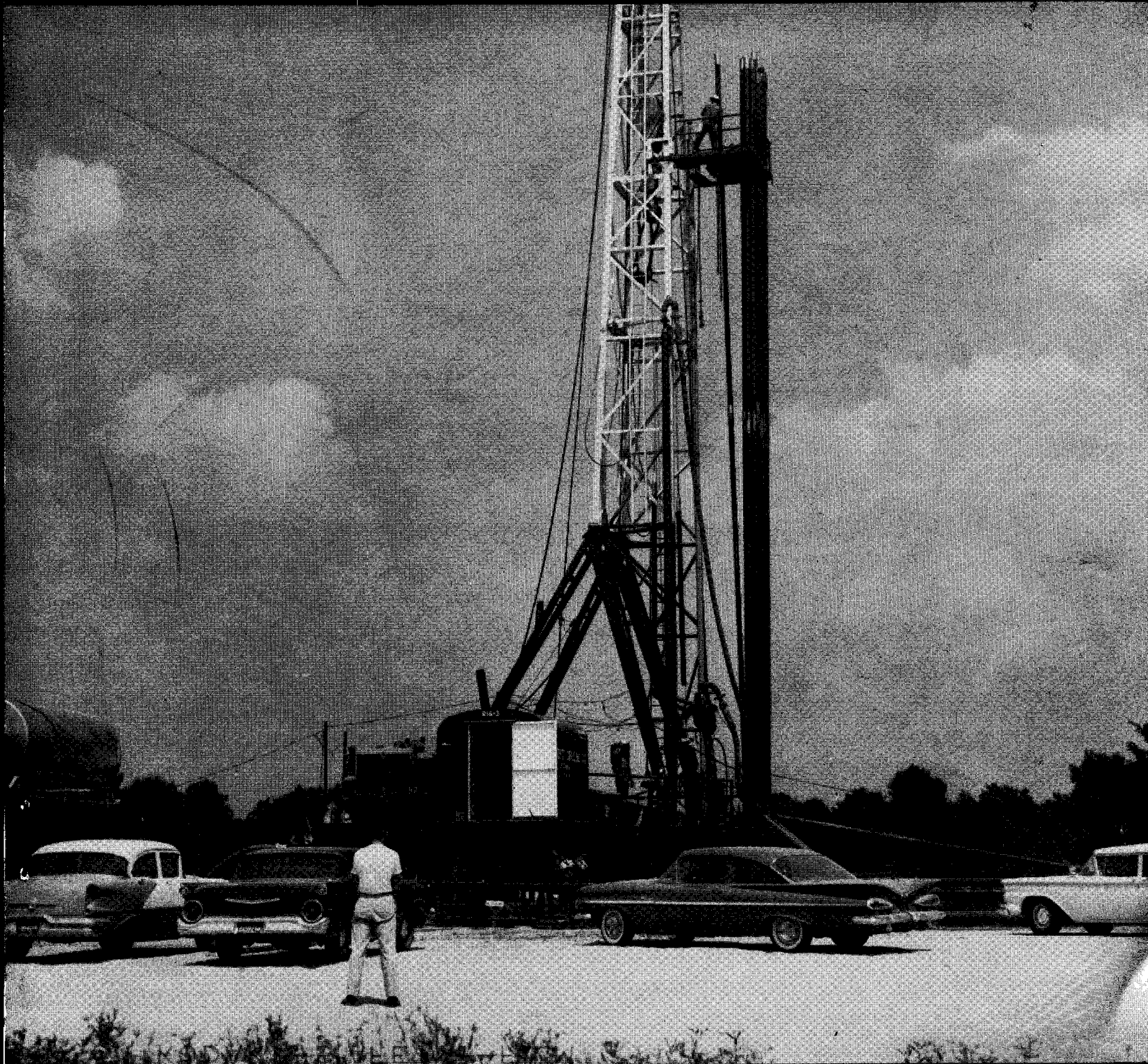


SURVEY

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83RD ANNUAL REPORT OF THE STATE GEOLOGIST  
FOR 1958-59



INDIANA DEPARTMENT OF CONSERVATION  
GEOLOGICAL SURVEY

### COVER

A new depth record for Indiana was set in 1959 by the Indiana Farm Bureau Cooperative Association in a test well drilled on the Luther Brown farm in eastern Lawrence County. Drilled to 6,806 feet by the West Drilling Co. of Mt. Carmel, Ill., the well bottomed in Precambrian rocks (more than 500 million years old) of volcanic origin before it was abandoned as a dry hole in June.

EIGHTY-THIRD ANNUAL REPORT OF THE STATE GEOLOGIST

Being the Annual Report

of the

GEOLOGICAL SURVEY (Division)  
Indiana Department of Conservation

For

The Fiscal Year Ending June 30, 1959

John B. Patton, Acting State Geologist

E. Kenneth Marlin, Director

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PERSONNEL

Permanent Personnel

Administration and Technical Service

Charles F. Deiss, State Geologist (Deceased June 13, 1959)  
John B. Patton, Principal Geologist  
    Acting State Geologist (from June 19, 1959)  
Bernice M. Banfill, Assistant to the State Geologist  
Mary Beth Fox, Mineral Statistician and Secretary to Principal Geologist  
Martha N. Smith, Secretary to State Geologist  
Theodore H. Appleton, Accountant  
Ellen L. Freeman, Librarian  
Betty A. Denney, Typist (to March 20, 1959)  
Barbara Ellsworth, Typist (March 1 to April 15, 1959)  
Elmyrta A. Snow, Typist (April 16 to May 16, 1959)  
Marguerite E. Trisler, Typist (from June 1, 1959)

Coal Section

Charles E. Wier, Geologist and Head  
S. A. Friedman, Geologist  
G. K. Guennel, Paleobotanist  
Harold C. Hutchison, Geologist  
Larry Lawrence, Geologic Assistant (from November 10, 1958)  
Richard C. Neavel, Coal Petrographer  
Lloyd Terrell, Geologic Assistant (to October 31, 1958)  
Julia L. Fortner, Secretary (September 15, 1958, to May 29, 1959)  
Janet Sue Helton, Secretary (from June 1, 1959)  
Linda Walker, Secretary (to September 12, 1958)

Drafting Section

William H. Moran, Chief Draftsman  
Robert E. Judah, Geologic Draftsman  
Micky P. Love, Geologic Draftsman  
John E. Peace, Topographic Draftsman

Educational Services

Reevan Dee Rarick, Geologist

Geochemistry Section

Richard K. Leininger, Chief Spectrographer and Head  
Maynard E. Coller, Chemist  
Elmer M. Craig, Technician  
Royston H. Filby, Spectrographer (to January 28, 1959)  
Louis V. Miller, Coal Chemist  
Erma J. Wolfe, Secretary, Geochemistry and Geophysics Sections

## GEOLOGICAL SURVEY

## Geophysics Section

Maurice E. Biggs, Geophysicist and Head  
Judson Mead, Research Advisor  
Arthur Wayne Aynes, Geophysical Assistant  
Robert F. Blakely, Geophysicist  
Donald P. Bray, Assistant Driller (to October 1, 1958)  
Jerry D. Fox, Assistant Driller (from September 29, 1958)  
Charles S. Miller, Instrument Maker  
Albert J. Rudman, Geophysicist  
Joseph F. Whaley, Geophysicist  
John D. Winslow, Engineering Geologist  
Glen L. Workman, Driller  
Erma J. Wolfe, Secretary, Geophysics and Geochemistry Sections

## Glacial Geology Section

William J. Wayne, Geologist and Head  
Wyman Harrison, Geologist

## Industrial Minerals Section

Duncan J. McGregor, Geologist and Head  
Gary R. Gates, Geologist  
Seymour S. Greenberg, Petrographer  
Jack L. Harrison, Clay Mineralogist  
Ned M. Smith, Geologist  
Jack A. Sunderman, Geologist  
Blanche B. Richards, Secretary

## Paleontology Section

Robert H. Shaver, Paleontologist and Head

## Petroleum Section

Thomas A. Dawson, Geologist and Head  
George A. Abbott, Draftsman  
Gerald L. Carpenter, Geologist  
James T. Cazee, Assistant Sample Curator  
Phillip Cazee, Sample Curator  
Olin R. Holt, Geologist  
Andrew J. Hreha, Geologist  
Stanley J. Keller, Geologist  
Arthur P. Pinsak, Geologist  
Howard Smith, Geologist  
Dan M. Sullivan, Geologist  
Frank H. Walker, Geologist  
M. Ruth Butcher, Curator of Records and Secretary  
Vivian McGuire, Clerk-Typist

GEOLOGICAL SURVEY

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Photography

George R. Ringer, Photographer

Publications Section

Gerald S. Woodard, Editor and Head  
E. Pauline Brickert, Secretary

Seasonal Personnel

Administration and Technical Service

Max Weseman, Laboratory Assistant (July 1 to August 15, 1958)

Coal Section

Vernon J. Petri, Research Assistant (May 26 to June 30, 1959)  
Richard L. Powell, Laboratory Assistant (September 1, 1958, to June 30, 1959)  
Marjorie Paton, Typist (February 10 to May 31, 1959)

Geochemistry Section

Thomas Arnold, Chemist's Assistant (February 27 to June 30, 1959)  
Mark Engledow, Chemist's Assistant (July 1 to August 29, 1958)  
Marilyn Traas, Laboratory Assistant (January 26 to June 25, 1959)  
Christine Waggoner, Clerical Assistant (July 1, 1958, to March 10, 1959)

Geophysics Section

Garland D. Anderson, Field Assistant (July 1 to August 31, 1958)  
Alan A. Colville, Shop Assistant (August 8 to September 12, 1958)  
Jack Conley, Shop Assistant (February 4 to March 6, 1959)  
Maxwell E. Gardner, Field Assistant (July 1 to September 12, 1958)  
Robert E. Groomer, Field Assistant (July 1 to August 31, 1958; June 15 to June 30, 1959)  
John S. Parker, Field Assistant (August 11 to September 10, 1958)  
Helmo Rand, Field Assistant (August 11 to September 10, 1958)  
Daniel O. Wright, Laboratory Assistant (September 22, 1958, to May 10, 1959)

Glacial Geology Section

Nityananda Bhattacharya, Laboratory and Field Assistant (July 1 to August 15, 1958)  
Bernard D. Karp, Laboratory Assistant (March 9 to June 1, 1959)  
Roy Williams, Laboratory Assistant (October 15, 1958, to May 31, 1959)  
Janet C. Crabtree, Typist (July 1 to August 15, 1958)  
Guillermina L. Ladoray, Typist (June 9 to June 30, 1959)  
Marlene Muth, Typist (January 20 to June 1, 1959)  
Lavonne Joyce Ohl, Typist (September 17, 1958, to January 20, 1959)  
Miriam Kay Sparks, Typist (June 4 to June 8, 1959)



