

DIVISION OF GEOLOGY

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During the fiscal year July 1, 1947 to June 30, 1948, the Division of Geology increased in size and more than trebled its scientific activities. The vigorous growth of the Division was the result of two years' planning and constructing laboratories, more personnel in specialized branches of geology, removal of oil and gas regulatory functions from the Division, sympathetic help by the industrial mineral producers in Indiana, active cooperation of Indiana University, and of the increase in appropriations from \$20,000 for 1946 to \$114,000 for 1948. The increased funds were made available by the strong support by the Governor; by the Commission of the Department of Conservation, particularly the Chairman, Lisle Wallace and the Assistant Director, Byron C. Kennedy; and by the legislature of 1947 which passed the Bill that created the severance tax of 1 percent of the value of oil and gas produced in Indiana.

The work of the Division of Geology in 1948 fell into five categories: (1) Laboratory and office work in Bloomington, (2) Field surveys of industrial mineral deposits and of basic geology, (3) Collection and preservation of information, samples, oil well cuttings, and specimens of rocks, minerals and fossils, (4) Public services, and (5) Preparation and sale of reports, maps, and directories of mineral producers and users. The activities of each of these five categories are discussed briefly under their respective headings.

The State Geologist's time was used to plan the field research for eight survey parties, to locate and hire new scientific personnel, to establish the new spectrographic laboratory, to maintain and improve the Division's public relations and contacts with the mineral industries, and to administer the organization.

LABORATORY RESEARCH

The research program of the Division of Geology ranges from chemical and optical analyses in one laboratory, to stratigraphy and mapping of subsurface formations in another. Because the research differs so greatly in content, method, objective, and application, the work of each laboratory is summarized under separate headings.

Petroleum Geology.—Two principal types of long-term studies are in progress in the laboratories of the Petroleum Geology section: subsurface petrology and stratigraphy, and subsurface structure and isopach mapping.

The petrologic and stratigraphic research involves studying with the microscope and with ultra-violet (black) light the oil well cuttings, cores, and sample strips, and studying electric logs of wells in order to describe, identify, and correlate oil-bearing strata and associated rock formations penetrated by the wells. This research resulted in 1948 in a report titled "The correlation of the Waldron and Mississinewa formations," by R. E. Esarey and D. F. Bieberman, to be published by November, 1948. A similar study of the Silurian and Devonian formations of northern Indiana is being made. This fundamental research on stratig-

raphy is the very foundation of petroleum geology and is the basis for making structure maps used in the search for new oil and gas pools.

The second type of research in petroleum geology, subsurface mapping, consists of first assembling all available oil well data, and then compiling from them geologic structure maps that indicate the presence and magnitude of folds, faults, and other deformities in the oil-bearing formations. These maps are being compiled by Miss Barbara E. Brooks under the direction of Professor Ralph E. Esarey. Production also is started of isopach maps of certain strata in order to suggest the amount that the formations thicken and thin throughout their known horizontal extent.

Sample Preparation.—Most of the equipment on order since 1946 was delivered and installed in 1948. Approximately 800 samples of limestone were crushed, pulverized, split, and packaged in preparation for chemical, spectrographic, and screen analysis. An equal number of limestones were sawed and polished for petrologic study. Fourteen large samples of sand and gravel, ranging from 400 to 1,000 pounds each, were screened in preparation for analyses of mineral content, and percentages of partical sizes.

Equipment for finely pulverizing, air-separating, and mixing clays was installed, and the Universal Testing Machine, which will exert pressures as great as 60,000 pounds per square inch, also was installed and will be in operation by December, 1948.

