana, as for the past several years. Gibson County led with 145 completions; followed by Posey County with 92, and Spencer with 65. Four hundred and sixty-six (466) wells were completed in Indiana from July 1, 1939, to June 30, 1940. Five hundred and twelve (512) drilling permits were issued during the period and 93 wells were drilling at the close of the fiscal year.

At the end of the year, drilling and prospecting continued at a rapid pace. Many operators have moved out of the "Basin" area, or that portion of southwestern Indiana included in the Eastern Interior Coal Basin, into other parts of the State. Northern Indiana, including counties north of the Wabash River, was becoming active, with many operators leasing large blocks and drilling test wells. Many of these northern