## GEOLOGICAL SURVEY

## Industrial Minerals Section

R. H. Beyers, Laboratory Assistant (November 14, 1958, to June 13, 1959)  
 Lyndon L. Dean, Laboratory Assistant (February 11 to June 13, 1959)  
 Richard McCammon, Field Assistant (July 1 to August 31, 1958)  
 Wilton N. Melhorn, Party Chief (July 1 to August 31, 1958)

## Paleontology Section

David R. Berendsen, Field Assistant (July 1 to September 5, 1958)  
 Donald E. Hattin, Party Chief (July 1 to September 5, 1958)  
 Fredrick Wampler, Laboratory Assistant (August 1 to October 15, 1958)  
 Donald W. Wirth, Laboratory Assistant (August 1, 1958, to June 15, 1959)

## Petroleum Section

Joan Wiggins, Typist (August 1 to August 31, 1958)

## Publications Section

James E. Fehribach, Editorial Assistant (September 15, 1958, to February 9, 1959)  
 Gale Helft, Editorial Assistant (March 2 to May 29, 1959)  
 David M. Kitley, Editorial Assistant (June 9 to June 30, 1959)  
 Ann Richardson, Editorial Assistant (July 1 to August 29, 1958)

## MEMORIAL

The Indiana Geological Survey during the years 1945 to 1959 has been the image of the man who directed it and contributed the most to its development. Dr. Charles F. Deiss, late State Geologist of Indiana who passed away on June 13, 1959, came to Indiana in 1945 at the height of a brilliant career as a scientist, teacher, and research worker in geology to head the Division of Geology, Indiana Department of Conservation, and the Department of Geology at Indiana University. Surely most people at that time would have regarded the academic half of his title as the more significant. To Doctor Deiss, however, geologic services for the citizens of Indiana presented a challenge to which he devoted his energies for the remainder of his life. To say that he saw the Division of Geology (later named the Geological Survey) grow to one of the strongest state geological surveys in the nation would be inaccurate; he *made* it grow, and he never thought his task was completed. Throughout the period he sold geology and its usefulness to the public, to industry, to other agencies, and even to the succeeding administrations in state government. He was con-

vinced that our strength and our prosperity rest upon a base of natural resources, of which the mineral resources are the most fundamental in that they furnish not only the raw materials for industry and construction but a means of improving and utilizing the other natural resources. The State of Indiana will feel the impact of his energies and will benefit from his wise planning for long years to come.

## INTRODUCTION

The role of state geological surveys is an ever-changing one, and a perusal of this report will reveal the wide diversity of the services and functions that have constituted the activities of the Indiana Geological Survey during the fiscal year that ended June 30, 1959. In addition to such well-recognized geologic endeavors as investigations of the state's mineral resources, responses to inquiries from the general public, and distribution of information in the form of publications and maps, the Geological Survey has been requested to offer increased assistance in such fields as industrial development and

city and county planning. To furnish basic geologic information is no longer sufficient. The Geological Survey, if its efforts are to be of maximum use to the public, industry, other agencies, and long-range planning groups, must be able to integrate diverse types of scientific information and to relate its findings to the complex economic and social structure resulting from the rapid growth and changes within the Hoosier state.

Our mineral industries yielded more than 235 million dollars of direct income during 1958 (table 1). This was an increase of nearly 9 million dollars over the preceding year. The totals are impressive but represent only a fraction of the indirect income that is based upon the mineral industries. Much of the importance of our mineral resources can be attributed to the fact that they are in this populous, industrialized, prosperous state and can be used fairly near their regions of occurrence. Our commercial minerals do not include the ores of metals, gemstones, or radioactive materials. They are not, in a word, glamorous. Prosaic as they may be, our production of them exceeds in value the mineral production of many states that are regarded as mining regions. The value of our clay and shale products annually exceeds the value of the gold produced in the leading gold-producing state. The value of either sand and gravel or building stone in Indiana annually exceeds the value of silver produced in the leading silver-producing state, and the value of cement in Indiana exceeds the value of the entire nation's silver production. A high proportion of our annual mineral product is used domestically or in nearby regions and is thus related far more closely to the well-being of the state's citizens than is the mineral product of any state that exports most of its produced raw materials. To produce, process, and utilize many of our commercial minerals requires detailed knowledge of physical and chemical properties. All these facts point to the inescapable conclusions that Indiana is highly dependent upon its own mineral raw materials and that to utilize them to maximum advantage we must work strenuously to know everything that research can tell us before the need for the information arises.

The most salient change of the fiscal year was a reduction in the relative amount of fieldwork, accompanied by an increase in laboratory work and office compilations. The change resulted partly from a restricted budget that would not cover extensive field expenses and

partly from a backlog of completed or nearly completed fieldwork that was ready for the finishing stages required for publication.

One of our series of publications, the circulars, changed considerably in aspect and emphasis. The new format is designed to be more attractive to the general public and is written and illustrated in a manner that will appeal to a nontechnical audience. A new policy whereby scientific reports are made available on an open-file basis substantially before the finished report is published resulted in broader utilization of our information by industry and the public. For the first time tables of data were prepared for publication by use of business machines. This method decreases the work of preparing tabulated data and increases the accuracy.

Early in the fiscal year an informal cooperative agreement was effected with the state geological surveys of the four states surrounding Indiana for the purpose of completing and publishing geologic maps that will cross state boundaries. The base maps to be used are the 1° by 2° topographic quadrangle sheets issued by the Army Map Service. These cover 1 degree of latitude and 2 degrees of longitude. Eight of them cover most of Indiana. The benefits of the proposed system of mapping are many. The interest of a map user rarely ends at the state line. When the user is required to shift from the geologic map of one state to the geologic map of another, he generally finds that different stratigraphic units have been mapped and that different standards of accuracy prevail, so that uniform information is not obtainable on the two sides of the state line. The first of the quadrangles to be mapped will be the Indianapolis Quadrangle, which extends some distance into Illinois. The Illinois portion will be mapped by the Illinois Geological Survey according to principles and standards developed through conferences between staff members of the Illinois and Indiana Geological Surveys.

During the year most of the carbonate rock samples were obtained from cores rather than from surface exposures. The footage of holes drilled by the Survey drilling crew dropped about 24 percent below the total of the preceding year. This decrease was brought about as the result of nearly 1,000 feet more core being cut this year than last. Drilling by rock bit methods is much faster than coring, but the samples obtained are less useful for some purposes. The number of samples of lime-

stone brought into the laboratory for determination of physical properties increased over past years. Persons associated with the building stone industries are demonstrating a more scientific regard for the properties of their product and for the possibilities of increasing its uses. Fewer samples were received for radioactivity testing. Initial enthusiasm arising from the discovery of valuable uranium deposits in the western states has apparently been dampened by the fact that no radioactive deposits approaching commercial ore grade have been found in Indiana. A program of analysis of oilfield brines was initiated during the year. Paper coals, discovered in Indiana during 1957-58, were extensively investigated in the course of the past year. They are particularly interesting because they had not been previously described from any locality except Russia.

The Survey engaged in an active program of projects involving engineering geology. Three major dam and spillway sites were examined in detail, and reports of the geological and engineering aspects of the sites were prepared. In the Geochemistry Section our work in development of new methods for spectrographic analysis lagged because the services of the spectrographer were lost during the fiscal year, but analytical work in the fields for which methods were already developed reached a new high.

The emphasis of geophysical fieldwork shifted during the year from seismic refraction to seismic reflection methods. This change was brought about by a decrease in funds available for fieldwork and by the purchase of new seismic equipment which is capable of producing highly resolved reflection records in areas previously considered unsuitable for such methods. Although reflection methods are more flexible than refraction shooting, they are also much slower and more costly. For this reason about 20 percent fewer geophysical measurements were made this year than during the preceding year.

Newly discovered oil-producing regions in the southern part of the Michigan Basin caused increased interest in the oil possibilities of northeastern Indiana. The Petroleum Section anticipated this interest by undertaking a program in which the location and altitudes of all wells were checked in the field and logs and other data were correlated and made available to the public. Petroleum exploration maps for 2 counties in northern Indiana were issued during the year, and maps for 17 additional

counties will be made available.

## ORGANIZATION AND ADMINISTRATION

The Geological Survey is headed by the State Geologist, who is responsible to the Director of the Indiana Department of Conservation. The organizational framework consists of three commodity sections (Coal, Industrial Minerals, and Petroleum), four research and analytical sections (Geochemistry, Geophysics, Glacial Geology, and Paleontology), and two service sections (Drafting and Publications). The sections differ widely in size, ranging from the Petroleum Section with 14 full-time employees and some seasonal personnel to the Paleontology Section, which consists of the paleontologist and a few summer field employees and part-time laboratory assistants. In addition to the staff members of the sections enumerated, a few employees work directly with or under the direction of the State Geologist.

Biennial budget requests are constructed by the State Geologist and submitted to the Director of the Department of Conservation, who in turn submits them to the State Budget Committee for action and transmittal to the Indiana General Assembly. Annual operating budgets of the Geological Survey also are constructed by the State Geologist and submitted to the Director for approval. Indiana University then acts as the fiscal agent for the Department of Conservation, and the appropriated funds are spent under the signature of the State Geologist. Records of all expenditures become part of the Accounting Department of Indiana University, are audited by the State Auditor's office, and monthly financial reports are sent to the Department of Conservation.

An Advisory Committee to the State Geologist, composed of representatives from industries closely related to the state's mineral economy, counsels the State Geologist regarding Survey policy and program. During the fiscal year 1958-59, the Advisory Committee met September 10, 1958, November 13, 1958, and April 28, 1959. Mr. E. J. Reading, Sun Oil Co., served as chairman of the committee. The other members were Warren W. Brown, Monon Railroad (to December 31, 1958); Eugene C. Clemens, Cannelton Sewer Pipe Co.; Robert Ingalls, Sr., Ingalls Stone Co.; F. W. Irving, Irving Brothers Gravel Co., Inc.; Norman E. Kelb, Ayr-

shire Collieries Corp.; Hugh B. Lee, Sr., Maumee Collieries Co. (to November 26, 1958); Hugh B. Lee, Jr., Maumee Collieries Co. (from December 27, 1958); J. D. Turner, Oil Producer; W. A. Unsworth, Ohio and Indiana Stone Corp.; and D. E. Willingham, Louisville Cement Co., Inc. During the year Mr. Richard Swallow served as alternate for Mr. Kelb, and Mr. Bert Cloud served as alternate for Mr. Turner.

administration of Indiana University offered the Geological Survey an opportunity to move into expanded, although still temporary, quarters near the new building that is under construction for the University's Department of Geology. A study of the proposed quarters revealed that the Geological Survey would benefit in many ways from the proposed move, and the offer was appreciatively accepted, contingent upon successful relocation of the University's facilities in the buildings to which the Survey would move.

