92nd ANNUAL REPORT OF THE STATE GEOLOGIST

of

INDIANA GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES

for

July 1, 1967 - June 30, 1968
PERSONNEL

Permanent Personnel

Administration

John B. Patton ........................................ State Geologist
Maurice E. Biggs ...................................... Assistant State Geologist
Mary Beth Fox ........................................... Mineral Statistician
Theodore H. Appleton .................................. Accountant
Marguerite Trisler .................................... Senior Account Clerk

Coal Section

Charles E. Wier ....................................... Geologist and Head
(On leave from Survey June 1-15, 1967)
S. A. Friedman ....................................... Geologist
(To January 2, 1968)
Harold Hutchison ..................................... Geologist
Richard L. Powell ..................................... Geologist
Marvin T. Iverson .................................... Geological Assistant
Sharon Kirkman ........................................ Secretary
(To April 15, 1968)
Bonnie Figg ............................................ Secretary
(From April 15, 1968)

Drafting and Photography Section

William H. Moran .................................... Chief Draftsman and Head
Robert E. Judah ........................................ Geological Artist-Draftsman
John E. Peace ........................................ Senior Geological Draftsman
Roger L. Purcell ...................................... Geological Draftsman
George R. Ringer ..................................... Photographer
Jerry L. Terrell ...................................... Draftsman
(October 16, 1967 to February 9, 1968)
Johny W. Turrill ...................................... Draftsman
(From May 8, 1968)

Educational Services

Reevan Dee Rarick .................................... Geologist

Geochemistry Section

R. K. Leininger ....................................... Geochemist and Head
Maynard E. Coller ...................................... Chemist
Elmer Craig ........................................... Geochemical Assistant
Rosalie V. Easton ...................................... Secretary
(Shared with Industrial Minerals Section)
Margaret V. Golde .................................... Instrumental Analyst
Louis V. Miller ....................................... Coal Chemist
Alfred White .......................................... Geochemical Assistant
Geology Section

Robert H. Shaver ........................................... Paleontologist and Head
Henry H. Gray ............................................. Head Stratigrapher
Alan S. Horowitz .......................................... Curator of Paleontology
Carl B. Rexroad ........................................... Paleontologist
(On leave September 1, 1967 to June 10, 1968)
Allan F. Schneider ........................................ Glacial Geologist
Martha N. Smith ........................................... Secretary
Susan G. Smith ........................................... Assistant Curator of Paleontology
(September 11, 1967 to January 25, 1968)
William J. Wayne ......................................... Head Glacial Geologist

Geophysics Section

Maurice E. Biggs .......................................... Geophysicist and Head
Robert F. Blakely ......................................... Geophysicist
Galen Cramer .............................................. Assistant Driller
(From August 14, 1967)
Linda Harris ............................................... Secretary
Clarence Haskins .......................................... Driller
John R. Helms .............................................. Geophysical Assistant
Glenn Johnson .............................................. Assistant Driller
(To August 4, 1967)
Charles Miller ............................................ Instrument Maker
Joseph F. Whaley .......................................... Geophysicist

Industrial Minerals Section

Lawrence P. Rooney ......................................... Geologist and Head
Curtis H. Ault ............................................. Geologist
(From March 27, 1968)
Donald D. Carr ........................................... Geologist
Rosalie V. Easton .......................................... Secretary
Robert R. French .......................................... Geologist
(To March 29, 1968)
William M. Webb .......................................... Geologist

Petroleum Section

Thomas A. Dawson .......................................... Geologist and Head
Leroy E. Becker ........................................... Geologist
M. Ruth Butcher ........................................... Secretary and Curator of Records
Gerald L. Carpenter ..................................... Geologist
James T. Cazee ............................................. Geological Assistant
Darryl Don Hayes ......................................... Geological Assistant
Andrew J. Hreha ........................................... Geologist
Stanley Keller ............................................. Geologist
Vivian McGuire ........................................... Senior Curator of Records
Jan Alan Mayer ............................................ Geological Assistant
Allen H. Pruett ........................................... Geological Assistant
(To September 8, 1967)
Howard Smith ............................................. Geologist
Dan Sullivan .............................................. Geologist
Publications Section

Gerald S. Woodard .................................. Editor and Head
Linda K. Ruble ....................................... Secretary
Donna C. Schultz .................................... Sales and Records Clerk

Seasonal Personnel

Coal Section

Eric Amt ............................................. Research Assistant
(January 15, 1968)
Ikram Khawaja ....................................... Research Assistant
(July 1 to September 5, 1967; June 1 to 30, 1968)
John McIntosh ....................................... Research Assistant
(June 24 to 30, 1968)

Drafting and Photography Section

Patricia M. Buckley ................................ Typist and Drafting Assistant
(July 1, 1967 to January 4, 1968)
Sheila K. Rawlins ................................... Drafting Assistant
(July 1 to August 23, 1967)
Jerry L. Terrell ...................................... Draftsman
(August 14 to October 15, 1967; changed to Appointment)

Geochemistry Section

Douglas Baumgardt .................................. Lab Assistant
(To August 11, 1967)
Donald Burton ....................................... Lab Assistant
(To August 7, 1967)
John E. Levindofskie ................................ Lab Assistant
(September 16 to December 12, 1967)
Paul E. Marciniak ................................... Lab Assistant
(September 18 to September 29, 1967)
Ted Petanoff ......................................... Lab Assistant
(From June 3, 1968)

Geology Section

Louise Kalafatic ..................................... Lab Assistant
(May 9 to June 30, 1968)
Alex Klishovich ...................................... Lab Assistant
(July 1 to October 19, 1967)
Randall Marmouze ................................... Lab Assistant
(September 16, 1967 to April 30, 1968)
Robert S. Nicoll .................................... Geologist
(July 1 to August 15, 1967; June 17 to 30, 1968)
Thomas G. Perry ................................... Paleontologist
(August 14 to September 1, 1967)
Geology Section (continued)

Mark Reshkin . . . . . . . . . . . . . . . . . . . . Glacial Geologist
(August 15 to 31, 1967)
Michael A. Retherford . . . . . . . . . . . . . . Lab Assistant
(July 1, 1967 to October 31, 1967)
Nancy Sheets . . . . . . . . . . . . . . . . . . . . Typist and Lab Assistant
(July 1, 1967 to January 15, 1968)
Katharine Sommer . . . . . . . . . . . . . . . . . . Geological Assistant
(July 1, 1967 to June 30, 1968)

