REPORT OF THE DIVISION OF GEOLOGY

(Sixty-First Annual Report of the State Geologist)

RALPH E. ESAREY, State Geologist.
M. M. FIDLAR, Supervisor of Natural Gas.
GORDON F. FIX, Assistant Geologist.
VERNE PATTY, Curator of Museum.
MARY E. LIVENGOOD, Clerk-Stenographer.

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. Visher, geography; W. D. Thornbury, glaciology and climatology; Wallace Buckley, geography; and H. W. Legge, preparator. These men receive no salary from the Department of Conservation.

OIL AND GAS SUPERVISION

The State Gas Supervisor and ten deputies enforce the state conservation laws and regulations pertaining to the production of petroleum and natural gas, supervise the plugging of dry or abandoned oil or gas wells, inspect well and pipe line equipment, and collect geological and production data in the oil and gas fields of the state.

The natural gas inspection force in Indiana is composed of M. M. Fidlar, Supervisor; Gordon F. Fix, 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, Sharpsville; H. W. Legge, Bloomington; Herschell Ringo, Muncie; and James Wyman, Sullivan. The deputy gas inspectors do not receive a salary from the Department of Conservation, but receive a percentage of the state fees collected for supervising the method and materials used in the plugging of abandoned oil and gas wells and dry holes in their respective territories.

Information on the progress of wells being drilled throughout the state is obtained by the natural gas inspection force, in conjunction with their supervision work. Additional information is obtained through the cooperation of drillers, operators and interested observers. These data are collected in a card file in the office of the Division, and on the first of each month the *Indiana Oil and Gas News* is published, incorporating the most recent news of operations in the state. This mimeographed publication is mailed gratis to an extensive list of operators and other persons interested in oil and gas developments in Indiana. Through the *Indiana Oil and Gas News* the Division of Geology, the operators and the drillers are enabled to keep in touch with one another.

A number of drillers and operators volunteered to keep samples of the rocks passed through in drilling oil, gas or test wells. Sample bags were furnished by the Division free of charge. The examination of drilling samples has furnished the Division and the operators with sev-

eral detailed and accurate well records. The data obtained from laboratory study of well samples have proven to be quite valuable to everyone interested in the wells.

Owing to increased interest in oil and gas exploration in Illinois and southwestern Indiana, there has been a great increase in the demand for information concerning the production and history of the oil and gas areas in Indiana. Many landowners have asked for information on leases and leasing practices. A number of abandoned gas wells in the Trenton area were examined and subsequently plugged. During the fiscal year ending June 30, 1937, one hundred and ninety-eight dry or abandoned oil or gas wells were plugged in Indiana, under the supervision of the natural gas inspection force, totaling $1,980.00.

OFFICE WORK

Routine work in the office of the Division of Geology consisted largely in furnishing information to callers, answering correspondence, and tabulation of data on the occurrence and production of Indiana's mineral resources. In addition, the office force during the past year has prepared several reports and many maps. The information requested from this office often requires a great amount of research or laboratory work before a satisfactory answer can be offered. Records for many years past must be consulted and the information collected in a form which can be used. Each year several hundred rock and mineral specimens are sent or brought to the attention of members of the division for examination and identification. In many cases, the owner of the specimen requires information upon the uses, value, composition, occurrence and distribution of the material. Numerous inquiries are received concerning coal, oil, gas, lime, cement, ground water and other water supply, building stone, mineral wool, sands, gravels, molding sands, soils, clays and kaolins, and their occurrence and distribution. In many cases, the Division is called upon for information about the economic status of industries utilizing our natural resources. Other requests require information upon state parks and forests, caves, fossils, rock garden materials, physiography, topography and various other phases of geology.

Samples examined for the presence of placer gold exceed all other samples in number, and during the past year only one sample brought to our attention contained true gold flakes. However, the Division welcomes all requests concerning natural mineral resources and is glad to dispense all information available.