QUARTERS

In the closing weeks of the fiscal year the

STATISTICAL SUMMARY OF ACTIVITIES FOR FISCAL 1958-59

Many of the activities of the Geological Survey can be most readily summarized by

the statistical listing that follows.

|  |         |
|--|---------|
| Projects in progress - - - - -                         | 68      |
| Projects completed - - - - -                           | 82      |
| Conferences - - - - -                                  | 1,502   |
| Press releases written - - - - -                       | 35      |
| Outgoing letters - - - - -                             | 3,267   |
| Incoming letters - - - - -                             | 5,708   |
| Mineral statistics questionnaires handled - - - - -    | 511     |
| Number of field surveys (projects) - - - - -           | 9       |
| Man days on fieldwork - - - - -                        | 1,743   |
| Area mapped (square miles) - - - - -                   | 430     |
| Special field trips (conferences) - - - - -            | 99      |
| Total number of Survey vehicles - - - - -              | 26      |
| Total miles traveled in state vehicles - - - - -       | 238,130 |
| Geophysical measurements - - - - -                     | 1,121   |
| Feet of holes drilled - - - - -                        | 10,474  |
| Feet of core obtained - - - - -                        | 2,800   |
| Stratigraphic sections measured - - - - -              | 138     |
| Thickness of sections measured - - - - -               | 7,751   |
| Samples collected - - - - -                            | 995     |
| Coal spore slides made - - - - -                       | 2,050   |
| Coal thin sections and blocks made - - - - -           | 443     |
| Coal analysis (determinations) - - - - -               | 586     |
| Coal spores identified - - - - -                       | 3,600   |
| Samples analyzed chemically - - - - -                  | 386     |
| Chemical analyses (determinations) - - - - -           | 1,540   |
| Samples analyzed spectrographically - - - - -          | 424     |
| Spectrographic determinations (qualitative) - - - - -  | 684     |
| Spectrographic determinations (quantitative) - - - - - | 2,550   |
| Samples tested for physical constants - - - - -        | 284     |
| Samples tested for radioactivity - - - - -             | 53      |
| Minerals and rocks identified - - - - -                | 45      |
| Rock and mineral sets mailed out - - - - -             | 160     |
| X-ray analyses (determinations)                        |         |
| Powder camera - - - - -                                | 26      |
| Spectrometer - - - - -                                 | 1,365   |

## GEOLOGICAL SURVEY

|  |         |
|--|---------|
| Differential thermal analysis determinations -----                     | 5       |
| Miscellaneous other tests on clays -----                               | 362     |
| Public lectures -----  | 60      |
| Well cutting sets catalogued and filed -----                           | 269     |
| Cores catalogued and filed -----                                       | 12      |
| Strip logs made -----  | 232     |
| Feet of well cutting represented on strip logs -----                   | 101,065 |
| Oil wells field-checked -----  | 2,095   |
| Fossil collections -----   | 160     |
| Genera or species identified -----                                     | 112     |
| Photographs taken (black and white and colored) -----                  | 802     |
| Photographic prints made -----   | 1,724   |
| Projection slides made, black and white -----                          | 260     |
| Reports completed for official publication (now in editorial progress) |         |
| Bulletins -----  | 2       |
| Circulars -----  | 2       |
| Mineral Economics Series -----   | 1       |
| Reports of Progress -----  | 1       |
| Maps -----   | 2       |
| Reports completed and sent to editors for outside publication          |         |
| Abstracts -----  | 6       |
| Complete reports -----   | 10      |
| Memorandum reports transmitted (not publications) -----                | 7       |
| Published reports  |         |
| Bulletins -----  | 3       |
| Circulars -----  | 2       |
| Directories -----  | 1       |
| Mineral Economics Series -----   | 1       |
| Reports of Progress -----  | 2       |
| Published maps   |         |
| Atlas Maps -----   | 1       |
| Coal Investigations Maps -----   | 1       |
| County Base Maps -----   | 1       |
| Petroleum Exploration Maps   |         |
| New -----  | 4       |
| Revised -----  | 44      |
| Checked without revision -----   | 14      |
| Published reports sold -----   | 3,706   |
| Published maps sold -----  | 3,346   |
| Announcements of publications sent -----                               | 26,800  |
| Outside publications -----   | 21      |

RESEARCH PROGRAMS AND  
ACCOMPLISHMENTS

The research programs and results accomplished by the Geological Survey during fiscal 1958-59 are described under the respective section headings, which, for easy reference, are arranged alphabetically. All publications for the fiscal year are listed at the end of the report of the Publications Section.

Coal Section  
By Charles E. Wier

Coal is the most important mineral commodity produced in Indiana. In 1958 the production was 15,620,680 tons (fig. 1) valued at more than 61 million dollars. The Coal Section is charged with the responsibility of increasing our knowledge concerning origin, geographic and geologic occurrence, and physical characteristics of this important

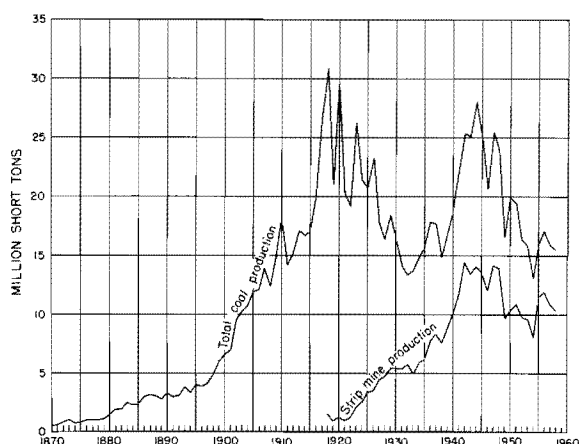


Figure 1.--Annual production of coal, 1870-1958. Compiled from annual reports of the U. S. Bureau of Mines, Minerals Yearbook.

commodity. Proper application of this knowledge can improve methods of mining, preparing, and utilizing our coals.

*Preliminary coal mapping.*—The purpose of one type of coal investigation is to delimit, in a general way, the extent of the commercial coals in Indiana and to map the areas where they have already been mined. The results of the work in each county are published as Preliminary Coal Maps on a scale of 1 inch to 2 miles. These maps show boundary lines and mined-out areas of commercial coals and present a general summary of the available information on each commercial coal. Additional factual and interpretive data are given in tables, cross sections, and a stratigraphic column. Maps of eight counties have been published. The map for Spencer County was published during the past year.

An area encompassing Fountain County, Warren County, and the northern part of Vermillion County was completed as one map and was submitted for publication. This area contains 52 million tons of known coal reserves. Several coals are as much as 7.5 feet thick locally but in most places are too thin for economical mining. Work is continuing on Knox County, and fieldwork was begun April 1, 1959, on Dubois County.

*Detailed coal investigation studies.*—Detailed geologic mapping of  $7\frac{1}{2}$ -minute quadrangles is done in order to obtain concise information concerning the coal deposits and associated rocks. Each quadrangle, which is at a scale of 1:24,000 and comprises an area of approximately 58 square miles, is carefully studied

by the geologist. Every outcrop, strip mine, underground mine opening, quarry, gravel pit, and shale pit and each available oil-test and coal-test drill hole and water well is carefully plotted in the field. Information concerning drilling and outcrops is plotted on mine maps, and the data are interpreted. Each report consists of a geologic map, which shows distribution of bedrock and unconsolidated surficial materials; an economic map, which shows extent of each coal bed and mined-out areas for each coal; an explanatory text; and a series of tables and other illustrations giving additional factual and interpretive geologic data.

Reports of six quadrangles have been published by the U. S. Geological Survey as Coal Investigations Maps. A map of the Seelyville Quadrangle in eastern Vigo County was published during the past year. Three other maps in the Coal Investigations Map series, the Coal City, the Switz City, and the Terre Haute-Dennison Quadrangles, are now in the hands of the printer. The fieldwork and preliminary drafting for these four maps were completed by the Coal Section geologists 2 to 3 years ago. Fourteen other quadrangles have been mapped and will be published in four separate bulletins by the Indiana Geological Survey. Maps of the Brazil East and Brazil West Quadrangles have been submitted for final drafting and will be published in a single report. The report of these two quadrangles includes information on the rather intensively mined Block coal area. Work on the Mansfield and Catlin Quadrangles is expected to be completed during 1960, and the final report will emphasize the lowermost coal-bearing rocks and the effects of glaciation on these rocks. The third report, which also will be completed during the coming year, covers the Rosedale, New Goshen, Sandford, Mecca, Clinton, and St. Bernice Quadrangles. This report will deal with most of the important commercial coals in the mining area of northern Vigo County, southern Vermillion County, and southern Parke County. The fourth report covers the Lewis, Pimento, Hutton, and Fairbanks Quadrangles and will be concerned with the upper half of the coal-bearing rocks in southern Vigo County and northwestern Sullivan County.

*Stratigraphic mapping of the Mansfield Formation.*—The purpose of another project is to enable us to delimit the various rock types in the 100 to 350 feet of sandstone, shale, clay, coal, and limestone that have been called the

Mansfield Formation. The Mansfield Formation crops out from Warren County southward to Perry and Spencer Counties and covers approximately 1,000 square miles. This vast area cannot be mapped in detail, but some detailed mapping is included in the project; for example, the previously mentioned Mansfield Quadrangle contains the type area of this formation. The work on the Huron and Hillham Quadrangles in Martin, Dubois, and Orange Counties also includes detailed mapping in the Mansfield Formation as well as in the formations in the underlying Mississippian rocks. Mapping of the Huron and Hillham Quadrangles is 95 percent complete, and the overall mapping of the Mansfield Formation is 70 percent complete. These studies will enable us to delimit more accurately the areas that contain commercial coal and to indicate potential areas for other mineral resources, such as silica sand and fireclay.

*Paleobotany.*—Work is continuing in palynology, the microscopic study of spores and pollen grains. Because each coal contains a distinct spore assemblage and thus can be differentiated from other coals, this work in palynology enables us to identify, differentiate, and correlate Indiana's coal seams. Spore analyses of Indiana's coals are being made to aid field geologists in stratigraphic interpretations.

As a means of better utilizing the great volume of spore data, Henry H. Gray has been employing electronic computing equipment. Preliminary results of this work were presented by G. K. Guennel in a talk to the American Institute of Biological Sciences in August 1958. A more comprehensive report entitled "Application of Statistics to the Correlation of Coal Beds by Means of Miospore Assemblages" was presented by Henry H. Gray at a meeting of the American Association of Petroleum Geologists on March 18, 1959.