Geophysics Section

Harry J. Allen . . . . . . . . . . . . . . . . . . . . Field Assistant
(July 1 to August 25, 1967)
Marcella Cummins . . . . . . . . . . . . . . . . . . . . . . . Clerk
(April 10 to May 2, 1968)
Abraham H. Dinarj . . . . . . . . . . . . . . . . . . . Geophysical Assistant
(July 1 to 20, 1967)
Mark C. Hahn . . . . . . . . . . . . . . . . . . . . . . . Geophysical Technician
(July 1 to August 25, 1967)
C. Geoffry Koenig . . . . . . . . . . . . . . . . . . . Geophysical Lab Assistant
(May 30 to June 30, 1968)
Michael McDowell . . . . . . . . . . . . . . . . . . . Lab Assistant
(January 31 to May 15, 1968)
Sharon McGlothlin . . . . . . . . . . . . . . . . . . . Computer Operator
(August 10, 1967 to June 30, 1968)
Helen Moreland . . . . . . . . . . . . . . . . . . . . . . . Computer Operator
(July 1 to August 31, 1967)
Albert J. Rudman . . . . . . . . . . . . . . . . . . . Geophysicist
(July 1 to August 31, 1967; June 17 to 30, 1968)
Lynn E. Shaffer . . . . . . . . . . . . . . . . . . . . Clerk-typist
(May 6 to June 30, 1968)
Daniel S. Tudor . . . . . . . . . . . . . . . . . . . . Field Party Chief
(July 1 to August 31, 1967)
Marsha Zoll . . . . . . . . . . . . . . . . . . . . . . . . Computer Operator
(June 17 to 30, 1968)

Industrial Minerals Section

Deborah Allen . . . . . . . . . . . . . . . . . . . . Lab Assistant
(July 1 to August 25, 1967)
James Keith . . . . . . . . . . . . . . . . . . . . . . . Lab Assistant
(July 1 to August 10, 1967)
Robert Lankston . . . . . . . . . . . . . . . . . . . . Lab Assistant
(September 18, 1967 to June 15, 1968)
James Lyons . . . . . . . . . . . . . . . . . . . . . . . Lab Assistant
(May 29 to June 30, 1968)
Linda Marie Niles . . . . . . . . . . . . . . . . . . . Lab Assistant
(November 10, 1967 to May 28, 1968)
Petroleum Section

James Cheesman ................ Geological Assistant
(June 24 to July 1, 1968)
David Denton .................... Geological Assistant
(July 1 to September 8, 1967)
(November 27, 1967 to January 26, 1968)
Larry G. Enochs .................. Geological Assistant
(July 1 to September 1, 1967)
(June 18 to 30, 1968)
Karen Ann Fuller ................ Secretary
(October 16 to November 24, 1967)
Susan Otlewski ................... Clerk-Typist
(September 9, 1967 to May 15, 1968)

Publications Section

Robert M. Goldstein .............. Clerk
(July 1 to August 25, 1967)
Roger Norris ..................... Clerk
(September 18, 1967 to June 30, 1968)
FINANCIAL STATEMENT

FUNCTION OR ACTIVITY

1. PERSONAL SERVICES

   101. Part-time-Summer ..................................... 6,975.
   101. Hourly .................................................. 2,500.

   TOTAL PERSONAL SERVICES .................................. 435,232.

2. SERVICES OTHER THAN PERSONAL

   201. Postage .................................................. 500.
   202. Telephone and Telegraph ................................ 4,400.
   204. Freight and Express .................................... 400.
   205. Travel .................................................... 16,000.
   206. Dues and Subscriptions .................................. 200.
   211. Gasoline Credit Cards .................................. 6,500.

   TOTAL SERVICES OTHER THAN PERSONAL ......................... 28,000.

3. SERVICES BY CONTRACT

   302. Printing and Binding ................................... 11,000.
   329. Insurance ............................................... 2,000.
   331. Repairs to Buildings ................................... 2,000.
   332. Repairs to Motor Vehicles .............................. 4,000.
   339. Repairs to Laboratory and Office Equipment .......... 4,000.
   399. Contractual Services N.C.C. ......................... 5,000.

   TOTAL SERVICES BY CONTRACT ................................ 28,000.

4. MATERIALS, SUPPLIES AND PARTS

   401. Office Supplies ........................................ 700.
   404. Laboratory and Field Supplies ......................... 19,000.

   TOTAL MATERIALS, SUPPLIES AND PARTS ....................... 19,700.

5. EQUIPMENT

   501. Office Equipment ....................................... 1,000.
   511. Motor Vehicle Equipment ................................ 6,000.
   521. Laboratory, Field and Shop Equipment ................. 7,188.

   TOTAL EQUIPMENT ............................................ 14,388.

   TOTAL EXPENDITURES ......................................... $535,000.
INTRODUCTION

The usefulness of the Geological Survey was clearly demonstrated during the year by the large number of people who visited us to obtain information about the geology and mineral resources of Indiana. Just one section, Industrial Minerals, reported that they answered 207 service requests for information related to the exploration for new sources of aggregate and other mineral resources. The greatest increase in service, however, was directed to problems related to man's utilization of the earth for waste disposal, foundations, dam sites and other uses made urgent by an increasing population.

At a time of an increasing number of requests for services and information, the Geological Survey came face to face with a critical problem of financial support. For the past several years a portion of the funds for the operation of the Survey has been provided from the General Fund and the balance from a Petroleum Severance Tax. During much of that time the production of oil in Indiana and the income from the Severance Tax held at a fairly uniform level.

Persons acquainted with the oil industry in Indiana, however, noted that each year less and less new oil was discovered, and that more and more of the oil was produced by secondary recovery methods. These unfortunate circumstances have predestined that a time would come when production of oil in Indiana would start to decline. Such has indeed been the case. Production of oil for the year was 6,730,000 barrels, down more than a million barrels from the preceding year. The Severance Tax reflected this drop in production; income was $281,000. compared to $308,000. for the past year.

Now that the decline has started it is likely to accelerate. If so, alternate methods of financing the Geological Survey must be developed or the organization will shrink in a manner parallel to the production of oil in the State. During the 1967-68 fiscal year, fortunately, the deficit in the Severance Tax balance was made up from emergency funds and from forced and drastic savings. For future years, however, the deficit may be larger than can be handled readily by savings. In order to insure that the Geological Survey can continue its vital functions a shift needs to be made away from the Severance Tax as a source of income.

Even if new discoveries of oil are made and the amount of tax money increases, the month to month method of collection makes budgetary operations difficult, particularly near the end of a fiscal year. A modification in financing for the Geological Survey should eliminate that difficulty.
The Geological Survey is headed by the State Geologist, who is responsible to the Director of the Department of Natural Resources. The organizational framework consists of three commodity sections (Coal, Industrial Minerals, and Petroleum), three research and analytical sections (Geochemistry, Geology, and Geophysics) and two service sections (Drafting and Photography, and Publications). The sections differ widely in size, ranging from the Petroleum Section with 13 full-time employees and some seasonal personnel to the smallest section (Educational Services) which consists of one full-time geologist. 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 Natural Resources, 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 Natural Resources, 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 and are audited by the State Auditor's Office; monthly financial reports are sent to the Department of Natural Resources.
STATISTICAL SUMMARY OF ACTIVITIES FOR FISCAL 1967-68

Many of the activities of the Geological Survey can be most readily summarized by the statistical listing that follows:

Projects in Progress ........................................... 47
Field Projects .................................................. 5
Projects completed ............................................. 15
Conferences with visitors to the Survey ..................... 1,032
Man days of field work ........................................ 1,225
Incoming letters ................................................. 4,850
Outgoing letters ............................................... 3,159
Total number of Survey vehicles .............................. 29
Total number of miles traveled in Survey vehicles ......... 186,110
Area mapped geologically (square miles) ................... 4,000
Thickness of stratigraphic sections measured (ft.) ......... 3,575
Stratigraphic sections measured ............................... 40
Public lectures
   Civic ......................................................... 13
   Industrial .................................................. 1
   School ....................................................... 31
   Other ......................................................... 22
Papers presented at professional meetings ................. 15
Field trips
   In connection with conferences ............................ 57
   Educational ................................................ 2
   News releases submitted .................................. 6
   Attendance at professional meetings ..................... 31
   Meetings sponsored by the Geological Survey ......... 1
   Exhibits prepared for special occasions ................. 3
Samples received or collected
   Rocks, Minerals .............................................. 708
   Coal ................................................................ 32
   Fossils ....................................................... 574
   Miscellaneous ............................................... 12
Identifications (Rocks, Minerals, Fossils) ................. 492
Packet of geologic education material sent ................. 257
Special rock sets for teachers ................................ 10
Rock and mineral sets sent ................................... 322
Soil and sand samples sent ................................... 3
Insoluble residues made ....................................... 215
Heavy mineral separations made .............................. 15
Polished blocks of coal made ................................ 72
Polished blocks of pyrite made ............................... 50
Samples prepared for analysis (by crushing) ............... 20
X-ray mineralogic analyses ................................... 25
Physical tests on building stone ............................ 236
Physical tests on other stone ................................ 474
Seismic refraction shots ....................................... 480
Seismic reflection shots ....................................... 28
Gravity stations measured ..................................... 45
Feet of hole drilled ........................................... 4,456
Feet of core recovered ........................................ 3,655
Feet of hole augered ........................................... 2,213
<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>Feet of core collected other than by Survey</td>
<td>959</td>
</tr>
<tr>
<td>Feet of core described</td>
<td>5679</td>
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<tr>
<td>Thickness of auger description (feet)</td>
<td>2200</td>
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<td>Oil wells field checked</td>
<td></td>
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<tr>
<td>Current drilling</td>
<td>324</td>
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<tr>
<td>Well cutting sets catalogued and filed</td>
<td>197</td>
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<tr>
<td>Well cores catalogued and filed</td>
<td>20</td>
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<tr>
<td>Strip logs made (wells)</td>
<td>142</td>
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<tr>
<td>Feet represented on strip logs</td>
<td>150,000</td>
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<td>Camera copies made</td>
<td>430</td>
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<td>Field Photographs</td>
<td>246</td>
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<td>Black and white prints</td>
<td>730</td>
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<td>Color transparencies</td>
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<td>Film prints</td>
<td>171</td>
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<td>Color slides</td>
<td>205</td>
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<td>Black and white slides</td>
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<td>Color prints</td>
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<td>Photomicrographs</td>
<td>220</td>
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<td>11</td>
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<td>Scribescot</td>
<td>17</td>
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<tr>
<td>Color proofs of map</td>
<td>8</td>
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<tr>
<td>Memorandum reports on special projects</td>
<td>12</td>
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<td>Bulletins</td>
<td>8</td>
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<tr>
<td>Regional Geologic Maps</td>
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<td>Miscellaneous Maps</td>
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<td>Special Reports</td>
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<td>Published Maps</td>
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<tr>
<td>Miscellaneous (new)</td>
<td>2</td>
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<tr>
<td>Miscellaneous (revised)</td>
<td>4</td>
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<tr>
<td>Petroleum Exploration Maps</td>
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<tr>
<td>New</td>
<td>4</td>
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<tr>
<td>Revised</td>
<td>127</td>
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<tr>
<td>Checked without revision</td>
<td>65</td>
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<tr>
<td>Published reports sold</td>
<td>8944</td>
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<tr>
<td>Published maps sold</td>
<td>6605</td>
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<tr>
<td>Publications Office customers</td>
<td>2873</td>
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<td>Announcements of publications sent</td>
<td>942</td>
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<td>Outside Publications</td>
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<td>Abstracts</td>
<td>3</td>
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<tr>
<td>Complete reports</td>
<td>4</td>
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<tr>
<td>Reports completed and sent to editors for outside publication</td>
<td></td>
</tr>
<tr>
<td>Abstracts</td>
<td>8</td>
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<tr>
<td>Complete reports</td>
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During the past year there has been an increased interest in coal not only by the coal companies but also by oil companies. Many representatives of these companies have obtained information on coal from the Indiana Geological Survey. Because the present trend is for oil companies to buy large operating coal companies or large blocks of deep coal reserves, they naturally want all of the background information that they can get. Inquiries fall into three general categories: 1) coal reserves - especially reserves for underground mining, 2) methods of evaluating roof rock material in underground mines and 3) nature of sulphur in the coal and possible methods of removing it.

In extending their coal reserves holdings both the oil companies and coal companies are interested in large blocks of coal consisting of 100 million tons or more of recoverable coal. In Indiana this large quantity rules out the possibility of coal that can be mined by stripping because such large tonnages have long since been discovered and are committed in long term contracts. Depending on the thickness of the coal (for example 4 to 6 feet) and on the percent of recoverable coal in underground mines (at present slightly more than 50 percent) for one seam of coal it would make about a township (36 square miles) for this large quantity. The 100 million tons figure commonly is used if the proposed utilization is for a new electricity generating power plant; if an installation for coal-to-gasoline conversion is contemplated the tonnage required is 3 to 5 times greater. The possible future location of such reserves is in the southwestern part of the state, along the Wabash River, in Posey, western Gibson, western Knox, and western Sullivan Counties.

Because coal reserves in Indiana that can be mined by stripping mostly are known, and are controlled by the operating companies, planning now is concerned with underground mining. The most difficult problem in planning an underground mine is to develop an accurate evaluation of the roof conditions. As a generality, the roof can be properly controlled from an engineering standpoint, but if the roof rock causes many unusual problems, then control is too expensive for economical operations.

Because future regulations may limit the amount of sulphur dioxide that can be emitted into the air or may limit the amount of sulphur that can be present in the coal, there is increased interest in the physical and chemical nature of sulphur in coal and in possible methods that might remove all or part of this sulphur. During the past year the Geological Survey has studied the distribution of iron sulphides in one of the commercial coals and can make some generalizations. Only about half of the sulphur in coal can be removed by the most efficient preparation plants now in operation. To remove a greater percent of sulphur would require an expensive chemical treatment. The chemical method, however, may have possible use in the future because the sale of sulphur as a by-product would in part pay for the extra expense of additional treatment of the coal.

-11-
The work performed in the Drafting and Photography Section during the past fiscal year consisted mainly of the final preparation of maps and reports for publication, compilation of base detail for regional geologic maps, preparation of drawings and slides for talks, and construction of exhibits.

