

DIVISION OF GEOLOGY

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As a result of the increased appropriations, new laboratories, and increased personnel and equipment, the Division of Geology during the 1948-49 fiscal year carried on a greatly enlarged research program on the industrial minerals of Indiana.

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

The State Geologist's time was utilized to develop public relations and make contact with mineral industries; to administer the organization; plan the field research for fifteen survey parties; design and construct new laboratories for research in coal geology, and to hire new scientific personnel.

LABORATORY RESEARCH

Laboratory research work in the Division of Geology ranged from microscopic analyses of oil well samples and cores, through chemical, optical, and spectrographic analyses of rocks and minerals, to studies of fossils and glacial deposits. The research work differs so greatly in content, objective, method, and application that the work of each laboratory needs to be summarized separately.

Coal Geology.—The coal industry in Indiana requires quantitative, dependable answers to such problems as: The number, thickness, and horizontal extent of workable coal beds in the State. The depth at which each coal bed or seam occurs beneath the surface of the earth. The tonnage of coal which may be expected at different depths in each of the beds that are more than two feet in thickness. The geologic structure and other conditions which affect mining. In order to answer these questions, the Division of Geology in 1948-49 greatly enlarged its field program and its laboratory facilities.

In order to identify accurately and thereby determine which coal bed is encountered at different places in the State, the physical composition of each coal bed including the plant remains (wood, leaves, and spores) must be known and understood. Accurate identification of each coal bed is necessary before the beds can be mapped throughout the coal lands of the State. Consequently, the laboratory work in coal consists of two different types of work. One is the preparation of final maps of mined out areas and of geologic structures from the data obtained in the field: The other type of work consists largely of microscopic studies of the coals themselves. New laboratory space was provided by Indiana University for the division's work on coal, and new personnel was added to the staff.

In addition to the laboratory work being carried on by this division, a new cooperative program was set up with the United States Geological Survey, which will establish a branch office at Bloomington to work on the problem of coal reserves of Indiana.

Chemical laboratory.—In order to obtain precise, dependable analyses of the chemical composition of Indiana's industrial rocks and minerals, a new chemical analytical laboratory was built during the year 1948-49. The chemical laboratory works closely with the spectrographic laboratory. This laboratory made 350 determinations of the carbon dioxide content and the percent of calcium, magnesium, silica, and combined iron and aluminum in each limestone sample. The analyses are needed urgently by mineral aggregate producers and consumers of Indiana dolomites and limestones.

Spectrographic laboratory.—The spectrographic laboratory, which was built in 1948 and began operation in 1949, is engaged in a long-term research program on the trace elements (substances present in minute quantities such as titanium, strontium, sulphur, potassium, etc.) in Indiana's limestones and dolomites. These trace elements are becoming of major importance to industries using these raw materials. Much of the spectrographic laboratory's time in 1949 was used to develop procedures and to make 2,358 determinations on 118 limestones. Some of these analyses and those from the chemical laboratory are available in the publication titled "Crushed stone in Indiana."

Glacial geology.—Work on the bed rock surface map begun in 1948 was continued throughout 1949. In addition, a new glacial geology map of Indiana is being prepared using the county soil maps as a base, on the scale one inch equals one mile, and is to be completed by June 1950. Since basic knowledge of the glaciers are prerequisite to a knowledge of the distribution of sands and gravels over two-thirds of Indiana, and since such knowledge also is essential to work on ground water, the maps will have immediate value to the sand and gravel industry and to the Division of Water Resources and other agencies that work with the problem of ground water in the State.

Industrial minerals laboratory.—The industrial minerals laboratory completed the preliminary study of Indiana limestones and prepared an index map showing the location of all active limestone quarries in the

State. Preparation of this publication required extensive laboratory study of the thin sections of limestones, in addition to the chemical and spectrographic analyses. The industrial minerals laboratory also identified and tabulated the minerals that comprise the sand and gravel samples collected during the field season of 1948. The results of this research indicated the problems that remain unsolved, and this determined the objectives of the field program on sand and gravel during the summer of 1949. (See field programs—Sand and gravel survey).