*Coal petrography.*—Work has just commenced in Indiana in the field of coal petrography. In order to utilize the coals to the greatest advantage, it is necessary to characterize adequately the variability of the coals, both within and between seams. It has long been recognized that coal consists of discrete entities which can be differentiated megascopically and microscopically and which react differently during preparation and utilization of the coal. The characterization of Indiana coal on the basis of the character and relative

abundance of these entities and their relationship to the preparation and utilization processes is the ultimate objective of the petrographic study of Indiana coals. The preliminary investigations in this field are concerned with a general survey of all Indiana coal seams in order to develop an understanding of the problems in analytical techniques with which the investigator will be confronted. This work on the petrographic character of Indiana coals will result in a report of progress that is now 60 percent complete. The results of one aspect of this work were presented by Richard C. Neavel in a paper entitled "A Petrographic Investigation of the Causes of Degradation of Sized Coal." This paper, presented at an American Institute of Mining, Metallurgical, and Petroleum Engineers-American Society of Mining Engineers Joint Fuels Conference in October 1958, will be published soon.

*Miscellaneous projects.*—Additional work was done on the Indiana paper coal. This unique coal, which consists mostly of plant cuticles, has not been reported from any other locality in the United States. A similar paper coal was found in Russia in 1860. G. K. Guennel reported on this coal in a talk entitled "Cuticles and Spores of Indiana Paper Coal" at the annual meeting of the American Institute of Biological Sciences, and Richard C. Neavel presented a paper entitled "The Occurrence of Paper Coal in Indiana" at the annual meeting of the Geological Society of America. An article by G. K. Guennel and Richard C. Neavel was published in *Science*, v. 29, no. 3364, entitled "Paper Coal in Indiana." Another paper, titled "Indiana Paper Coal: Composition and Deposition," has been submitted to the *Journal of Geology*. The chemical aspect of the cuticular part of the paper coal was reported by Richard C. Neavel and Louis V. Miller at a meeting of the American Chemical Society in a paper entitled "Some Properties of Cuticle-Derived Components of Coal."

A guidebook for the paleobotanical field trip that preceded the American Institute of Biological Sciences meetings at Indiana University was prepared by G. K. Guennel. A popular article entitled "Coal Mining in Indiana, 1812-1958" was prepared by Charles E. Wier; it was published in the March 1959 issue of *Outdoor Indiana*. Another article by Charles E. Wier, entitled "Coal Stratigraphy and Resources 1949-1957," was submitted to the *Society of Economic Geologists* for pub-

lication.

Several other talks were given by members of the Coal Section, including a talk by S. A. Friedman at a meeting of the Geological Society of America entitled "The Cincinnati Arch: Source for Some Middle Pennsylvanian Channel Sandstones in Indiana" and talks by four members of the Coal Section to the Indiana Coal Preparation and Utilization Society.

In addition to the above items, considerable time was spent by Henry H. Gray and G. K. Guennel on Survey activities outside of the Coal Section. Henry Gray spent 22 percent of his time on his job as Map Editor, and G. K. Guennel spent 37 percent of his time on the job of Illustrations Editor and Chairman of the Publications Committee.

#### Drafting Section

By William H. Moran

The work performed by the Drafting Section consists mostly of the final preparation of maps and other line drawings used in the Geological Survey's reports and map series.

Major drafting jobs completed during the year were: (1) illustrations for Bulletin No. 13, Miospore Analysis of the Pottsville Coals of Indiana; (2) illustrations for Bulletin No. 15, Cement Raw Materials in Indiana; (3) illustrations for Report of Progress No. 12, Lightweight Aggregate Potentialities of Some Indiana Shales; (4) illustrations for Report of Progress No. 13, Natural Brines of Indiana and Adjoining Parts of Illinois and Kentucky; (5) illustrations for Report of Progress No. 14, Fossil Plants of Indiana; (6) illustrations for Report of Progress No. 15, Petrographic Similarity of Wisconsin Till in Marion County, Indiana; (7) illustrations for Circular No. 6, Adventures With Fossils; (8) illustrations for Directory No. 6, Directory of Sand and Gravel Producers in Indiana; (9) illustrations for Directory No. \_\_, Catalogue of Well Samples of the Indiana Geological Survey; (10) illustrations for a special report on Geological Aspects of the Site for the New State Office Building; (11) special report on the Geology of Marion County; (12) special report on Dam Sites and Reservoir Areas in Scott, Jennings, and Jefferson Counties; (13) Coal Investigations Map No. C 28, Geology and Coal Deposits of the Coal City Quadrangle, Greene, Clay, and Owen Counties, Indiana; (14) Coal Investigations Map No. C 41, Geology and Coal Deposits of the Switz City

Quadrangle, Greene County, Indiana; (15) Preliminary Coal Map No. 8, Distribution, Structure, and Mined Areas of Coals in Spencer County, Indiana; (16) Atlas of Mineral Resources Map No. 10, Glacial Geology of Indiana; (17) Base Map No. 44, Base Map of Lagrange County, Indiana; (18) Petroleum Exploration Map No. 4A, Well Location Map of Sullivan County, Indiana, Showing Total Depth of Wells; Petroleum Exploration Map No. 4B, Well Location Map of Sullivan County, Indiana; (19) Petroleum Exploration Map No. 55A, Well Location Map of Steuben County, Indiana, Showing Total Depth of Wells; (20) Petroleum Exploration Map No. 56A, Well Location Map of Lagrange County, Indiana, Showing Total Depth of Wells; (21) revision of Petroleum Exploration Map series; (22) preparation of topographic base positives of six quadrangles covering parts of Vigo, Vermillion, and Parke Counties; (23) preparation of two exhibits; (24) illustrations for 16 talks and (or) for use in scientific journals.

Other jobs started, but not completed, during the year were: (1) Bulletin No. \_\_, Geology and Coal Deposits of the Brazil Quadrangles, Indiana; (2) Report of Progress No. 16, The Mount Carmel Fault and Related Structural Features in South-Central Indiana; (3) Circular No. 7, Fossils: Prehistoric Animals in Hoosier Rocks.

#### Educational Services

By R. Dee Rarick

During the past year the Office of Educational Services submitted a total of 35 news releases concerning activities of the Geological Survey. A report of the major news items of the Survey was submitted to the Editor of the State Geologists Journal.

Articles prepared for and published in Outdoor Indiana included: "Spelunking," by R. L. Powell (July 1958 issue); "Indiana's Radioactive Rocks," by Robert F. Blakely (August issue); "Oil Found in Indiana," by R. Dee Rarick (September issue); "Indiana Limestone," by R. Dee Rarick and George Ringer (October issue); "Dams--and Engineering Geology," by John D. Winslow (November issue); "Indiana's Sharpenin' Stones," by R. Dee Rarick (December issue); "Oil in Indiana," by Olin R. Holt (January 1959 issue); "Coal Mining in Indiana, 1812-1958," by Charles E. Wier (March issue); "Indiana's 'Puffed' Rocks," by R. Dee Rarick (April issue); "In-



diana's Buried Valleys," by William J. Wayne (June issue). Articles prepared for and appearing in other publications include: "More Oil for Indiana," by Olin R. Holt (October 1958 issue of Indiana Business and Industry) and "A Geologic Excursion to Southampton Island," by William J. Wayne (Science Club paper, Shawe Memorial High School, Madison, Ind.). The following articles are in preparation: "Lead Ore--Hoosierland Legend," by R. Dee Rarick (for publication in Outdoor Indiana); "Channel Sandstones in Southwestern Indiana," by S. A. Friedman (for publication in Outdoor Indiana); "Indiana's Deepest Oil Test Well--Picture Story," by R. Dee Rarick (for outside publication).

The following field trips were conducted during 1958-59: Field trip for 4-H Camp to Wilford Storage Field, Sullivan County; 1-day field trip to Jefferson Lake, Jefferson County, for mapping party from Westlane Junior High School, Indianapolis, Ind.; half-day field trip for members of the Indiana Academy of Science meeting at McCormick's Creek State Park (McCormick's Creek Park-Lieber State Park area); 1-day field trip for Central Indiana Boy Scout Council, Indianapolis, Ind., to Bradford Woods-Martinsville area.

For the Indiana University High School Science Institute, a program sponsored by the National Science Foundation, a guidebook was prepared and a field trip was conducted.

"The Geological Survey Serves Indiana," the first of four programs by the Indiana Geological Survey, was prepared for the Department of Conservation radio series on Station WIRE, Indianapolis, Ind. Other programs were prepared by W. Harrison, Richard C. Neavel, and John D. Winslow.

For the summer of 1959 the Geological Survey offered a research assistantship in geology for a senior boy in an Indiana high school. Announcement and application forms were prepared and mailed to 749 Indiana high schools. Ten applications and four requests for additional information were received. Four finalists were chosen by a committee composed of John D. Winslow, G. K. Guenel, and R. Dee Rarick, Chairman. All finalists were interviewed at their schools by the committee chairman. Mr. Stanley K. Hamilton, Lawrence Central High School, Marion County, Ind., was chosen by the committee as the 1959 winner of the award.

Talks and lectures presented by the Office of Educational Services included: (1) lectures to three sessions of the Conservation Officer's

School, Camp Riley, Bradford Woods, on the Indiana Geological Survey and its services; (2) address on "The Role of Geology in National Defense" to the Bloomington Business and Professional Women's Club; (3) lecture on "Indiana's Mineral Industry" to a class in Conservation Education at Anderson College, Anderson, Ind. (fall and spring quarters, 1958-59 academic year); (4) "Choosing Geology As a Profession," a talk given to a class in Conservation Education at Anderson High School, Anderson, Ind.; (5) a talk to a mapping group at Westlane Junior High School, Indianapolis, Ind., prior to a field trip to Jefferson Lake.

"The State Beneath Us," a film depicting the geology of Indiana and the activities of the Geological Survey, was shown to the following groups: (1) Greencastle Rotary Club, (2) Brazil Exchange Club, (3) Anderson College class in Conservation Education (fall 1958 and spring 1959 quarters); and (4) Anderson High School class in Conservation Education.

The Office of Educational Services also participated in the Conservation Education Advisory Committee meeting, Camp Riley, Bradford Woods; the annual meeting of State Park Naturalists, McCormick's Creek Park; and the Conservation Education Camp, Versailles State Park, Versailles, Ind.

#### Geochemistry Section

By R. K. Leininger

In the fiscal year 1958-59 the Geochemistry Section continued its work of preparation, analysis, and storage of samples collected by personnel of other sections of the Survey and collected from cores by personnel of the Geochemistry Section. A total of 271 samples was obtained from cores. During the year the spectrographer resigned in order to continue his education; because this position remained unfilled for the remaining half of the year, the section lacked personnel to carry out its complete program. The analytical chemist is shared by the Survey and the Department of Geology at Indiana University. The position of spectrographer must be filled and a full-time chemist must be added to provide the increased analytical work requested by other sections of the Survey.