Spectrograph Laboratory.—Spectrographs have been used during the past several decades by many industries for making rapid precise spectro-chemical analyses and for fundamental research on the structure and composition of steels and other metals and alloys. The instrument, however, has not been widely applied to the problems of nonmetalliferous minerals and geology. In order to strengthen its research in nonmetals and thereby increase its usefulness to Indiana's mineral industries, the Division of Geology is constructing the most modern spectrographic laboratory that can be built for research and analysis of limestones, clays, coals, and other nonmetals. Much of the State Geologist's time was used to obtain information, order equipment, and employ a competent spectrographer. Richard K. Leininger joined the staff in April, 1948, to design, supervise construction, and operate the laboratory. The first analyses will be run in November, 1948. The mineral aggregate producers, the Testing Laboratory of the Highway Department, and the highway engineering laboratory of Purdue University will benefit directly from the new spectrographic laboratory, and have given much help during the period of its construction.

Bed-rock Surface Map.—Professor W. D. Thornbury continued in 1948 to assemble water well records that give the thickness of overburden on the upper bed-rock surface of Indiana. The information is recorded on cards, and the thickness of glacial drift and location of each well were plotted on a base map of the state. This information will be interpreted and compiled into a topographic map of the bed-rock surface that underlies the glacial drift, river deposits, and other overburden.

FIELD SURVEYS

By June 15, 1948, the Division of Geology had eight field parties working on mineral surveys, geologic mapping, or on fundamental geology. In addition, the U. S. Geological Survey in cooperation with the Division, mapped more than a third of the state with the airborne megnetometer. Of the eight field parties, two worked on coal, two on limestone and gravel, and one each worked on petroleum geology, glacial geology, clay, and sedimentary petrology.

Aeromagnetic Survey.—From September 6 to November 29, 1947, a geophysical crew of the U. S. Geological Survey made an airborne magnetometer survey of the northern part of the state. The crew consisted of three geophysicists, a pilot and co-pilot, and was based at South Bend. The airborne magnetic equipment was carried by a twin-engine Beechcraft. Control lines were flown for the entire state, and the area from the Michigan boundary southward 105 miles to township 23 North was mapped on flight lines that extended north-south and one mile apart. Profiles were constructed from the magnetic data and plotted on county road maps which serve as the base for drawing the aeromagnetic maps. The compilations were completed in Bloomington in January, 1948, but the Federal Survey has not been able to keep its commitment to deliver the preliminary maps during fiscal 1948. The aeromagnetic survey will be continued from September to December, 1948, when more than three-fourths of the state should be flown. The U. S. Geological Survey expects to complete the field work by December, 1948.

Coal Survey.—The purpose of the new coal survey is to obtain exact information concerning the position and extent of the coal beds and other economic minerals, the availability of the coals for stripping and underground mining, the areas from which the coal has been mined out, the structure of each coal, and the thickness of glacial drift upon the coal-bearing rocks. This long-term program is cooperative with the Fuels Section of the U. S. Geological Survey, which furnishes technical advice, and will publish the colored geologic maps as each quadrangle is completed.

As the first step in the coal program, a field party mapped the Jasonville quadrangle in Greene and Clay counties in July and August, 1947. Two field parties directed by Mr. Charles E. Wier began mapping 174 square miles covered by the Linton, Dugger, and Hymera quadrangles in June, 1948. As coal underlies more than 60 quadrangles, the Division of Geology plans to have four field parties mapping coal lands in 1949. The maps and report on the geology and mineral resources of the Jasonville quadrangle will be ready for publication in 1949, and the maps and reports on the other three quadrangles probably will be ready for publication in 1950.

Petroleum Geology Survey.—A field party directed by Professor Ralph E. Esarey began on June 14, 1948, to locate, and determine the altitude of oil and gas wells, to collect samples of surface formations for comparison with subsurface cuttings from wells, and to determine surface geology and structure near the wells. The field work during 1948 was in Daviess and Martin counties, and will be continued next year in Pike,

Greene, Dubois, Jasper, Pulaski, White, Cass, and Miami counties. The Division of Geology will be compelled to continue for several years, this expensive program of gathering and correcting old records before the master file of information on oil well drilling can be completed (*See* headings, "Records, Oil and gas wells").