FIELD INVESTIGATIONS

The field survey was resumed during the summer of 1937, under the direction of Ralph Esarey, State Geologist. The field party consisted of Hollis Fender, George Heap, and Frank Williams. Work was confined to Daviess, Martin, and Dubois Counties, and consisted of location and examination of rock outcrops, in an attempt to determine the stratigraphy and structure in the area. Such work is a great aid in completing our knowledge of the coal-bearing strata in Indiana.

A large amount of field investigation was connected with projects of the Department of Conservation; work necessary to the enforcement

of the conservation laws pertaining to natural mineral resources, in particular oil, gas and ground water; and collection of data for use in oil and gas production reports.

PUBLICATIONS

In February, 1937, a report entitled "Oil and Gas Developments in Indiana in 1936" was prepared to be used in the publication of the American Institute of Mining and Metallurgical Engineers, "Petroleum Development and Technology, 1937." Separates of the paper on Indiana are available at the office of this Division.

A report upon the production of natural gas in Indiana was also prepared for the "Minerals Yearbook, 1937," a publication of the United States Bureau of Mines. During the year, the Division of Geology also compiled information upon the future petroleum reserve in Indiana, for use by the American Petroleum Institute. Work was also started on two publications, one to deal with the glacial geology of the state, and the other a compilation of records of oil and gas wells drilled since 1931. These should be available in a short time.

Many oil field maps have been prepared during the past year, showing the locations of all oil or gas wells, and dry holes, in the producing areas. These maps have proved to be very popular in the past few months, owing to the greatly increased interest in oil and gas exploration. The recent oil boom in Illinois and southwestern Indiana has also resulted in an increased demand for all publications, particularly those dealing with the oil and gas industry. Records of wells drilled in the state, since the publication of "Sub-Surface Strata of Indiana," are made available in typed form at a nominal charge. Distribution of publications during the past fiscal year was as follows:

Free publications distributed	1,025
Publications sold	$ 601.78
Well logs sold	421.46
Total	$1,023.24

DEPARTMENTAL WORK

During the past fiscal year, the Division of Geology has continued to cooperate with other state and federal agencies in their projects which required geological control. Geological investigations were made at the site of earth fill dams being constructed on state properties. Such investigations at dam sites included the determination of the form of the bedrock channel, and the depth and character of the fill material; the type of bedrock; the presence, character, direction and spacing of joints or laminations; the position of the beds; the permeability of the bedrock; the depth to which weathering has affected the rock; and the ability of the foundation rock to withstand dynamic and hydraulic pressure.

The earth fill material used in dams was selected under the supervision of members of the Division of Geology. Samples of soil were taken and laboratory soil tests were made, during the preliminary examination, prior to the opening of borrow pits where the earth fill material was obtained.

There have also been requests for geological examinations of sites for fish hatcheries and rearing ponds. Materials used in the levees and bottoms of the ponds were selected under the supervision of this Division. Local conservation clubs have asked for this type of advice, in the construction of hatcheries and small dams.

The Division of Geology and the Department of Public Health are sponsoring a program to seal abandoned shaft and strip coal mines in thirteen counties in southwestern Indiana. This program has resulted from the pollution by acid of streams in the coal districts. Sulphuric acid is formed when air and water come in contact with iron sulphide contained in the coal and black shales. By the elimination of either air or water, it is possible to prevent acid water from leaving the mines and entering the streams. In the abandoned strip pits, small dams are being constructed, so as to raise the water level above the coal outcrop throughout the pit. In this way, the air cannot come in contact with the coal. In the case of shaft mines, all openings have been closed so as to prevent air circulation. The water level can also be raised to a point above the coal. In hillside, or "drift," mines, a small dam has been constructed across the mouth to raise the water level within. In one county alone, an estimated 54,800 tons of sulphuric acid were pouring into the streams yearly, before the sealing program was started. Some of the strip pits which were highly acid, before sealing was started, are now supporting fish life. It is hoped that the continuation of this program will render all the pits and streams free from acid, so that fish and other wild life may flourish.