*Routine analyses.*—Five projects carried on by the section involve routine analyses. This work is divided into separate projects based

on the types of material because of the different analytical procedures involved. The materials, with the number of analyses made during the year, are as follows: brines, 30; carbonate rocks, 375; clays, shales, and soils, 4; coals, 108; and sands and sandstones, 6. In addition, 43 miscellaneous samples were analyzed in the spectrographic laboratory.

*Method development.*—In an effort to obtain efficient operation of the laboratories, investigations of analytical procedures are part of the work of the Geochemistry Section. Five projects of this kind were in progress during the year. Methods for the spectrographic determination of certain trace elements in carbonate rocks and silicates were developed. In conjunction with development work, a manuscript was written concerning spectrographic determination of major constituents of silicate rocks. This paper will be included in a bulletin of the U. S. Geological Survey. A method of determination of iodide in brines was checked for accuracy. In the coal analysis laboratory an investigation of paper coal required development of an inexpensive device for determination of amounts of distillable tar, water, and light oils. A paper on the results of this and other work was presented at a meeting of the American Chemical Society by Richard C. Neavel and Louis V. Miller.

*Compilation of data.*—A manuscript containing analyses completed during the years 1948-58 was completed for publication by the Survey. Compilation of new data in easily usable form was continued.

*Research projects.*—The research projects of the section are of two types. One is the study of data in the solution of geologic problems, such as the correlation of stratigraphic units on the basis of chemical composition of the rocks. Work on this type of project was restricted to the sampling and analysis of cores. The other kind of research is the investigation of natural geochemical processes. Two projects of the section, both concerning weathering, received attention. In one, a glacial till has been treated with water and carbon dioxide in an effort to follow changes in clay minerals of the till. In another, the minerals of weathered loess were investigated. This project resulted in a paper by R. K. Leininger, John B. Droste, and William J. Wayne. This paper was presented at the November 1958 meeting of the Geological Society of America; it was entitled "Expanding-Lattice Clay Minerals in Loess of Southern

Indiana and Northern Kentucky."

Geophysics Section  
By Maurice E. Biggs

The Geophysics Section utilizes reflection and refraction seismology, resistivity measurements, gravitational measurements, electrical well logging, and magnetic analyses to aid in the solution of problems in glacial geology, stratigraphy, structural geology, and engineering geology. The section also handles problems involving the engineering geology of dam and spillway locations and the foundations of other heavy structures and administers the drilling program of the Geological Survey and the instrument shop.

*Seismic reflection measurements.*—Since June 1958 a seismic reflection party has completed a survey in Posey, Vanderburgh, Warrick, Gibson, and Pike Counties. This project was designed to measure the depth to the Precambrian basement rocks in southwestern Indiana in order to obtain a better understanding of the structural framework of the state. A report of progress has been prepared to cover the first phase of this program. In June 1959 a seismic field party started the second phase of the program: to run a seismic reflection profile from Pike County northeastward to Dearborn County and from there northward to Steuben County. The second phase of this program is intended to show structural relationships in the area of the Cincinnati Arch. This program was approximately 20 percent complete at the close of the fiscal year.

*Seismic refraction measurements.*—A seismic refraction field party made detailed surveys of the depth to bedrock in areas in Newton, Jasper, Johnson, and Allen Counties and at proposed dam and spillway sites in Tippecanoe County. Results of this seismic work supplemented data being collected by geologists and engineers of the Indiana Geological Survey and the Indiana Flood Control and Water Resources Commission.

*Engineering geology.*—Since June 1958 work has been completed on the engineering geology of a proposed reservoir area on Big Graham Creek and Big Camp Creek in Jennings and Jefferson Counties. A report entitled "Preliminary Engineering Geology Report of Dam Sites and Reservoir Areas in the Valleys of the East Fork of the Muscatatuck River and Big Camp and Big Graham Creeks in Northern Scott County, Southern Jennings

County, and Western Jefferson County, Indiana" was completed in October and transmitted to the Flood Control and Water Resources Commission.

The engineering geologist also examined reservoir sites on Salt Creek in Monroe County and at the Bradford Woods and conducted a project to study the conditions under which valid Atterberg limits might be obtained in the laboratory. Reports on the Salt Creek Reservoir and Atterberg limits have been completed and submitted for editorial review.

*Magnetic and gravitational surveys.*—In August 1958 a field party began gravitational and vertical and horizontal magnetometer measurements in Randolph, Wayne, and Fayette Counties. This is an area characterized by an unusually strong anomaly on the aeromagnetic maps of Indiana. The linearity and intensity of this anomaly suggest that it may result from a major fault or dike-like intrusive body. The field party established gravitational and magnetic stations spaced approximately one-quarter mile apart along 20 traverses crossing the area of the anomaly. Although gravitational and magnetic fieldwork on this project is complete, a seismic reflection party will shoot a continuous profile across the anomaly to determine if the feature is due to faulting. The project was 90 percent complete at the end of the fiscal year.

*Electrical resistivity measurements.*—Electrical resistivity surveys were made in the vicinity of New Goshen, Milan, and Moore's Hill to aid in the search for a ground-water supply. These projects are complete, and resistivity curves and interpretations have been transmitted to the Indiana Department of Conservation, Division of Water Resources.

The programs of logging electrically all Survey drill holes and measuring changes in the electrical characteristics of drill holes with time were continued.

*Altitudes of wells and seismic shot points.*—Altitudes of all seismic stations and of selected water, oil, and gas wells were measured. This continuing program determines altitude of bedrock for stratigraphic, structural, and bedrock topography studies.

*Physical properties of Indiana rocks.*—Measurements of the seismic velocity, resistivity, conductivity, coefficient of absorption, crushing strength, density, magnetism, and radioactivity of sedimentary rocks in Indiana were continued during the year. All cores cut by the Survey's drill were sampled for testing. Tests also were run on other sam-

ples selected by other sections of the Geological Survey. This project was started in September 1953 and is a continuing one. A compilation of all results to date is now in preparation.

*New requirements.*—The Geophysics Section is equipped with both conventional and high resolution seismic instruments as well as other geophysical equipment. During the 1959 field season, however, the section can operate only one seismic field party because of lack of funds for personnel and supplies. As a result of this limitation of operations, the Geophysics Section must defer the completion of projects in progress and postpone initiation of new field surveys.

#### Glacial Geology Section By William J. Wayne

About five-sixths of Indiana was covered by glacial ice one or more times during the past half million years or so. Problems in mineral resources, civil engineering, water supply, and land use frequently result from the presence of materials left by these glaciers that once reached the state. Observations and records obtained by the Glacial Geology Section during the fiscal year 1958-59 have added to the fund of basic knowledge upon which we draw when the need arises to solve problems relating to these deposits.

Four basic types of projects are undertaken by the Glacial Geology Section; these are areal mapping, stratigraphic research, service projects, and public information projects.

*Areal mapping.*—Two types of mapping are undertaken by the Glacial Geology Section: detailed and reconnaissance. Detailed mapping, using U. S. Geological Survey topographic maps as a field base, will result in accurate county maps published on a scale of 1:48,000. During the fiscal year 1958-59 the section has had three detailed projects of this kind in progress and has begun two reconnaissance mapping projects.

The Geology of the Catlin and Mansfield Quadrangles is a cooperative project between the Coal and the Glacial Geology Sections. Harold C. Hutchison mapped the Mississippian and Pennsylvanian rocks and coal resources, and William J. Wayne mapped the sediments of Pleistocene age. The Pleistocene part of the project was started in 1956 and is now about 96 percent complete.

Fieldwork for a report on the Geology of Marion County, the most populous county of Indiana as well as the location of the state capitol, was begun by Wyman Harrison in 1956. The completed report, submitted in June 1959 for review for publication as a bulletin, includes both a nontechnical and a technical discussion of the geology of the county and a summary of the economic mineral resources of the county. The geologic map of the county was prepared for publication in color on a topographic base map, scale 1:48,000. The report also includes a structural-topographic cross section, a geomorphic map, and contoured maps showing bedrock topography and thickness of glacial drift.

The Geology of Johnson County, a project begun in 1956, will result in a report accompanied by a colored geologic map and contoured maps showing bedrock topography and drift thickness. The project has had to undergo several delays and was about 15 percent complete at the close of the fiscal year.

In preparation for a revision of the geologic map of Indiana, scale 1:250,000, the Glacial Geology Section is compiling and correcting the Pleistocene geology of the Indianapolis and Danville 1° by 2° Army Map Service Quadrangles. These will be the first two sheets of the new map to be prepared. Wyman Harrison began work on counties in the Danville sheet in June 1959, and William J. Wayne will begin fieldwork during the summer of 1959 to complete the Indianapolis sheet.

*Stratigraphic research.*—Areal geologic studies, as well as most of the applied fields of geology, depend extensively on accurate and detailed knowledge of the sequence and character of each layer or lens of sediments or sedimentary rocks in the study. Pleistocene geology is no exception, and four projects have been in progress in the Glacial Geology Section to provide more adequate information about the stratigraphy, sedimentation, and paleontology of Pleistocene sediments in Indiana.

One of the needs in stratigraphic research is data regarding the composition of sediments. Two studies on this subject have been undertaken by Wyman Harrison. One of these, entitled "Petrographic Similarity of Wisconsin Till in Marion County, Indiana," was submitted for publication as a report of progress. This manuscript includes a description of methods of analysis and a discussion and evaluation of the results of these analyses.

The second study will result in a paper on the petrology of some tills in central Indiana, also by Wyman Harrison, and presents an hypothesis on the significance and origin of the materials that are present in the glacial sediments of Marion County, Indiana. This study and manuscript were about 95 percent complete at the close of the fiscal year.

Snails and clams are among the few groups of organisms whose remains are well represented as fossils in Pleistocene sediments. These land and fresh-water mollusks are sensitive indicators of the local vegetation and climate. Research on the fossil mollusks, therefore, provides data on the environmental conditions surrounding their existence and burial during the Ice Age. Faunal changes took place from one glaciation to the next, so that some stratigraphic value can also be realized from these fossils. The fossil snails from five sample localities will be included in the "Geology of Marion County," and a compilation of the stratigraphy and paleontology of 15 fossiliferous samples that have been included in guidebooks is being prepared for publication in the initial issue of a new journal, *Sterkiana*. This paper was about 60 percent complete at the close of the fiscal year.

Stratigraphic studies of glacial sediments have not utilized a system of nomenclature like that used for other rocks. As a result, a mixture of stratigraphic and other types of terminology is found in most reports on this subject. William J. Wayne is working on a new classification of Pleistocene rock units that will permit a unification of nomenclature with that currently in use for the older parts of the geologic column. The study was begun in October 1958 and was about 60 percent complete at the close of fiscal 1958-59.