Limestone Survey.—The field survey of active limestone quarries begun in 1947 was completed in 1948 by two field parties headed by Dr. John B. Patton and Mr. Frank Kottowski. This survey already has provided much information to producers and consumers of crushed stone. The results of the survey are in the form of memorandum reports, one for each deposit. Each report contains the location and ownership of the operation, a detailed stratigraphic section of the quarry rock, a description of the topography geology and drainage, quarry operations, plant capacity, production, and reserves. Sketch maps are made of each quarry, and chip and character samples are taken of all rock units, usually less than 10 feet thick, that are uniform in composition or that must be mined as a unit because of economic reasons. The reports not only have been consulted by producers and consumers of limestones, but are proving to have much value to scientific workers on Indiana geology. This intimate relationship between the various surveys makes the comprehensive program much more valuable than the mere sum of the separate surveys.

Upon completion of the limestone survey in August, 1948, the two field parties will begin a survey of the sand and gravel deposits in Indiana.

Clay Survey.—Areal mapping under Professor Eugene Callaghan's direction was continued in 1948 when the Huron and southern part of the Oolitic quadrangles were surveyed. This work in Lawrence, Martin, and Orange counties was a continuation of the study of the endellite clay began in 1946. Detailed maps also were made in 1948 of abandoned mines from which iron ore was taken early in the century for manufacturing ferrosilicon. The Wilson deposit of endellite also was mapped in detail on a large scale. The maps and report on the two quadrangles should be published in 1950.

Glacial geology.—In order to get precise information concerning the origin, distribution and size of the sand and gravel deposits, outcrops of bed rock, and the thickness and extent of the water-bearing glacial deposits of central and northern Indiana, the Division of Geology in 1848 started a long-term study of the glaciology of the state. The field work was begun in June by Professor W. D. Thornbury in the Wabash quadrangle, which will be mapped by September, 1948. The maps and report on the Wabash quadrangle are expected to be published in 1950.

The mapping will include end and ground moraines, outwash sands and gravels, special glacial deposits, all outcrops of bed rock, and marl and other economic mineral deposits. The survey will result in a detailed areal geologic map, a thickness of drift map, and a topographic map of the bed-rock surface. Samples of potentially economic mineral deposits are being collected for testing. In addition to the economic value of this survey, much information is being added to the glacial history of central United States.

Sedimentary Petrology.—At the suggestion of the oil industry, the Division of Geology in 1948 began the first of a series of systematic studies of the microscopic characteristics of oil-bearing rocks. After consultation with the Research Committee of the American Association of Petroleum Geologists, the Lower Mississippian Ste. Genevieve Limestone was selected for the first study. The problem is to determine the origin, textures, cementation, variations, and cementation patterns that govern porosity and permeability of the oolitic beds within the Ste. Genevieve.

The field work, which was started by Dr. Carlton J. Leith in June, 1948, consisted of measuring 26 detailed stratigraphic sections of the Ste. Genevieve, and collecting more than 800 samples of each type of rock in the formation. Much of the research must be done in the laboratory after the field work is completed in September, 1948. In the laboratory the samples will be studied petrographically to determine their mineral composition, texture and origin. The report of progress on this research is intended to be written for publication in 1949.

PRESERVATION OF RECORDS AND GEOLOGIC MATERIALS

Records

One of the important routine functions of a State Geological Survey is to gather, classify, and preserve technical information related to the drilling of oil, gas, and water wells; and to the production of industrial minerals such as clay, coal, limestone and others. These records are constantly being consulted by oil and mining companies, state institutions and private individuals, and occasionally are requested by the Federal and other state geological surveys.

Oil and gas wells.—Before 1947, the Division of Geology was not provided with enough money to gather and maintain complete records. Consequently, the Division now is carrying the enormous and expensive burden of locating, classifying, and recording old information, and at the same time maintaining and digesting the records of current drilling. All of Mrs. Patricia Kelly's time and more than half of Miss Barbara Brooks' time has been used to copy old drilling reports, well logs, scout tickets, and sample numbers for the master information file. All information pertaining to wells drilled since 1947 is complete and is recorded daily.