During the past year, the Division of Geology continued its cooperative research agreement with the Ground Water Branch of the United States Geological Survey. During the winter the observation wells in northern Indiana were checked and observations on several additional wells were started in southern Indiana. The wells throughout the entire state are situated in areas representing all variations of topography, altitude, and water-bearing strata. Observations of the static water level were made semi-monthly and the readings sent to the federal survey where the data are assembled. Some wells are located in municipal areas where ground water is used extensively, and will be very valuable for information in regard to the safe yield of water from these areas. The continuance of the observation wells will result in a wealth of valuable data concerning many problems, such as: the amount of ground water available; the effects of land drainage projects on the 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 water table.

The Division of Geology has been called upon to supply information upon the economic studies carried on by the State Planning Board, particularly as they pertain to industries utilizing mineral resources in Indiana. The State Geologist is a member of the permanent State Planning Board.

MAPPING

During the past fiscal year, the Department of Conservation entered into a cooperative agreement with the U. S. Geological Survey, whereby

each organization will furnish $25,000 per year for a period of ten years, such money to be used in the compilation of topographic maps in Indiana. The Divisions of Geology and Engineering have charge of the selection of areas to be mapped, as well as the selection of a part of the personnel of the survey parties. The work in the field is done under the direction of the U. S. Geological Survey, and the data are compiled by the men in the federal office. Printed maps are made available at a nominal cost.

At the end of the fiscal year, four control parties were working under this program, in the vicinity of the Ohio River. The finished maps will be of nearly limitless value in flood control projects throughout the state. The utility of such accurate maps is great, and this fact alone should justify the expenditures of money for this purpose. The ten-year program now in progress should be extended at the end of that time to allow the complete mapping of Indiana.

OIL AND GAS OPERATIONS—1936-1937

During the past fiscal year from July 1, 1936, to June 30, 1937, oil and gas operations in Indiana showed a decrease over the previous year. In spite of the decrease in drilling activity, there was an increase in oil production, due in large part to a better price for crude oil. The increase in crude oil price allowed many operators to put in service old wells which had reached their economic limit under the prevailing prices of 1935-36. The following table shows the number of completed wells in Indiana during the past fiscal year.

WELLS COMPLETED IN INDIANA—JULY 1, 1936 TO JUNE 30, 1937

County	Proven Area			Wildcat Area			Totals
	Oil	Gas	Dry	Oil	Gas	Dry	
Daviess		3	2		2	7	14
Decatur		5			1		6
Delaware		1					1
Dubois						1	1
Gibson	2	2	2			3	9
Hamilton						1	1
Hancock		1					1
Harrison		1				1	2
Jay	1	1	1				3
Johnson						1	1
Knox	1	12	4		2	5	24
Lawrence			1				1
Martin						2	2
Monroe						1	1
Perry	5	1	8	1		6	21
Pike	9	5	5	1		4	24
Posey		1	1		1	2	5
Randolph			1				1
Ripley					1		1
Rush					1		1
Shelby		2	2				4
Spencer	5		3			7	15
Sullivan	2		3				5
Vanderburgh	12	1				7	20
Vigo	4					2	6
Totals	41	36	33	2	8	50	170

Exploratory drilling for gas was most pronounced in the Oaktown field, Knox County. Most of the wells completed here were in a proven area, but two wildcat gas wells extended the proven field southward about one-half mile. The search for more gas continued in the Daviess County area, and of the five gas wells completed, two were in new territories. Interest in natural gas is high because in this state the highest prices are paid at the well by the pipeline companies.

Of the 170 wells completed in Indiana in the past twelve months, 81 were dry, 45 produced gas and 44 yielded oil. The decrease in number of completions from a total of 242 for the previous year was due in large part to the floods and wet weather during the spring. Nearly all operations ceased at this time, since rigs could not be moved to new locations. The greater part of the drilling activity has been in Knox, Pike, Perry, Vanderburgh, Spencer and Daviess counties.