*Service and educational program.*—The Glacial Geology Section provides assistance to other organizations in Indiana in the interpretation of unconsolidated sediments. The section also has worked from time to time with groups of nongeologists in order to help as many persons as possible gain a better appreciation and understanding of earth science and of the mineral resources of their state. "Let's Look At Some Rocks," by William J. Wayne, published as Circular No. 5, was an attempt to present rock identification in a manner understandable to those of school age. "Indiana's Buried Valleys," also by William J. Wayne, was published in the June 1959 issue of *Outdoor Indiana*. The first part of the

manuscript on the Geology of Marion County, by Wyman Harrison, is a nontechnical resume of the rocks and geologic history of that central Indiana county.

A special report on the Geology of Marion County was prepared by Wyman Harrison for the use of the Metropolitan Planning Department of Marion County and was transmitted to that organization in December 1958. Doctor Harrison also prepared an open-file report on the Geology of the Site of the New State Office Building in Indianapolis in July 1958.

Industrial Minerals Section  
By Duncan J. McGregor

The industrial minerals produced in Indiana in the fiscal year 1958-59 included clay and shale, dimension limestone and sandstone, crushed limestone and dolomite, cement, sand and gravel, quartz-pebble conglomerate, gypsum, whetstones, marl, peat, and pyrite.

*Clay and shale.*—The Clay Mineralogy Laboratory continued to investigate the manner in which the mineralogy of natural clays and shales correlates with such physical properties as elasticity, hardness, fusion point, strength, shrinkage, and color. A report on the clays and shales of Indiana is nearly completed. The scope of the report has been broadened from that contemplated a year ago. Other projects now in progress include "The Economic Utilization of the Borden Group of Rocks in Indiana" and "Refractory Clays of Indiana."

*Dimension stone.*—Several conferences were held during the year with producers of dimension stone. Topics discussed included the petrography of rocks brought in by producers or potential producers and sites for new quarry openings. Eleven days were spent in examining prospective quarry sites with various representatives of the dimension stone industry. The report "Petrology and Economic Geology of the Salem Limestone" is nearly complete.

*Crushed stone.*—The work of measuring and sampling new quarry faces and the extensions or deepening of old quarries continued during the year. Three new quarries were opened, and several operators have deepened their quarries. Several conferences were held with producers or potential producers of crushed stone. Most discussions involved the best place to explore for new sites. Cur-

rently there are 79 crushed stone operations in Indiana.

A project on high-calcium limestone and dolomite was about 37 percent complete, and a petrographic investigation of northern Indiana limestones was 67 percent complete at the close of the year.

*Sand and gravel.*—A report that reviews types of gravel deposits, the importance of sedimentary processes in gravel deposition, and the size distribution and composition of Indiana gravel is being edited and should be available next year. Currently there are 119 sand and gravel operators in Indiana.

*High-silica sand.*—High-silica sand deposits exist in Indiana but are not as yet used by industry. A report entitled "Petrography of Indiana Sandstones Collected for High-Silica Evaluation" is in preparation.

*Gypsum.*—Active interest in gypsum continued throughout the fiscal year. Some 20 conferences were held to discuss exploratory sites. Core drilling by potential producers has continued, and prospects look favorable for additional production of this mineral.

*Geologic mapping.*—Geologic mapping of Monroe and Washington Counties is completed, and the texts for the respective reports are written. Publication awaits the drafting of the county geologic maps. The maps will be on a scale of 1:48,000 and will show the distribution of rock units in detail. Work will continue on the mapping of Lawrence and Orange Counties, and it is hoped that this work can be completed next year.

A report entitled "The Mt. Carmel Fault and Related Structural Features in South-Central Indiana" should be published during the next fiscal year.

*Papers and talks.*—Members of the Industrial Minerals Section wrote and gave the following scientific papers and talks before professional societies and commercial clubs: "Industrial Minerals of Indiana," "Conservation and Industrial Mineral Resources," "Petrography of Some Indiana Sandstones," "Origin of Clay Deposits at Gardner Mine Ridge," "Crandallite (Pseudowavellite) from Gardner Mine Ridge," and "Clay Partings in Gypsum Deposits in Southwestern Indiana."

*Meetings, field trips, and schools attended.*—Members of the Industrial Minerals Section attended the following scientific meetings and schools: General Electric X-ray school in Milwaukee, Wis.; American Association of Petroleum Geologists annual meetings in Dallas, Tex.; Geological Society of America

annual meetings in St. Louis, Mo.; the Seventh National Clay Conference in Washington, D. C.; Indiana Academy of Science in Indianapolis; Indiana Mineral Aggregates Association annual meetings in Indianapolis. Field trips attended were "Southeastern Missouri Lead Belt," "Mississippian Rocks of Western Illinois," "Geology of Mackinac Island and Lower and Middle Devonian South of the Straits of Mackinac," "Geology of Columbus, Galena, Gohanna Area, Ohio," "Stratigraphy of Nelson County and Adjacent Areas, Kentucky," "Paleobotanical Field Trip in Indiana," and "Guide to Some Geologic Features of McCormick's Creek State Park and Vicinity, Indiana."

*Special projects and reports.*—The following spe-

cial projects and reports were prepared or are being prepared by members of the Industrial Minerals Section:

"Preliminary Engineering Geology of Dam Site and Spillway Areas for the Monroe Reservoir, Southern Indiana." This is a joint project with the Geophysics Section.

"Effects of Soil Rehydration Characteristics upon Atterberg Limits." This is a joint project with the Geophysics Section.

"Mineral Resources of Howard County, Indiana," prepared for the Kokomo Chamber of Commerce.

"Mineral Resources of Crawford County, Indiana," prepared for the Crawford County Development Association.

Mineral Statistics  
By Mary Beth Fox

During 1958 the cooperative agreement between the U. S. Bureau of Mines and the Indiana Geological Survey continued to provide statistical information on the mineral production in Indiana. Data received from the mineral producers of the state and from other sources, such as the trade associations and similar organizations, have been compiled in table 1 and are the basis for the graph (fig. 2).

Each year since the contract was negotiated our production figures have become increasingly accurate as more and more companies realize the value of a central source for various types of statistical information and, therefore, furnish data for their companies. Although individual company figures cannot be revealed, our summaries have been useful to companies interested in establishing new market areas and in planning expansion programs; to mineral producers' legal firms in court cases, to government agencies for various purposes, and to others.

Table 1.—Mineral production in Indiana in 1957 and 1958

| Commodity  | Quantity <sup>1</sup><br>(1957) | Value <sup>1</sup><br>(1957) | Quantity <sup>2</sup><br>(1958) | Value <sup>2</sup><br>(1958) | Increase or Decrease |                 |
|--|---------------------------------|------------------------------|---------------------------------|------------------------------|----------------------|-----------------|
|  |                                 |                              |                                 |                              | Quantity<br>(pct.)   | Value<br>(pct.) |
| Coal   | 15,893,141 tons                 | \$62,142,181                 | 15,620,680 tons                 | \$61,701,686                 | -1.71                | - .71           |
| Cement<br>(portland and<br>masonry)  | 14,022,955 bbl                  | 47,736,095                   | 16,268,891 bbl                  | 54,984,516                   | +16.02               | +15.18          |
| Petroleum  | 11,810,000 bbl                  | 36,759,381                   | 11,811,000 bbl                  | 35,201,943                   | + .0085              | -4.24           |
| Clay and shale<br>(raw clay)<br>(manufactured<br>products)                                       | 1,276,043 tons                  | 24,832,363                   | 1,350,229 tons                  | 29,783,135                   | +5.81                | +19.94          |
| Limestone, crushed   | 14,181,112 tons                 | 17,419,321                   | 14,479,077 tons                 | 17,914,054                   | +2.10                | +2.84           |
| Limestone, dimension   | 9,119,127 cu ft                 | 19,768,901                   | 7,803,655 cu ft                 | 17,163,521                   | -14.43               | -13.18          |
| Sand and gravel  | 16,865,659 tons                 | 13,873,320                   | 16,905,705 tons                 | 14,835,897                   | + .24                | +6.94           |
| Sandstone, dimension   | 30,000 tons                     | 732,900                      | 25,831 tons                     | 636,125                      | -13.90               | -13.20          |
| Natural gas  | 650,027,000 cu ft               | 95,911                       | 631,440,000 cu ft               | 88,383                       | -2.86                | -7.85           |
| Peat   | 30,000 cu yd                    | 91,800                       | 30,265 cu yd                    | 144,974                      | + .88                | +57.92          |
| Marl   | 84,796 cu yd                    | 50,714                       | 63,792 cu yd                    | 77,890                       | -24.77               | +53.59          |
| Whetstones   | 8,000 lb                        | 8,129                        | 20,000 lb                       | 10,500                       | +150.00              | +29.17          |
| Undistributed:<br>(gypsum, alumina and<br>natural cement,<br>quartzite, recovered<br>sulfur)     |                                 | <u>4,936,852</u>             |                                 | <u>4,745,636</u>             |                      | -3.87           |
| Total (adjusted so<br>values for stone<br>and clay used for<br>cement will not be<br>duplicated) |                                 | 226,530,071                  |                                 | 235,307,556                  |                      | +3.87           |

<sup>1</sup> Adjusted.

<sup>2</sup> Subject to adjustment.

The overall value of minerals produced in 1958 increased 3.9 percent over 1957, although the fuels (coal, petroleum, natural gas) showed a decrease of 2.0 percent. This

decrease was offset by the increased demand for most of the building materials--cement, crushed limestone, sand and gravel, and gypsum. The one outstanding exception to the