Petroleum geology.—The two long-term research programs in the Petroleum Geology Section were continued and enlarged during 1949. These research studies are (1) sub-surface petrology; and stratigraphy, (2) sub-surface structure and isopach mapping. The oil boom in Indiana during the past year greatly increased the activity of the Petroleum Section, which acted at once to produce sub-surface maps that would assist the oil industry in producing new oil at the time the drilling was going on. In order to carry out this objective, the Division of Geology published the results of research by D. F. Bieberman on deep wells in Sullivan and Vigo Counties, and a new series of 16 sub-surface structure maps compiled by R. E. Esarey and B. E. Brooks. The title of this map series is Petroleum Exploration Maps.

Sample preparation laboratory.—Most of the time of the sample preparation laboratory in 1949 was spent in preparing samples of limestone for spectrographic and chemical analysis. Such preparation not only requires much labor to pulverize finely and separate the samples, but also requires treatment of each sample by the isodynamic separator in order to remove magnetically all iron and other impurities that may have been introduced by the crusher and pulverizer. In addition to the 271 samples thus prepared, the laboratory made polished sections of an additional 200 samples of limestone for microscopic study. The laboratory also crushed and prepared clay samples and screened and separated the sand and gravel samples collected during the 1948 field season.

FIELD SURVEYS

In 1949, 15 field parties worked on mineral surveys, geologic mapping, and on fundamental research problems. Of the 15 field parties, seven worked on coal, four on sand and gravel, two each on petroleum and glacial geology, and one on stratigraphy and paleontology. In addition, the Topographic Branch of the United States Geological Survey had one field party correcting culture data on the quadrangle maps of coal lands being surveyed by the Division of Geology and had a field party of geophysicists completing the aeromagnetic survey of the State.

Aeromagnetic survey.—The aeromagnetic survey of Indiana, begun September 1947, on a cooperative basis with the United States Geological Survey, was completed November 29, 1948. During the period January to June 1949 the United States Geological Survey established a field station at Bloomington in which the flight data were computed and made usable. Magnetic profiles were constructed from the field

records and were plotted on county road maps, which served as the base for drawing the aeromagnetic maps. In addition, 24 preliminary aeromagnetic maps were made in pencilled form. The compilation of all the county maps of the State should be finished by June 1950. As an immediate result of the aeromagnetic survey, maps of four counties in the northeast part of the state have been published, and 43 preliminary pencilled maps have been placed on open file in Washington, D. C., Indianapolis, and Bloomington, Indiana. When all the maps of the counties are completed they will be combined to produce the first aeromagnetic map of an entire state ever made. The importance of these maps to the oil industry is indicated by the fact that the major oil companies have made strong efforts to see the data as soon as it could be made available, and many of the oil companies have made photostat copies of the preliminary maps now on open file.

Coal survey.—During the field season of 1949 the program of coal resources was continued and enlarged in central Indiana. Detailed geologic mapping was completed for five quadrangles totaling 283 square miles. These are the Coal City, Shelburn, Fairbanks, Lewis, and Seelyville quadrangles. Other maps of the area were made to show the mined-out areas and lateral extent of each commercial coal, the structure of each coal bed, the areal geology, and the thickness of glacial deposits above the coals. Approximately 250 geologic sections, totaling more than 3,000 feet of thickness, were accurately measured in order to get the correct sequence and thickness of the beds of rock between and above the coals. More than 150 rock samples were collected for the study, and 35 fossil collections were made in order to work out in detail the age of these coal bearing formations. In addition, a reconnaissance mapping program was begun, and as the first step of that program, Vigo and Sullivan counties were mapped. As a result of this work the Division of Geology can now furnish up-to-date coal information on Sullivan and Vigo counties and on parts of Greene, Clay, and Owen counties. During the 1949 field season, the staff made more than 150 collections of coal samples from 46 localities. They will classify and identify the coal spores in order to identify accurately the coal beds. This work on coal spores is new to Indiana, but its worth has been tested by many years of research in Illinois and in the United States Bureau of Mines laboratories.