Work also is progressing on the new master set of well-location maps that was planned and started by Professor Ralph E. Esarey in 1947. Each of these maps is a township plat on which each well is correctly located and its top altitude, total depth, and the box number of samples taken from it are shown. When complete these maps will be a master index to all available information relating to oil and gas wells in the state.

Water wells.—The Glaciology section continued to assemble information relating to water wells similar to that described above for oil and gas wells. Most of the information concerning old water wells must be obtained personally from copies of drilling records now in possession of water-well drillers. (*See* headings, Laboratory research, Bed-rock surface map.)

Mineral producers.—The Division of Geology maintains, under Professor Eugene Callaghan's direction, a file of producers of industrial minerals such as coal, clay, limestone, sand and gravel, building stone, and others. The information in the file includes the name of the company, its chief officials, the name and location of the plants and quarries or mines, the shipping point and method of transportation, the geologic aspects of the deposits which affect mining, the rated capacity of the mine and plant, the production in tons, and the products mined or manufactured. This information was assembled in a directory published in April 1948. Such directories will be published periodically. (See heading "Publications.")

Geologic materials

Another important function of the Division of Geology is to preserve samples of cuttings from oil wells, from limestone and other mineral deposits, and specimens of minerals, rocks and fossils that are native to Indiana. The cost of storing, cataloging and maintaining such collections amounts to thousands of dollars annually, and increases as the collections grow. In 1948, the time of three persons and nearly half of two buildings were needed for this task. The cost of preserving geologic materials is augmented by the fact that finely pulverized samples, thin and polished sections for microscope study, and well-strip sample logs require special containers and cabinets to protect them and also keep them readily accessible for study and reference.

PUBLIC SERVICES

The Division geologists performed five types of public service during the year. (1) Scientific and factual data were furnished to producers of coal, limestone, petroleum, and sand and gravel. In some instances one to three days were used to provide the information requested. More than 150 letters were written in reply to individuals requesting information. (2) Nearly 200 specimens of minerals, rocks, and fossils were identified for interested persons. (3) Lectures were given by members of the staff to conventions of mineral producers, service clubs, scientific societies and educational organizations. (4) Statistical reports and questionnaires were prepared for Federal and State geological surveys outside Indiana. (5) Conferences were held with individuals representing the coal, petroleum, and mineral aggregates industries, and with members of the Testing Laboratory of the Highway Department and the highway research laboratory of Purdue University.

Annual Field Conference.—As part of its public relations program the Division of Geology cooperated with the Department of Geology of Indiana University in sponsoring the second annual field conference in Indiana, May 7-9, 1948. The conference studies the Upper and Middle Mississippian formations in Perry, Crawford, Orange, and Lawrence counties. Nearly 200 geologists representing the major and independent oil companies, universities and geological surveys in Illinois, Indiana, Kansas, Kentucky, Missouri, and Ohio, and the U. S. Geological Survey attended the conference. The enthusiastic response to the second annual

field conference confirms its need and indicates the confidence of the oil industry in the Division's work on petroleum geology.

PUBLICATION PROGRAM

A publication program was formulated during fiscal 1948, and a professional photographer, and publications clerk and editor were added to the staff. Mr. George Ringer was employed to operate the photographic laboratory which makes permanent photographic records of quarries, mines, and geologic phenomena in the field; copies of records, correspondence, and illustrations; original photographs of fossils, rocks, minerals, well log strips, geologic sections, and diagrams for illustrations in published reports; and photomicrographs of thin and polished sections of fossils, minerals, rocks, and ores being studied in all the Division's laboratories.

Mrs. Evelyn S. Poto joined the staff as Publications Clerk and Editor. She reads and criticises, edits, and retypes all manuscripts, and works with the printers and engravers until the reports are published. She also writes and distributes the advertising notices for each new publication, maintains stocks of the Division's publications since 1869, and is responsible for correspondence and money resulting from the sale of the publications.