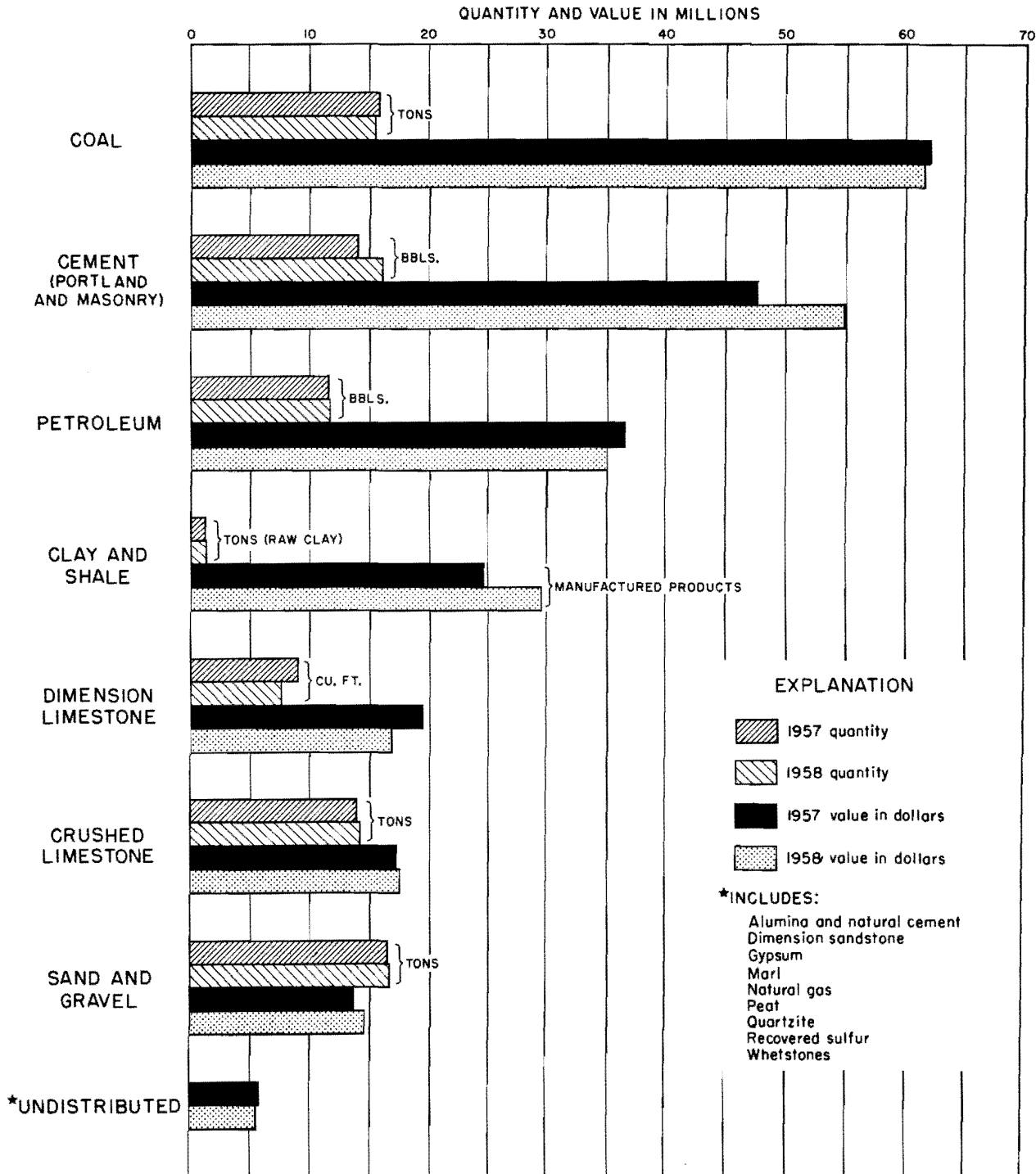


Figure 2. --Comparison of quantity and value of Indiana mineral resources in 1957 and 1958.



general increased use of building materials was dimension limestone, which showed a decline of 14.4 percent in quantity and 13.2 percent in value. The industries manufacturing products from clay and shale, such as brick, tile, and vitreous plumbing fixtures, played a substantial role in increasing the value of Indiana's mineral production.

Paleontology Section  
By Robert H. Shaver

The Paleontology Section was established July 1, 1956, and was charged with: (1) service--collecting and studying fossils as an aid to and supplementing the work of field parties or other personnel of the several sections of the Geological Survey, (2) research--providing basic information on fossils and their enclosing rock strata which is intended as a contribution to the science of paleontology and as a useful stratigraphic tool leading to greater understanding and utilization of Indiana's rock strata, (3) information and education--answering specific inquiries and otherwise informing Indiana's citizens and agents on matters pertaining to fossils, and (4) maintaining the Survey's fossil collections.

Items 2 and 3 have taken the greater effort of the section, and item 4 is incidental to the other functions. The specific research projects are on microfossils of Mississippian and Pennsylvanian age. These projects were undertaken partly in response to interests of Survey stratigraphers and because rocks of the specified ages are most intensively studied by the Survey and used by industry. Microfossils are emphasized because of past neglect, great abundance, and greater potential use.

Public interest in fossils has been uncommonly strong in Indiana, because the state presents an obvious abundance of excellent fossils of three types: (1) ancient marine invertebrates of Paleozoic age, (2) relatively modern mammals and fresh-water invertebrates of the Ice Age, and (3) plant fossils from the coal-bearing rocks. Such interest is shown to the Survey by private citizens, school children, educators, amateur geological societies, industry, and other state agencies; for example, the Division of State Parks. Many of the needs of the public can be met with published reports.

*Research projects.*--Four basic research and field projects have been initiated by the Pa-

leontology Section since 1956. The first of these, Mississippian Ostracoda of Indiana, was begun in July 1956 and is 44 percent complete. The project did not progress during 1958-59 because an opportunity for cooperative work with the Illinois Geological Survey offered greater prospect of immediately useful results. This study is expected to provide an additional basis for correlation of Mississippian formations.

M. L. Thompson of the Illinois State Geological Survey and Robert H. Shaver began work during August 1957 on two joint projects, Pennsylvanian Fusulinidae and Ostracoda of Indiana. The projects are less than half completed. Hundreds of samples from 90 sections and 4 cores have yielded nice faunas of both groups of fossils. Faunal studies should aid in our adoption of Mid-continent series terminology for the Pennsylvanian System and in regional correlation of formations in the Illinois Basin. A preliminary paper, "Early Pennsylvanian Fusulinids and Ostracodes of the Illinois Basin," will be published during 1959 by the Journal of Paleontology. A more general report on the lower Pennsylvanian faunas is being prepared for publication by the Survey.

The fourth basic project, on Cincinnati stratigraphy, was begun on August 1, 1957, and was continued during the summer of 1958 by D. E. Hattin. Doctor Hattin measured 1,923 feet of section at 21 locations and collected 223 samples for lithologic, paleontologic, and geochemical studies. A core of the entire Cincinnati Series was taken from near Richmond. The objectives are to determine practical formations, mappable on a lithostratigraphic basis, and to map these formations in selected areas of the Ordovician outcrop. The project will be discontinued during 1959-61 because of lack of funds.

*Educational reports.*--Circular 6, *Adventures With Fossils*, was released in August 1959. It was prepared for popular consumption in Indiana, especially for children of school age. A second paleontologic circular, "Fossils: Prehistoric Animals in Hoosier Rocks," by Professor T. G. Perry, will be released during the coming fiscal year. It was prepared in a more complete manner for children of advanced school age and laymen who are seriously interested in fossils. Older semi-popular reports on Indiana fossils are: (1) Circular 3, *Common Rocks, Minerals, and Fossils Found in Indiana*, by Smith, Brookley, and McGregor, 1954 (out of print) and

(2) Publication 90, The Geological History of the Vertebrates of Indiana and Their Position in the Ancient North American Fauna, by R. L. Moodie, 1929. Other work on fossils that is of special interest to the public is sponsored by the Coal and Glacial Geology Sections.

An article on the Salem Limestone entitled "A New Look at an Old Rock" was published in Earth Science. A manuscript on several families of Ostracoda was sent to the editor of the Treatise on Invertebrate Paleontology.

Talks were given to the Journal Club of the Department of Geology of Indiana University and to two amateur geological groups.

Petroleum Section  
By T. A. Dawson

*Reports on oil developments in Indiana.*—Statistics on exploratory drilling in Indiana for 1958 were prepared for the American Association of Petroleum Geologists Committee on Statistics of Exploratory Drilling. Detailed records on exploratory drilling are maintained throughout the year so that the statistics for this committee can be compiled quickly at the end of the calendar year. The statistics on exploratory drilling in Indiana are part of a statistical summary on exploratory drilling in the United States which is compiled by the national chairman of the Committee on Statistics of Exploratory Drilling. The statistical summary on exploratory drilling in the United States is published in the June issue of the AAPG Bulletin.

The annual AAPG paper "Developments in Indiana in 1958" was prepared at the close of the calendar year. The principal theme of this paper is oil exploration; that is, newly discovered oil and its significance. Publication is in the June issue of the AAPG Bulletin.

The annual paper "Oil Development and Production in Indiana During 1958" was prepared at the end of the calendar year. This paper is primarily a statistical report on oil production. It encompasses, however, most of the information presented in the annual AAPG paper. The paper is published in the annual volume of the Petroleum Branch of the American Institute of Mining, Metallurgical, and Petroleum Engineers "Statistics of Oil and Gas Development and Production," which contains papers on oil and gas development and production for all oil-producing states.

The Indiana chapter is also published separately by the Indiana Geological Survey in its Mineral Economics Series. The paper for 1958 will be published as Mineral Economics No. 5.

*Sullivan County well records.*—A project designed to remove inaccuracies from the Sullivan County well records was begun in July 1957 and completed in June 1959. The petroleum exploration map resulting from the project was published under date of April 2, 1959.

*Brine analysis records and brine report.*—A project whose objective was the collection and publication of records on brine production available for Indiana and adjoining parts of Illinois and Kentucky was started in July 1958. Several hundred records were collected from company files, and additional records were obtained from published reports. These records were compiled on cards and set up as a permanent file. A statistical report "Natural Brines of Indiana and Adjoining Parts of Illinois and Kentucky," based on this file, was published under date of April 1959.

*Sample directory.*—A project started in June 1958 and completed in December 1958 was the compilation of a catalogue showing all well samples in the files of the Indiana Geological Survey as of July 1, 1958. This catalogue now is being set up for offset printing.

*Field checking northern Indiana wells.*—Accurate locations and elevations for all wells in 19 northern Indiana counties were obtained by field checking during the year. The 19 counties in which wells were checked are Allen, DeKalb, Steuben, Lagrange, Noble, Whitley, Kosciusko, Elkhart, St. Joseph, Marshall, Fulton, Cass, Pulaski, Porter, Starke, LaPorte, Jasper, Newton, and Lake (fig. 3). Approximately 550 wells were checked. This was part of a major project of upgrading well records in northern Indiana, an area of considerable current concern in the oil industry. During the coming fiscal year the field-checked locations and elevations will be added to the well records, drillers' logs and electric logs will be correlated, all well data will be reviewed and indexed, and petroleum exploration (well location) maps will be compiled. Petroleum exploration maps for Steuben and Lagrange Counties were published under date of April 2, 1959.