Drafting of the following publications was completed: Bulletin 37, Crushed stone resources of the Devonian and Silurian carbonate rocks of Indiana; Mineral Economics Series 13 and 14, Oil development and production in Indiana during 1966 and 1967; Petroleum Exploration Map 98A (Hamilton Co.); Petroleum Exploration Map 99A (Madison Co.); Miscellaneous Map 15, Map of southwestern Indiana showing areas strip mined for coal; Preliminary Coal Map 11 (Martin Co.); and Preliminary Coal Map 12 (Knox Co.). Miscellaneous Map 7, Map of southwestern Indiana showing locations of active coal mines; Miscellaneous Map 11, Locations of crushed stone operations in Indiana; and seventy petroleum exploration maps were revised. Also finished were three new and two modified exhibits, illustrations for four outside publications, slide drawings for thirteen talks, revision of base maps of Monroe, Brown, and Jackson Counties, and compilation of base maps of the Louisville and Cincinnati Quadrangles for the Regional Geologic Map series.

Other projects in progress are: Bulletin 39, Geology and mineral resources of Washington County, Indiana; Bulletin 40, Stratigraphy and conodont paleontology of the Salamonie Dolomite and Lee Creek Members of the Brassfield Limestone (Silurian) in southeastern Indiana and adjacent Kentucky; Regional Geologic Map 3 (Vincennes Sheet); Preliminary Coal Maps 13 and 14 (Parke-southern Vermillion Cos. and Perry Co.); compilation of a base map for a geologic map of the Muncie Sheet; and an exhibit of iron ore processing in Indiana.

Approximately 7500 prints were made on the diazo printer.

Photographic items produced consist of 320 copy camera photographs, 216 field photographs, 652 black and white prints, 3 color prints, 171 film prints, 8 color transparencies, 86 black and white slides, 155 color slides, 11 photomicrographs, 17 scribblecoat prints, 8 color proofs, and approximately 300 stripping film prints of type.

EDUCATIONAL SERVICES

The Office of Educational Services was established by the State Geologist of Indiana to coordinate the Geological Survey's efforts in providing information for the public. This office aids in preparing materials for public schools, youth groups, and persons interested in rocks, minerals and the earth. By means of news releases to Indiana's newspapers and articles sent to appropriate magazines, the Office of Educational Services not only informs the public about activities of the Indiana Geological Survey but also aids in the distribution of educational information. In addition to giving public lectures and conducting special
field trips, when requested, the Educational Services geologist works
directly with geology clubs, Scout groups, 4-H clubs, conservation clubs,
teachers in public schools, and children throughout the school systems of
the State on projects concerning Indiana's geology and mineral resources.
On occasion he serves as guest lecturer and field trip guide for college
classes. The geologist in charge of Educational Services also aids in
the preparation and installation of exhibits for fairs, for amateur rock
shows, and for the display spaces in the Geology Building.

Activities of the Office of Educational Services for the past 12 months
were very similar to those for the preceding fiscal year. A noticeable trend
is the increase in requests from County Agricultural agents and 4-H adult
leaders for assistance to 4-H Club members who are doing geology projects.
Also, the Educational Services geologist is called upon more and more
to judge 4-H geology exhibits at fairs.

During the 1967-68 fiscal year the geologist in charge of Educational
Services spent 73½ days in the field and traveled 13,101 miles. In answer
to requests received from the public, 32 public lectures were given and
15 special field trips were conducted during the 12-month period.

Public lectures, laboratory demonstrations, and film showings were made
to the following groups: Forestry 580, "Conservation of Natural Resources,"
Purdue University; Decatur County 4-H group (geology projects); Lawrence
and Orange County 4-H groups (geology projects); Indianapolis Metropolitan
School System's School Camps, Bradford Woods and Camp Gallahue; Brown
County; Indiana Gem and Geology Society; Edgewood (Indianapolis) Boy
Scout Troops; Adult leaders of Tulip Trace Council (Indianapolis area) at
annual leaders retreat, Columbus Youth Camp, Bartholomew County; Science
Club, Wes-DeI High School, Gaston, Indiana; Mt. Gilead Christian Fellowship
Group, Monroe County; Grandview School Boy Scout Troop, Monroe County;
Science Club, Cloverdale High School, Putnam County; 4th Grade class,
Elm Heights School, Bloomington; Tulip Trace Council adult leader meeting,
Morgan County; Solon-Robinson Elementary School, Crown Point, Indiana;
Meridian School, Kokomo, Indiana; Vigo County Boys Conservation Club,
Shakamak State Park; Blackford County Hme Demonstration Club; Hartford
City, Indiana; Education M540, "Methods of teaching conservation," Indiana
University.

Special field trips, tours, and collecting hikes were conducted for the
following groups: Forestry 580, Purdue University; High School Science
Institute, Indiana University; Tulip Trace Girl Scout Council, Morgan County;
Education M540, Indiana University; Lawrence and Orange County 4-H group;
3rd grade group, Rogers School, Bloomington; 3rd grade group, Childs
Elementary School, Bloomington; 4th grade group, Childs Elementary School
Bloomington; 4th grade group, Elm Heights School, Bloomington; 6th grade
group, Smithville School, Monroe County; and 9th grade science classes,
University School, Bloomington.

One major exhibit was prepared by the Indiana Geological Survey and
was installed at the 1967 Indiana State Fair. Pre-existing or reworked
displays were installed at the Wabash Valley Rock and Mineral Club's rock
show, Lafayette, Indiana; Indiana-Kentucky Geological Society's annual High
School Night, Owensboro, Kentucky; and the Oilmen's Outing, Centrailia, Illinois.
During the past 12 months the Office of Educational Services submitted six news releases to Indiana's newspapers about the activities and accomplishments of the Geological Survey. Reports of the major news items concerning Geological Survey activities were submitted to the editor of the State Geologists Journal, published semi-annually by the Association of American State Geologists. Two magazine articles about Indiana geology or mineral resources were written and submitted to Outdoor Indiana. Four issues of the Survey newsletter were prepared and distributed among the personnel of the Geological Survey during the past year.

A small guidebook was prepared by the Office of Educational Services for the 13th annual Indiana University High School Science Institute field trip. The geologist in charge of Educational Services aided in the presentation of lectures to the group about the field of geology, training in geology, and career opportunities in geology and also served as co-leader on the geologic field trip conducted for the group.

During the 1967 county fair season 4-H science exhibits were judged at the Decatur County 4-H Fair by the Office of Educational Services geologist. Earlier in the summer assistance in the form of demonstration lectures and collecting field trips were conducted for the members of the Decatur County, Lawrence County, and Orange County 4-H clubs.

GEOCHEMISTRY SECTION

The major responsibility of the Geochemistry Section is to provide chemical and/or mineralogic analyses of samples of Indiana's rocks. The data pertaining to coal, high-calcium limestone, clays, and raw material for glass sand are obviously of direct use for those who wish to locate certain materials. Data for aggregates, agricultural lime, brines, cement raw-materials, gypsum and shales are equally important.