The new publication program of the Division of Geology comprises four series: (1) the Report of Progress series will contain short reports that result from completed stages of a larger incomplete research program, and also will contain statistical or summary reports on mineral industries and mineral reserves. (2) The Directory series will consist of directories of all or any specific group of mineral producers in Indiana, such as coal, petroleum, limestone, and others, and may also include directories of corporations that consume minerals. (3) The Bulletin series will include complete scientific and industrial reports. These reports usually are more comprehensive than those in the Report of Progress series, and will cover all phases of the Division's research. (4) The annual reports of the State Geologist are administrative summaries of the Division's activities. Scientific and industrial papers will not appear as parts of the Annual Report of the State Geologist, which is published by the Department of Conservation. Maps will be published as illustrations in a Bulletin or Report of Progress, and maps will not be published separately without a brief explanation in text form.

Hereafter, all of the Division's publications will be sold. The price of each is to be determined by dividing the cost of printing by the number of copies in the edition, and adding 10 per cent for postage and handling. A price list of all available publications may be obtained by writing to the Publications Clerk, Division of Geology, Indiana University, Bloomington, Indiana.

PUBLICATIONS

Esarey, Ralph E., and Malott, Clyde A. (May 1948), *Guide Book, Indiana Geologic Field Conference, Upper and Middle Mississippian formations of southern Indiana*, Indiana University, Department of Geology, and Indiana Department of Conservation, Division of Geology, 26 pages, 2 pls., 8 figs.

- Callaghan, Eugene, and Ecker, Jean (March 1948), *Directory of producers of mineral raw materials, exclusive of oil and gas, in Indiana*, Indiana Department of Conservation, Division of Geology, Directory series No. 1, 88 pages.
- Deiss, Charles F. (October 1948), *Seventy-first annual report of the State Geologist*, 30th Ann. Rept. of the Indiana Department of Conservation, 1947 Year Book of Indiana, 10 pages.
- Callaghan, Eugene (November 1948), *Endellite deposits in Gardener Mine Ridge, Lawrence County, Indiana*, Indiana Department of Conservation, Division of Geology, Bull. No. 1, 48 pages, 7 pls. 4 figs. (In press. Available for distribution by November 1948.)
- Fidlar, M. M. (October 1948), *Physiography of the Lower Wabash Valley*, Indiana Department of Conservation, Division of Geology, Bull. No. 2, 107 pages, 5 pls., 3 figs. (In press. Available for distribution by October 1948.)
- Esarey, Ralph E., and Bieberman, D. F. (October 1948) *The correlation of the Waldron and Mississinewa formations*, Indiana Department of Conservation, Division of Geology, Bull. No. 3, 50 pages, 4 pls., 5 figs. (In press. Available for distribution by October 1948.)

DIVISION OF OIL AND GAS

A. C. COLBY, Director

The Division of Oil and Gas, a regulatory body over the drilling and production of crude oil and gas, began to function May 1, 1947, after having been divorced from the Division of Geology by the 1947 Legislature.

Purpose of this division is the conservation of oil and gas. The law vested in the Commission the control over drilling of oil wells, well spacing, plugging of wells, and the issuance of permits for every well drilled. This division also has charge of the leasing of state property for the development of oil and gas.

Personnel of the division consists of the director, three office employees and three field men with ten well pluggers who work on a fee basis.

During the fiscal year there were 1,487 drilling permits issued at a fee of \$25 each.

Also, during the 1947-48 fiscal year, there were 403 oil wells (383 pool wells and 20 wildcat wells) completed, as well as 48 gas wells. There were 352 dry holes plugged and 77 producing wells plugged.

Indiana's "pipeline run" of oil in that fiscal year totaled 6,743,954 barrels.

Future work of the division will involve secondary recovery programs; a collection of well samples for the geological department; checking of well elevations; and improving the present law in order to simplify many phases of the division's operations.