*Pipeline map.*—A pipeline map of Indiana, started in November 1957, was completed in June 1959. The map will be published in color so that crude oil pipelines, gas pipe-

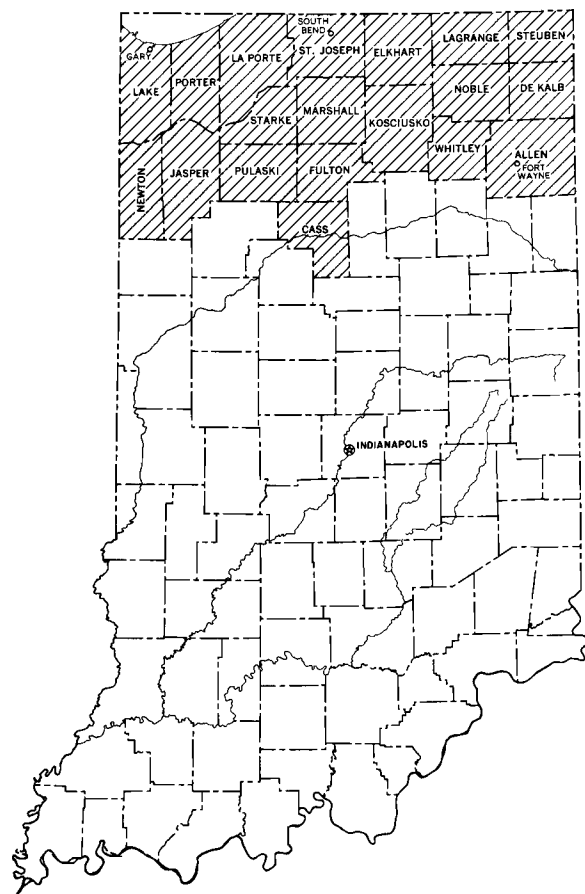


Figure 3.--Counties in northern Indiana field-checked by the Petroleum Section during 1958-59.

lines, and products pipelines can be distinctly shown.

*Oil reserves.*—Production curves have been plotted for oilfields with reserves of as much as 500,000 barrels. These production curves will be maintained in future years, and some new curves will be added. The amount of time devoted to reserves work in the future, however, probably will be small.

*Renault-Aux Vases-St. Genevieve subsurface study.*—A study of the interrelationships of the Renault, Aux Vases, and St. Genevieve formations, started in June 1955, was brought to 93 percent of completion by the end of the year.

*Cypress-Paint Creek-Bethel subsurface study.*—A study to show the distribution of the various lithologic units that compose the Cypress-Paint Creek-Bethel section and to show the geographic and stratigraphic distribution of oil in the Cypress-Paint Creek-Bethel unit, initiated in October 1957, was continued

during the year. The estimated date of completion is March 1961. It is estimated that the project was 32 percent complete at the end of 1958-59.

*Collection of Indiana brines.*—The Petroleum Section is cooperating with the Geochemistry Section in a 4- to 5-year program of collecting and analyzing Indiana brines. Analysis of the brine samples is the responsibility of the Geochemistry Section, and collection of the brine samples is the responsibility of the Petroleum Section. Collection of brine samples involves planning so that samples collected will be uniformly distributed, both geographically and stratigraphically. Brine samples will be collected at the rate of approximately 100 per year. Approximately 25 samples have been collected and analyzed to date. The project was started in March 1959 and is scheduled for completion in 1964. It should result in a comprehensive brine report in 1965.

Principal Geologist  
By John B. Patton

The Principal Geologist served as chairman of the Geologic Names Committee, directed the work of the Mineral Statistician, and was in charge of special projects such as cooperative work with the Interstate Oil Compact Commission.

*Disposal of oilfield brines.*—A project of the Research Committee of the Interstate Oil Compact Commission for the study of oilfield brine disposal, begun during the year 1957-58, was continued during 1958-59. On September 30, 1958, the Editorial Subcommittee of the Research Committee, under the chairmanship of the Principal Geologist, met in Bloomington to edit the reports submitted by the various state-members of the Commission and to discuss the problems involved in final publication of the national volume. The volume was reported ready for printing in May 1959.

*Report on mineral industry in Indiana in 1957.*—In January 1959 "The Mineral Industry of Indiana," a 14-page preprint from the U. S. Bureau of Mines Minerals Yearbook 1957, co-authored by Donald F. Klyce of the U. S. Bureau of Mines and the Principal Geologist, was issued.

*Chart of Indiana stratigraphic terms.*—In an attempt to clarify and bring into consistent

usage by Indiana Geological Survey authors the Indiana stratigraphic terms currently acceptable to the Indiana Geological Survey, the Geologic Names Committee, under the chairmanship of the Principal Geologist, issued a "Chart of Indiana Stratigraphic Terms" on January 14, 1959, to all scientific personnel of the Survey. Copies also were sent to a selected list of geologists throughout the country with a request for their comments and recommendations. After a year or so of use, suggested changes and corrections will be considered, a text written to accompany the charts, and a publication will be released.

*Annotated bibliography of Indiana geology.*—An annotated bibliography of Indiana geology covering the period from the earliest published works through 1955 is in the hands of the Publications Section for editorial processing. Supplements will be issued, probably on a 5-year basis. In order to keep current with published material, all important geological and technical journals received by the Geology Library (an official joint library for the Geological Survey and the Department of Geology at Indiana University) were checked during the year for articles that contain reference to the geology of Indiana. A monthly checklist was kept, and all appropriate articles were cited and filed alphabetically by author. Annotations and index references will be prepared when the time arrives to issue a supplement.

Publications Section  
By Gerald S. Woodard

The Indiana Geological Survey presents much of the results of its field and laboratory investigations to the public in the form of published maps and reports. The Publications Section, together with the Drafting Section, prepares these maps and reports for printing. The Publications Section also informs the public of new reports and maps as they are issued and handles all matters pertaining to the sale and distribution of publications.

During the fiscal year the Publications Section sold 3,346 maps and 3,706 publications other than maps. The section sent 704 reports and maps on exchange to institutions in the United States and 469 reports and maps on exchange to institutions in foreign countries. It also distributed without charge 2,941 publications to individuals, libraries, and

companies in the United States and abroad. The Publications Section sent 13 general publications announcements to companies, schools, and individuals; served 345 office customers; received 2,789 letters; and answered 670 requests for geologic information.

Figure 4 shows the number of various kinds of maps and reports sold by the Publications Section from July 1951 through June 1959.

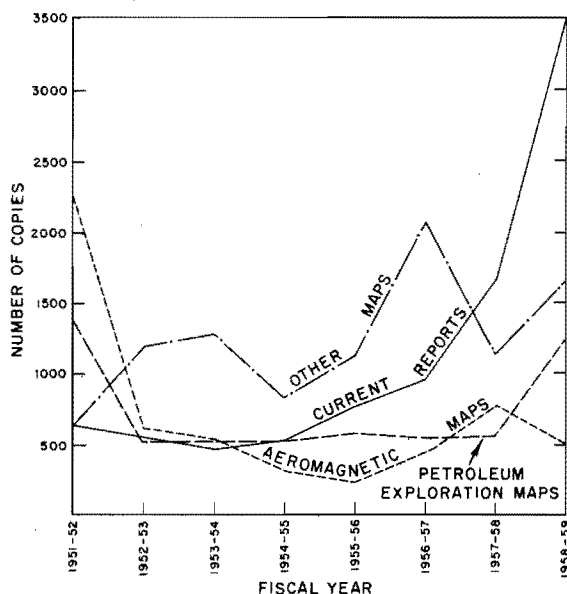


Figure 4. --Maps and reports sold by the Publications Section from July 1951 through June 1959.

#### PUBLICATIONS RELEASED BY THE GEOLOGICAL SURVEY DURING 1958-59

##### Bulletins

Guennel, G. K., 1958, Miospore analysis of the Pottsville coals of Indiana: Bull. 13, 101 p., 6 pls., 20 text figs., 11 tables.

Gutstadt, A. M., 1958, Cambrian and Ordovician stratigraphy and oil and gas possibilities in Indiana: Bull. 14, 103 p., 1 pl., 17 figs., 8 tables.

McGregor, D. J., 1958, Cement raw materials in Indiana: Bull. 15, 88 p.,

2 pls., 3 figs., 34 tables.

#### Circulars

Wayne, W. J., 1958, Let's look at some rocks: Circ. 5, 36 p., illus.

Shaver, R. H., 1959, Adventures with fossils: Circ. 6, 52 p., illus.

#### Directories

McGregor, D. J., 1958, Directory of sand and gravel producers in Indiana: Directory 6, 53 p., 4 figs.

#### Mineral Economics Series

Dawson, T. A., and Carpenter, G. L., 1958, Oil development and production in Indiana during 1957: Min. Econ. Ser. 4, 12 p., 1 map, 2 tables.

#### Reports of Progress

Murray, H. H., and Smith, J. M., 1958, Lightweight aggregate potentialities of some Indiana shales: Rept. Progress 12, 42 p., 1 pl., 7 figs.

Walker, F. H., 1959, Natural brines of Indiana and adjoining parts of Illinois and Kentucky: Rept. Progress 13, 58 p., 13 figs., 20 tables.

#### Atlas Maps

Wayne, W. J., 1958, Glacial geology of Indiana: Atlas Min. Res. Indiana, Map 10.

#### Coal Investigations Maps

Hutchison, H. C., 1958, Geology and coal deposits of the Seelyville Quadrangle, Vigo County, Ind.: U. S. Geol. Survey Coal Inv. Map C 27.

#### County Base Maps

Peace, J. E., April 1, 1959, Base map of Lagrange County, Ind.: Base Map 44.

#### Petroleum Exploration Maps

Keller, Stanley, April 2, 1959, Well location map of Sullivan County, Ind. showing total depth of wells: Petroleum Explor. Map 4A.

Keller, Stanley, April 2, 1959, Well location map of Sullivan County, Ind. Petroleum Explor. Map 4B.

Keller, Stanley, and Walker, F. H., April 2, 1959, Well location map of Steuben County, Ind., showing total depth of wells: Petroleum Explor. Map 55A.

Keller, Stanley, and Walker, F. H., April 2, 1959, Well location map of Lagrange County, Ind., showing total depth of wells: Petroleum Explor. Map 56A.

Well location maps showing total depth of wells for the following counties were revised as of April 2, 1959: Warrick County (3A), Vigo County (5A), Martin County (12A), Greene County (13A), Clay County (14A), Parke County (15A), Vermillion County (16A), Fountain County (17A), Owen County (18A), Putnam County (19A), Dubois County (21A), Knox County (23A), Monroe County (24A), Lawrence County (25A), Daviess County (26A), Orange County (27A), Crawford County (28A), Washington County (29A), Harrison County (30A), Bartholomew County (32A), Hendricks County (33A), Marion County (34A), Tippecanoe County (37A), Spencer County (39A), Perry County (40A), White County (42A), Boone County (45A), Pike County (51A), and Vanderburgh County (52A).

Well location maps for the following counties were revised as of April 2, 1959: Warrick County (3B), Vigo County (5B), Martin County (12), Greene County (13B), Clay County (14B), Dubois County (21B), Knox County (23), Daviess County (26), Harrison County (30), Spencer County (39), Perry County (40), Pike County (51), Vanderburgh County (52), Gibson County (53), and Posey County (54).

Well location maps showing total depth of wells for the following counties were checked without revision as of April 2, 1959: Montgomery County (20A), Jackson County (22A), Brown County (31A), Morgan County (35A), Johnson County (36A), Warren County (38A).

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Benton County (41A), Carroll County (43A),  
Clinton County (44A), Jennings County (46A),

Jefferson County (47A), Scott County (48A),  
Clark County (49A), and Floyd County (50A).