In addition to the study of samples collected by geologists at quarries and roadcuts, an attempt has been made in the past to analyze samples from all widely spaced cores available to the Survey. Due to lack of qualified personnel, a large backlog of cores has been accumulated, especially during the last two years. Without additional staff, these accumulated cores cannot be processed and analyzed. Unless this problem is alleviated, the available storage space will soon be filled, thus requiring disposal of core, and a resultant loss of potential data. Availability of modern analytical equipment has decreased the time required for analysis of samples, but the equipment has not replaced personnel required to sample the cores and to prepare and analyze the samples.

By careful selection of samples to be analyzed the Geochemistry Section has aided geologists to provide data to the aggregate, cement, coal, dimension stone, gypsum, limestone, sand and other producer-industries throughout the year. A mapping project of the Geology Section was aided by mineralogic analyses. Assistance was given the dimension limestone industry concerning problems of staining. And last but not least, information has been given in answer to inquiries by individual citizens concerning the nature of materials found in the State.
The section was organized on July 1, 1960, and incorporated older, less separately embrace sections and programs that dealt basically with the noncommodity-oriented geology of the State that is associated with bedrock, glacial and other near-surface unconsolidated materials, physiography, and fossils. Its responsibilities may be classified further as: (1) service -- providing information as an aid to State and federal agencies (including other sections of the Survey), to members of the public, and to industry and other organized nongovernmental groups; (2) research--seeking new information on the nature, arrangement, distribution, age and correlation of virtually all the accessible geologic materials of the State; and (3) maintenance of geologic collections and reference materials upon which the section's programs are based.

The year 1967-68 is the last in which the Regional Geologic Map program will have taken the largest single effort of the section inasmuch as the last three 10 x 20 sheets are nearly ready to leave the section for editorial processing. Classified by us as applied work, the program in fact has much of the research aspect in it, having had so much new data input, particularly for the glacial materials. The commodity-related uses discussed in "A Brief Guide to the Use of the Indianapolis Sheet" are at least as obvious as the academic objective, but, partly because only two of the maps are published, the real benefits of the total effort surely are not yet appreciated.

Only two of many examples: (1) How does one measure the dollar and cents value to the Indianapolis Water Company and its clientele for our having shown its representative on June 3, 1968, the four northwestern Johnson County 72-minute quadrangle work maps (used in the basic compilation of the Indianapolis sheet) on which were drawn geologic contacts outlining the possible aquifers containing the supply of water that was being newly sought for advancing urban development. (2) These work maps constitute an as yet hardly used reservoir of both old and ew data in ready state for a series of reports on urban and environmental geology, which would be particularly useful for planning purposes and in general not only for solving certain urban problems but also for avoiding them altogether.

The year 1967-68 saw, in fact, the new label "Urban and Environmental Geology" placed by the Survey and by the Department of Natural Resources on the kind of effort the section has been advocating for years and on which we have been able to work only sporadically for want of funds. The newest effort, begun in 1967-68, is for Madison County and is a pilot study in the light of new attention from the Department (Fig. 2).

We cannot predict all the practical applications of the section's research projects; we can assert, however, that our research pays off in unexpected ways. One example of many: Sufficient data were on hand from the project on "Stratigraphy of Cincinnatian rocks in Indiana" (described in the body of this report) as to assure an inquirer this year that shale bodies, at specified depths and locations and having certain relationships with other rock bodies, are present within the Cincinnatian Series and are suitable for excavation of underground caverns for the storage of liquified gas.
Service and Applied Activities

The work described here was undertaken mostly in response to specific requests and to further the progress of standing applied programs. Particularly the State-mapping part employs some original investigation, so that assignment of this program to the heading above is somewhat arbitrary.

Regional Geologic Map series.—The section very nearly completed all its work in this project in a formal sense. The first half of fiscal year 1968-69 should see this section submitting the final sheets (Fort Wayne, Muncie, and the combined Cincinnati and Louisville sheets).

A new project on "Discriminating tills and loesses of several ages and relating them to other unconsolidated deposits on the basis of clay-mineral and heavy mineral profiles" was begun as an aid to this mapping. Although several dozens of samples were analyzed by different means, interpretation has not yet been made.

The state mapping projects have resulted in an unusual number of separate reports as byproducts. The 7½-minute topographic quadrangle maps, containing the primary map contacts and covering much of the State, have real dividends and are repeatedly used in conferences with members of the public, industry, and government; our field and office work has suggested areas and problems needing formulation of primary research projects (some reported herein); and these reports, published during 1967-68 or remaining in editors' hands, testify to quantity of basic information that has been produced:

Published: (a) Schneider, A. F., and Johnson, G. H., 1967, Late Wisconsin glacial history of the area around Lake Maxinkuckee: Indiana Acad. Sci. Proc., v. 76, p. 328-334, 3 figs.
(b) -----, History of a morainal gap at Valparaiso, Indiana (abs.): Geol. Soc. America Special Paper, 2 p.
(e) -----, and Jacobs, Alan, The origin of Chesnut Ridge, Jackson County, Indiana (abs.): Geol. Soc. America Special Paper, 2 p.

Activities applied to urban geology, planning, and water.—Although the section has been involved in community planning needs, including those relating to water resources, the past year marks the first that our involvement has come under the label urban geology and the first in which sanitary landfills have received so much attention. This new label reflects the great attention now being given to urban affairs on the national, state, and local levels.

1. A new project, Urban Geology of Madison County, was begun in response to the Department of Natural Resources request for a trial
report on urban geology that possibly will lead to a broader program. Six maps and other figures and 30 pages of text, much of this being compiled from existing data, will be the measure of our effort, which was 70 percent completed during the year. The report will go to the Department in an unpublished state, but we expect to publish in one of our series.

2. Memorandum reports: (a) Wayne, W. J., July 15, 1967, Description of problem and proposal for an interdepartmental study of the nature and movement of leachates from sanitary landfills in Indiana, 5 p.; to State Geologist to outline scope of a program for the State.

(b) ------, July 26, 1967, Urban geology, 6 p.; to State Geologist to outline scope of an urban geology program for the State.

(c) ------, January 19, 1968, Geology of Morgan County, 25 p., 2 pls., 3 figs.; to John Sirbu, Morgan County Plan Commission.

(d) ------, June 30, 1968, Memorandum report on geology of a proposed landfill site near Columbus, Indiana, 4 p., 1 fig.; to Columbus city engineer.


4. Other activities: (a) Schneider continued as our representative to the interagency committee on sedimentation in reservoirs.

(b) Wayne became a member of the new Committee on Safe and Effective Disposal of Liquid Wastes of the Indiana Association of Sanitarians.