Of all the gas fields in Indiana, the Unionville field in eastern Monroe County is the only one closed in because of lack of a market. All the gas produced in southwestern Indiana was used to supply the demand of cities and towns using natural or mixed gas for domestic and commercial consumption. After 51 years of steady production, the old Trenton field is still supplying gas to several communities in eastern and northeastern Indiana. Of the 21 wells completed in the Trenton area during the past 12 months, five were dry, two produced oil and 14 produced gas. Activity was greatest in Decatur County, where 7 gas wells were completed.

Although the Oaktown field in Knox County produced more gas during the past year than any other field, the open flow capacity per well has been decreased considerably. This is due in part to a natural decrease in pressure, and in part to the fact that too much gas was taken from the area during the cold months. The heavy pull during winter months has caused bottom-hole water to come up in several wells. During the past year, all new gas wells in the area were equipped with bleeders at the time they were drilled.

During the past year, repressuring projects have been underway in the West Princeton field in Gibson County, where compressed air is being used, and in the Dodds Bridge field, Sullivan County, utilizing natural gas. Both projects have proved successful in increasing the oil production. Treatment of wells with acid has also been popular during the past twelve months in areas where production is obtained from limestones. Acid treatment in the Trenton limestone areas, however, has been rather disappointing, because this particular limestone does not seem to respond to such a treatment. In southwestern Indiana, limestone wells have responded very favorably to acidizing, and in many cases the oil production has been doubled.

During the past twelve months, the entire southwestern portion of Indiana has become involved in the activity connected with the search for new oil fields producing from deeper sands. Much seismograph work and geological investigation has been carried on by the large oil companies from the mid-continent and gulf coast areas. At the end of the past fiscal year, many thousands of acres in southwestern Indiana had been leased for oil or gas exploration, and much more activity was prophesied for the coming year.

STATE MUSEUM

During the past year several fine pieces of antique furniture have been added to the Sullivan Memorial collection, with a promise of added material next year.

Store room facilities for the future, to care for added museum material and collections, promise to be more adequate and call for better care and housing.

The approximate number of visitors for the year was 40,000.

REPORT OF THE DIVISION OF ENGINEERING

ORGANIZATION

W. K. HATT, State Engineer
DENZIL DOGGETT, Assistant State Engineer
CHARLES H. BECHERT, Field Engineer
ALLEN V. BAILEY, Field Engineer
JUNE GRADY, Stenographer

The Division of Engineering of the Department of Conservation was created by an act of the Seventy-second General Assembly and was organized in May, 1921.

The work of the Division of Engineering falls under two classifications, namely, drainage and land reclamation and engineering service. The work under drainage and land reclamation is specifically set forth in the act creating the division, and considerable detail is given regarding the duties pertaining to these types of engineering work. The division's work under "Engineering Service" is allocated to the various divisions of the Department of Conservation and consists of planning and executing engineering works, making surveys, maps, investigations, reports, graphs and similar work. These two general classifications are grouped in more detail as follows:

I. Drainage and Land Reclamation.
   1. Collection and dissemination of data and statistics.
   2. Legislative recommendations.
   3. Special investigations and reports on drainage and levee projects.
   4. Advisory consultation.

II. Engineering Service.
   1. State parks, memorials, forests, game preserves and fish hatcheries.
      a. Surveys, design, construction.
      b. Supervision of ECW design and construction.
   2. Lakes.
      a. Lake levels, surveys, and reports.
   3. Special surveys, investigations and miscellaneous works.

I. *Drainage and Land Reclamation.*

The Division of Engineering is empowered by statute to make investigations of drainage and flood control projects, to compile and disseminate information which may be used in planning such works, to recommend and secure enforcement of laws pertaining to such works, to assist in design of such works by measuring or computing flows in natural or artificial channels, to collect such data or information as it may regard