The publications resulting from this coal work will give the people of Indiana a better idea of the nature of our coal resources. The work will be useful to coal producers and consumers by showing where coal is likely to be present and where it is mined out, thereby limiting the areas which must be drilled. When drilling is necessary, the geologic section will indicate the kind and thickness of the formations encountered. The farmer or land owner will have a much better idea as to what economic minerals underlie his land.

Petroleum geology survey.—The field program begun last year was continued in an effort to locate and determine the altitude of oil and gas wells and to collect samples and determine the surface geologic structures near the wells. In addition to that program the Petroleum

Section began a new field survey of the St. Louis limestone where it crops out at the surface of the earth to determine its composition and distribution. The purpose of this work is to identify accurately the formation in well cuttings from the sub-surface. The top and base of the St. Louis limestone are important "markers" in sub-surface oil geology but at present are difficult to identify with certainty. Control of drilling wells will be increased when the St. Louis can be identified in all wells because the McClosky oil-producing zone occurs immediately below it. Laboratory studies in the Petroleum Section are continuing the work by comparing well cuttings from the sub-surface with the rock samples taken from surface outcrops.

Stratigraphy and paleontology surveys.—The objectives of this survey are to determine the areal extent, thickness, composition, and variations in composition of the Harrodsburg limestone and determine the stratigraphic relationships of the Harrodsburg to the Borden formations below and the St. Louis formation above. The field work consisted of a detailed measurement of 33 stratigraphic sections totaling 1,533 feet of thickness, collecting all available fossils and rock specimens of the limestone, and checking of the upper and lower boundaries of the formation of the map. The results of this study are urgently needed by the Industrial Minerals Section and also by the oil industry in Indiana, as the Harrodsburg limestone will be an excellent sub-surface "marker" bed in the oil wells when the details of the formation are made known.

Sand and gravel survey.—Investigations of sand and gravel deposits during the field season of 1949 were carried on. Four field parties worked in four districts in the State, each of which ranged in size from 18 to 29 counties. The survey was made for two reasons: (1) Inquiries received by the Division of Geology indicated an extensive interest on the part of the public in sand and gravel and a need for geologic information by the producers and consumers, and (2) geologic work had not been done on sand and gravel deposits in Indiana since 1905. Consequently, a reconnaissance survey of the entire state was necessary before the most important problems for detailed investigations could be intelligently selected. The field parties examined 3,079 sand and gravel pits, of which 581 are active or are active on demand, and 2,498 inactive or abandoned. In addition, detailed investigations were made of 21 deposits, and 59 samples were collected. Most of the sand and gravel in Indiana has been derived from the continental glaciers (ice sheets which moved southward into Indiana several times during fairly recent geologic history). Consequently, a thorough study of these glacial deposits is necessary.

In addition to the objectives which motivated the program, several additional applications of the work have come to life. Since deposits of glacial origin, rather than bed rocks, constitute the surface materials over most of the State, glacial geology is an important form of economic geology in Indiana and has determined the soils, drainage, topography, the routes of transportation, water supply, and the availability of mineral raw materials in much of Indiana, particularly in the northern half, which is more highly industrialized and populated than the southern half.

Thus, a complete knowledge of the glacial geology is vital to the industrial and economic welfare of the state, and the thorough knowledge of the sand and gravel deposits, in turn, contributes to the broader subject of glacial geology.

Glacial geology.—In order to obtain quantitative information about the distribution of rocks, minerals, sand and gravel, and other economic resources of the Wabash Valley, Professor W. D. Thornbury and William J. Wayne conducted two field parties mapping the areal geology of three quadrangles: Peru, Rich Valley, and Lagro. In addition to the contribution to the sand and gravel program, this detailed field work contributed much quantitative information concerning the glacial geology of central Indiana. Nearly 600 well records were obtained in Miami County from water wells, most of which lie within the four quadrangles in the Wabash Valley. These records contribute detailed information and accuracy to the drift thickness map being prepared for use of agencies concerned with ground water in the state.