Field trip, Second Annual Meeting, North-Central Section, Geological Society of America, Iowa City.---Although our contributor for this field trip was on leave of absence when the publication was released, we report it here because the subject matter was in part supplied through our auspices: Glennister, B. F., and Rexroad, C. B., 1968 Field trip no. 6: Conodont successions, in Steinhilber, W. L. (ed.), A field-trip guidebook prepared for the Second Annual Meeting of the North-Central Section of the Geological Society of America: Denver, Geol. Soc. America, p. 6-1 to 6-17, 8 figs.

Miscellaneous applied activities.---Scores of letters and conferences and some lectures reflect our applied activities in many areas of geologic endeavor, and they are counted in the statistical part of this report. Other activities are itemized.

1. A project, Catalogue of Type Specimens, cosponsored with the Indiana University Department of Geology, was begun and completed during the year.


(b,c) ------, December 7, 1967, Curating the paleontological collections No. 7, 6 p.; June 4, 1968, No. 8, 6 p.; to State Geologist.

Research Activities

Stratigraphy and area geology.—1. Quantitative aspects of the geomorphology of southern Indiana. This new project was suggested to take advantage of recently completed, modern topographic map coverage of the southern part of Indiana by applying quantitative methods to geomorphic studies. These are expected to yield more penetrating information on the history and nature of landform development and to result in refinement of the formal physiographic boundaries.

These reports were prepared and remained in the hands of editors at the end of the year: (a) Gray, H. H., Landscape stability in southern Indiana and its geomorphic significance: Science, 6 p., 1 fig.; (b) -----, Geomorphic significance of stability of southern Indiana landscapes (abs.): Geol. Soc. America Special Paper, 2 p.

2. Pleistocene geology of northern Indiana. This new project is to produce information on the stratigraphy and materials of Pleistocene deposits and to result in synthesis of Pleistocene historical events and environments.

3. Stratigraphy of upper Chester rocks. This project, begun in 1966-67 was brought to a stage of 50-percent completion. All the primary data have been gathered, which includes that from as many as 500 electric and other subsurface logs for southwestern Indiana; interpretation, writing, and preparation of illustrations remain.

4. Stratigraphy of Cincinnatian rocks in Indiana. This project was advanced from 50- to 95-percent completion through completion of data gathering and preparation of most of two manuscripts (for Special Report series and outside publication). The scope includes surface and subsurface considerations throughout the state, and computer methods were used in log and map making and in correlation.

Biostratigraphy, paleontology, and paleoecology.—1. Conodont biostratigraphy of the upper part of the Borden Group and of the Sanders Group (middle Mississippian). This new project was begun during the year for the purpose of establishing conodont biostratigraphic zones, correlating these zones and the rock units with Mississippi Valley units, and studying lithologic and sedimentational interrelationships.

2. Middle Paleozoic geology of the southern part of the Michigan Basin. This project, described in earlier annual reports was advanced by completion of much of the laboratory work needed to recover conodont faunas for study and by submission of these reports for outside publication: (a) Nicol, R. S., and Rexroad, C. B., Divergent or convergent evolution in conodonts (abs.): Geol. Soc. America Special Paper, 2 p.

(b) Pollock, C. A., Questionable Silurian natural conodont assemblages from Indiana (abs.): Ibid., 2 p.

(c) -----, Fused Silurian conodont clusters from Indiana: Jour. Paleontology, 23 p., 3 pls., 1 fig.
3. In separate projects, but related to that described under no. 2 above, these reports were submitted for publication and remained in editorial hands at the end of the year: (a) Nicoll, R. S., and Rexroad, C. B., Stratigraphy and conodont paleontology of the Salamonie Dolomite and Lee Creek Member of the Brassfield Limestone (Silurian) in southeastern Indiana and adjacent Kentucky: Indiana Geol. Survey Bull., 139 p., 7 pls., 3 figs., 2 tables.

(b) Orr, R. W., Middle Devonian conodonts from northern Indiana (abs.): Geol. Soc. American Special Paper, 2 p.

4. Conodonts from the Jacobs Chapel Shale. The project, described in earlier reports, was completed with submission of this manuscript that remained unpublished at the end of the year: Rexroad, C. B., Conodonts from the Jacobs Chapel Bed of the New Albany Shale in southern Indiana: Indiana Geol. Survey Bull., 100 p., 4 pls., 2 figs., 1 table.

5. Biostratigraphic studies of Kope (Cincinnatian) bryozoans. This project, described in the 1966-67 report was advanced by the continued and near completion of the laboratory work and by partial compilation of a manuscript.


Editorial, committee, educational, and miscellaneous activities.---1. Most permanent members of the section belong to intra- or extra-Survey committees or perform editorial, report-reviewing, and chairmanship duties for the Survey and other organizations. In such capacities (a) the Geologic Names Committee handled 30 manuscripts of record during the year; it also completed a project of long standing by submitting this report: Shaver, R. H., and others, Compendium of rock-unit stratigraphy in Indiana: Indiana Geol. Survey Bull., 379 p., 1 fig., 7 tables (unpublished at end of year); (b) Schneider and Wayne served on committees dealing with reservoir silting and waste disposal (mentioned in the applied activities); (c) Schneider was chairman of the Geology and Geography Section, Indiana Academy of Science, 1967 meeting, was cochairman of the Pleistocene geology session, Geological Society America, 1967 meeting, and served on the membership committee, Indiana Academy of Science; (d) Shaver continued as one of two editors of the Journal of Paleontology for the Society of Economic Paleontologists and Mineralogists; and (e) Wayne was elected 1968 president of the Indiana Academy of Science.

2. The section disseminated educational and similar informative knowledge through the media of hundreds of letters, 185 conferences of record, several reports, and 18 lectures of record. Two examples are: (a) Wayne, W. J., Rocks and their relatives: Outdoor Indiana, 10 p., 4 figs. (unpublished at end of year), and Wayne's class on "Environmental and Urban Geology," offered through Indiana University during the spring of 1968.
During the past year the Geophysics Section worked on field surveys by seismic refraction, seismic reflection, gravity and electrical methods. In the laboratory measurements were made of the density, resistance to abrasion, crushing strength, radioactivity and other properties of rocks that influence their uses and serve as guides to their location. In order to assimilate and make meaningful the large volume of data that was obtained from field and laboratory projects, the Geophysics Section operated both digital and analog computers. The Section also operated a Failing Model 1500-S rig capable of drilling and coring to depths of 1,000 feet, and a truck-mounted auger capable of augering to depths of 100 feet.

Seismic Surveys

Two counties were surveyed by seismic refraction methods during the year and several smaller projects were done at scattered locations in the State. Although the seismic shots were made to measure the thickness of unconsolidated deposits at particular locations, the purpose of the work was quite different in each of the counties mapped.

In Henry County seismic refraction profiles were shot throughout most of the county in order to supplement drilling information on bedrock stratigraphy. Bedrock topography was mapped in order that stratigraphic units might be projected across drift-covered portions of the county.

Shooting was done in Daviess County to map the bedrock topography in order to obtain information on the thickness of overburden, depth to coal layers, and areas where coal deposits have been removed by erosion. This work was done to supplement county coal investigations by the Coal Section.