RECORDS AND GEOLOGIC MATERIALS

This division is charged with the responsibility for gathering, classifying, and preserving technical records related to the drilling of oil, gas, and water wells, and to the production of industrial minerals. Much time and money is consumed in the routine tasks necessary to house properly and make available these materials. Such records are constantly examined by oil and mining companies, railroads, and other producers of Indiana's industrial minerals.

During the past fiscal year the time of five persons was needed to clean, organize, and store geologic materials such as oil well samples, limestone and other mineral deposits, and specimens of rocks and fossils native to Indiana.

Oil and gas wells.—The Petroleum Section boxed and stored oil well cuttings from 510 wells, cut and washed samples from 49 wells, stored and organized cores from six wells, copied and filed 1,218 scout tickets, 1,200 driller's logs, and 1,000 electric logs. This laboratory also made well strips from 109 wells totaling 88,299 feet of wells drilled. This figure is better understood if the reader realizes that it represents more than 16 linear miles of oil well holes drilled in Indiana during 1949. In obtaining these records the Petroleum Section also scouted 30 oil wells as they were being drilled.

Water wells.—The Glaciology Section recorded 595 Logs of water wells, and thus continued to assemble information pertaining to water wells similar to that described above for oil and gas wells.

Mineral producers.—The file of producers of industrial minerals in Indiana was considerably enlarged during 1949. The name of the companies, the name and location of the plants and quarries or pits, the shipping point and method of transportation, the geologic aspects of the deposits which affect mining, the rated capacity of the plant, and the production in tons of 2,916 producers of sand and gravel and more than 21 producers of limestone and coal were added to the permanent records. This information is being classified and assembled for a revision of the directory published in 1948.

In addition, the Industrial Minerals Section collected 59 large samples of sand and gravel, the Coal Section obtained 149 samples of the coal beds, and the Stratigraphy and Paleontology Section obtained 35 collections of fossils. The division also prepared, stored, and classified several hundred samples of limestone and other rocks in special containers to keep them readily accessible for study and reference.

PUBLIC SERVICES

The four types of public service performed by the Division of Geology were continued during the year. (1) Scientific and factual data were furnished to producers of coal, limestone, petroleum, sand and gravel, and clay by means of personal conferences. Nearly 840 persons visited the laboratories for such information, and 993 letters were written in reply to requests. The publications office wrote an additional 889 letters in reply to persons requesting geologic literature in which they were seeking information. The increased usefulness of the Division of Geology to the State can be gauged by the fact that in 1946 only 97 requests were made for information. (2) Seventy specimens of minerals, rocks, and fossils were identified for interested persons, 58 samples of Indiana minerals and rocks were mailed on request, and 12 field trips were made to get specific data for requested information. (3) Lectures were given by members of the Division to conventions of mineral producers, service clubs, scientific societies, and educational organizations. (4) Statistical reports and questionnaires were prepared for federal and state geologic surveys.

On May 11-13, 1949, the Division of Geology and the Department of Geology of Indiana University sponsored the third annual field conference in Indiana. The conference studied the Silurian formations and reef structures of northern Indiana and was attended by more than 200 geologists from such widely located areas as Massachusetts, Alberta, Canada, and Texas. These geologists represented the major and independent oil companies, universities, and geological surveys. The response to the annual field conferences has grown so great that the conferences are tending to become unwieldy.

PUBLICATIONS

The publication program formulated early in 1948 was enlarged in 1949 with the addition of the series of Petroleum Exploration Maps. The volume of sales and correspondence handled by the Publication Section during the fiscal year 1949 is indicated by the fact that 1,387 maps and 1,085 other publications were sold last year. These figures include both cash sales made in the office and mail orders. They do not include gratis copies and exchanges. The names of 91 institutions were added to these lists by the end of 1949, and an additional 547 free publications were sent out. The importance of the publications program and the rapidity with which it has grown and is being used by the people of the state can be indicated by the fact that nearly 600 persons called at the publications office during the year for specific information or to publish reports or maps.

REPORTS AND MAPS PUBLISHED DURING FISCAL YEAR 1949

A price list of all available publications may be obtained by writing to the Publications Section, Division of Geology, Indiana University, Bloomington, Indiana.