Refraction shooting also was done along the White River in Lawrence County in connection with a ground water problem in that area. Measurements were made to determine the thickness of valley fill along the river. Seismic work was supplemented by electrical resistivity measurements to learn the type of materials that fill the valley and their probable porosities.

The largest effort by the Geophysics Section in seismic exploration was made through west-central and southern Indiana. Seismic reflection shots were made over that portion of Indiana that is underlain by the Borden Group of rocks. The purpose of this work was to attempt to detect changes in rock types within the Borden from one place to another by means of reflections from different layers. The project had the secondary purpose of adding to our knowledge of the thickness of sedimentary rocks and depth to the pre-Cambrian basement in southern Indiana.

A smaller reflection survey was made in Martin County in an attempt to get shallow reflections from rocks associated with the gypsum deposits. This project was coordinated with gravity and electrical surveys in an effort to map the edge of the gypsum deposits and learn if solution cavities associated with the gypsum can be detected by geophysical methods.
Laboratory Studies

In addition to the routine testing of rock samples for resistance to abrasion, crushing strength, absorption, specific gravity and elastic properties some new laboratory procedures were added during the year. The Geology Department of Indiana University has obtained and made available to the Geophysics Section a Seismoline Analog Computer and a magnetic record playback center. These instruments have proved to be powerful tools for the computation of seismic data. Geophysicists from the Geological Survey are making extensive use of these facilities.

Along a similar line of research a program is underway to convert some of the numerous electric logs of wells in the State to velocity information for seismic computations. This effort will contribute to the seismic field program by providing velocity information at well locations throughout the State for accurate depth computations.

The Geophysics Section's supervision of the Geological Survey's digital computer required a considerable effort during the year. In addition to assisting the geologic staff in programming and in setting up problems for computation, several challenging maintenance and repair difficulties were solved with a minimum of "down time" for the computer.

The program to encode data from all of the thousands of oil wells for which the Survey has records continued. By the end of the year well data from nearly all of the counties had been punched onto cards. The eight counties that remained to be done, those in the southwestern corner of the State, were those with the heaviest concentration of wells. When completed this project will enable geologists to call for data on location, depth, production and formations and even to print out structural contour maps of particular rock units.

At the end of the year all seismic information available in the Geophysics Section was printed by the computer and distributed to interested persons.

INDUSTRIAL MINERALS SECTION

Industrial minerals produced in Indiana in 1967 were valued at $191,000,000, 65 percent of the state's mineral production. These minerals, which include limestone, dolomite, gypsum, sand, gravel, sandstone, clay, shale, peat, and marl as well as processed products such as cement, lime, and lightweight aggregate, are widely distributed throughout the state and are thus of direct interest to a large number of citizens. Because of their bulk, low unit value, and high transportation cost, production of these minerals is as dispersed as the resources themselves and requires some 300 active quarries and pits, as well as a small number of underground mines. Many of the mineral operations can be characterized as small business. Moreover, the very abundance and wide distribution of industrial minerals make it impossible for even a large company to maintain adequate information on their distribution, composition, and other geological considerations, such as thickness of overburden. State Geological surveys do have the capacity to gather and provide this information to mineral producers and citizens and thus play an important role in the state and national economy. Through the foresight of Indiana's
legislature of the 1940's and its continued support in the 50's and 60's, the Indiana Geological Survey has become one of the most competent organizations in the country to assist industry in its efficient development of our mineral resources.

Research Projects

The following list summarizes the projects which were active during the year and indicates their possible benefit to the people of Indiana:

1. Origin of the gypsum deposits in northern Indiana. - In June 1964 the Indiana Geological Survey discovered a thick bed of gypsum near LaPorte, and reported on that discovery both in talks and publications. Since that time, a chapter on the deposits in northern Indiana incorporating additional information obtained by Survey and other drilling has been prepared for the Mineral Resources Volume. A study of the insoluble residues and the texture of the deposits will be published in a national journal in September 1968. Through talks at Calgary, Alberta, L'Esteral, Quebec, and Socorro, New Mexico, further national attention was brought to these deposits in 1967-68 and further exploration was encouraged. Members of the section worked closely with industry concerning the possible development of these deposits.

2. Economic Geology of the Devonian and Silurian Rocks. - The report summarizing the results of this study was submitted to the publisher late in the fiscal year and will probably be available for distribution early this fall. This summary of geologic information on the State's largest source of industrial limestone is expected to be of great value to industry.

3. Economic Geology of Blue River Rocks. - As part of this project, a companion study to the study of the Devonian and Silurian rocks, the Survey took about 15 cores along the outcrop belt from Harrison to Putman County. These cores have been described and samples submitted for chemical analysis. In addition, stratigraphic sections exposed in a number of active and abandoned quarries were measured and described. In response to one of a number of service requests having to do with this group of rocks, the survey provided assistance in locating a new quarry site near English, Crawford County. This quarry will go into production in 1968.

4. Electronic Sorting of Gypsum. - The results of this project, completed early this fiscal year, will be published in a forthcoming issue of A.I.M.E. Transactions. An earlier study conducted by the Survey on the beneficiation of gypsum indicated that low purity gypsum deposits such as those in southern Indiana in which the only significant contaminants are limestone and dolomite. In the deposits presently being worked in southern Indiana, where shale is a significant contaminant, electronic color sorting could separate the white gypsum from the darker dolomite and shale.

5. Sand and Gravel Resources Along the Upper Reaches of the Ohio River. - This project got well underway during the past year when a large number of holes were augered in Switzerland, Jefferson, and Clark Counties. Gravel pits and natural exposures were also described and sampled. Reserves of coarse gravel are large in the bottoms along the Ohio River, and this study should allow the Survey to delineate the most favorable areas for exploration and estimate the total reserves.

6. Limestone and Dolomite Resources Along the Ohio River. - This study will gather together all available information on the limestone resources available to barge transportation on the Ohio River. It will emphasize the availability of Mississippian, Devonian, and Silurian carbonate rocks from Perry to Jefferson Counties but also provide information
as to the drilling depth to thick units of limestone in Posey, Vanderburgh, Warrick, and Spencer Counties in southwestern Indiana and drilling depth to the Trenton-Black River rocks in Switzerland, Ohio and Dearborn Counties in southeastern Indiana. It is unlikely that underground mining of limestone will ever take place in southeastern Indiana, but subsurface information indicates that large reserves of some suitable for cement and aggregate could be mined at about 300 feet depth in southeastern Indiana. This project is about 50 percent complete.

7. The Economic Geology of the Upper Block Underclay of Clay County, Indiana.- All available data on the distribution, thickness, and thickness of overburden of the upper block underclay in Clay County was compiled and plotted on a map for the benefit of interested clay producers. This study is essentially complete and has been placed on open file for possible publication at a later date.