- Bieberman, D. F. (January 1949) *Stratigraphy of three wells in Sullivan and Vigo Counties, Indiana*, 10 pages, 1 fig.
- Patton, John B. (April 1949) *Crushed stone in Indiana*, Report of Progress No. 3, 47 pages, 1 pl.
- Esarey, R. E. and Bieberman, D. F. (May 1949) *Silurian formations and reef structures of northern Indiana*, Guide Book, Third Annual Indiana Geologic Field Conference, 19 pages, 2 pls., 2 figs.
- Esarey, R. E. and Brooks, B. E. (August 30, 1948) *Structure map of Alford gas field and surrounding area, Pike County, Indiana*, Petroleum Exploration Map No. 1.
- Esarey, R. E. and Brooks, B. E. (December 18, 1948) *Structure map of Prairie Creek oil field, Vigo County, Indiana*, Petroleum Exploration Map No. 2.
- Esarey, R. E. and Brooks, B. E. (December 18, 1948, Rev. August 5, 1949) *Structure map of Warrick County, Indiana*, Petroleum Exploration Map No. 3.
- Esarey, R. E. and Brooks, B. E. (January 12, 1949, Rev. April 21, 1949) *Structure map of Sullivan County, Indiana*, Petroleum Exploration Map No. 4.
- Esarey, R. E. and Brooks, B. E. (January 12, 1949, Rev. April 21, 1949) *Structure map of Vigo County, Indiana*, Petroleum Exploration Map No. 5.
- Esarey, R. E. and Brooks, B. E. (January 12, 1949) *Structure map of Wilfred oil pool, Sullivan County, Indiana*, Petroleum Exploration Map No. 6.
- Esarey, R. E. and Brooks, B. E. (February 7, 1949) *Structure map of Dodds bridge and Heien fields, Sullivan County, Indiana*, Petroleum Exploration Map No. 7.
- Esarey, R. E. and Brooks, B. E. (February 7, 1949) *Structure map of Siosi oil field, Sullivan and Vigo Counties, Indiana*, Petroleum Exploration Map No. 8.
- Esarey, R. E. and Brooks, B. E. (February 7, 1949) *Structure map of Old Terre Haute field, Vigo County, Indiana*, Petroleum Exploration Map No. 9.
- Esarey, R. E. and Brooks, B. E. (February 7, 1949) *Structure map of Riley field, Vigo County, Indiana*, Petroleum Exploration Map No. 10.
- Esarey, R. E. and Brooks, B. E. (February 7, 1949) *Structure map of Spring Hill field, Vigo County, Indiana*, Petroleum Exploration Map No. 11.
- Esarey, R. E. and Brooks, B. E. (July 2, 1949) *Structure map of Martin County, Indiana*, Petroleum Exploration Map No. 12.
- Esarey, R. E. and Brooks, B. E. (September 15, 1949) *Structure map of Greene County, Indiana*, Petroleum Exploration Map No. 13.
- Esarey, R. E. and Brooks, B. E. (September 15, 1949) *Structure map of Clay County, Indiana*, Petroleum Exploration Map No. 14.
- Esarey, R. E. and Brooks, B. E. (September 15, 1949) *Structure map of Parke County, Indiana*, Petroleum Exploration Map No. 15.
- Esarey, R. E. and Brooks, B. E. (September 21, 1949) *Structure map of Vermillion County, Indiana*, Petroleum Exploration Map No. 16.
- U. S. Geological Survey (1949) *Total intensity aeromagnetic map of Benton County, Indiana*. Prepared in cooperation with Indiana Department of Conservation, Division of Geology.
- U. S. Geological Survey (1949) *Total intensity aeromagnetic map of Lake County, Indiana*. Prepared in cooperation with Indiana Department of Conservation, Division of Geology.
- U. S. Geological Survey (1949) *Total intensity aeromagnetic map of Jasper County, Indiana*. Prepared in cooperation with Indiana Department of Conservation, Division of Geology.
- U. S. Geological Survey (1949) *Total intensity aeromagnetic map of Newton County, Indiana*. Prepared in cooperation with Indiana Department of Conservation, Division of Geology.