8. Physical and Chemical Properties of the Brassfield Limestone.- This project needs only statistical analysis to be complete. It is an attempt to look at one stratigraphic interval in terms of its physical and chemical characteristics to determine the relationship between them and the quality of the stone as aggregate.

9. Limestone and Dolomite Resources of northernmost Indiana.- This project, begun in the latter part of the fiscal year, focuses mainly on the limestone immediately overlying the gypsum deposits of LaPorte County. These limestones, which lie at approximately 300 feet drilling depth, are being tested for their suitability as aggregate and analyzed for their suitability as cement raw material. Northernmost Indiana, approximately one-sixth of the area of the state, has no quarries but almost one-third of the state's population. In contrast, the remaining five-sixths of Indiana has about 90 quarries. (If limestone were available at the surface, one would expect on the basis of geography more than 10 quarries in northernmost Indiana.) With its large population, dense highway network, and intense farming, northern Indiana is an excellent market for aggregate and agriculture limestone, but all limestone must be imported, most from counties to the south and from Illinois.

10. Data on Abandoned Limestone Quarries in Indiana.- Late in the fiscal year, a compilation of data on all the abandoned limestone quarries in Indiana was begun. This project, which has less priority than most projects, is intended to extend over a number of years. In Indiana, whose humid climate results in few natural exposures of limestone, active and abandoned quarries are often the best source of stratigraphic information. Abandoned quarries are also guises in the exploration for new sources of limestone. Once the information on abandoned quarries is compiled, survey directories, miscellaneous maps and memorandum reports will make it easy to keep this record up to date.

Services

We received 207 service requests during 1967-68, up 12 percent from the previous year. Many of these requests bear directly on the exploration for new sources of the aggregate, high calcium limestone, high purity dolomite, gypsum, gravel, shale, and cement raw materials. Other requests enabled us to help solve problems that have arisen in current mineral production. Robert French's paper on the electronic sorting of gypsum given at the annual fall meeting of the Society of Mining Engineers was a step both towards the more efficient exploitation of the gypsum deposits.
in southern Indiana and the potential exploitation of the deposits in northern Indiana.

A new directory and a new map showing the location of crushed stone producers in Indiana were issued during this year.

Most service requests are answered by a letter. In a few instances the information gathered is considered of general interest and filed for future reference as an Industrail Minerals Section (IMS) memorandum report. The following memorandum reports were prepared in 1967-68 and placed on open file:

Rooney, L. F., 1967, Results of physical testing of samples of Salem Limestone treated by Professor Seymour Lawin, New York University, IMS 45, 10 p., 2 tables, 5 histograms, pertinent correspondence.


Webb, W. M., 1968, Insoluble residues in three sand samples from the Indianapolis area, IMS 47, 3 pages, correspondence.

French, R. R., 1968, Mineral resources of Madison County, Ind., IMS 49, 6 p., 1 graph, 2 tables.

Ault, D. H., 1968, Physical tests of Geneva dolomite subbase aggregate from the Cave Stone Co. quarry, Flat Rock, Indiana, IMS 50, 6 p., 3 tables, 1 graph, correspondence.

Committees

Lawrence F. Rooney was elected chairman of the steering committee of the Forum on Geology of Industrial Minerals for 1968-69. He was also named Indiana’s representative on the Minerals Resources Work Group of the Great Lakes Basin Study Commission, in which capacity he is responsible for reviewing the economic geology of northern Indiana and the future prospects for the mineral resources of that area. Donald Carr was the Survey’s representative on the Natural Stream Task Force.

In July, members of the section hosted the annual summer meeting of the Indiana Mineral Aggregates Association. They conducted a field trip through the Survey’s laboratories and a dimension stone quarry and mill.

Papers


Members of the Industrial Minerals Section gave talks at a number of national meetings during the year. On September 8, Robert French spoke on the electronic sorting of low grade gypsum deposits at the Fall meeting of the Society of Mining Engineers in Las Vegas. On September 6, Lawrence Rooney spoke on insoluble residues in the northern Indiana evaporites at the International Symposium on the Devonian System in Calgary, Alberta. On September 25, he spoke on the origin of the northern Indiana evaporites before the I. U. Geology Colloquium, and on October 3 he spoke on the same subject at a joint meeting of the Canadian and American Institute of Mining Engineers at L'Esterel, Quebec. On May 2, he addressed the Fourth Idea Conference in Socorro, New Mexico on the role of industrial minerals geologists.

MINERAL STATISTICIAN

The combined value of mineral production and items or materials manufactured from minerals in Indiana continued the upward trend which began in 1962, reaching a total of $293,218,511.00 for 1967, an increase of 3.54 percent over the previous year (see table attached). Certain mineral industries, such as the clay products industry, imported part of the raw material requirements from outside the state. The method of reporting makes it impossible to determine precisely how much of the manufactured products total is ascribable to imported minerals, but the estimated net value, based entirely on Indiana raw materials is $284,474,461.00.

Thirty-six counties attained production values in excess of $1 million, exclusive of oil, natural gas, and peat, and accounted for 96.7 percent of the total non-petroleum mineral production of the state. Of these 36 counties, 13 had mineral production in excess of $5 million and accounted for 76.8 percent of the non-petroleum total. These 13 counties, mostly in the southwestern quarter of the state, are listed below, with the commodities produced.

$20 million +
- Clay County
- Lake County
- Lawrence County
- Warrick County

$15 - $20 million
- Clark County

Clay products, coal.
Cement, clay products, sand and gravel.
Cement, crushed limestone, dimension limestone, dimension sandstone.
Coal, crushed limestone, sand and gravel.
Cement, crushed limestone, sand and gravel.
$10 - $15 million

Greene County  Clay products, coal, sand and gravel.
Monroe County  Crushed limestone, dimension limestone, dimension sandstone.
Pike County    Coal.
Putnam County  Cement, clay products, crushed limestone, sand and gravel.
Sullivan County Coal, crushed limestone, sand and gravel.

$5 - $10 million

Cass County  Cement, crushed limestone, sand and gravel.
Howard County Clay products, crushed limestone, sand and gravel.
Jackson County Clay products, sand and gravel.

Twenty-three counties reported mineral production valued between $1 million and $5 million, and eleven counties had production valued between $100,000 and $1 million.

All construction materials, with the exception of dimension sandstone and products manufactured from clay and shale, showed gains ranging from slightly less than 1 percent to slightly more than 21 percent in value. The decline in the manufacture of building brick can be explained by the fact that three large plants ceased operation in Indiana. A large contract, under which several companies in the building limestone district shipped relatively inexpensive breakwater stone for the new Indiana port on Lake Michigan, accounts for the unusually large increase in volume as compared with the increase in value from 1966.

Production of crushed limestone for use in concrete and as road stone increased 15.79 percent in volume and 18.38 percent in value over the previous year, more than offsetting decreases for most other uses.

An increase of 2.93 percent in the quantity of sand and gravel produced for paving purposes was not enough to offset the 6.83 percent decrease in the amount produced for building purposes, but an increase in the price per ton resulted in a 14.03 percent increase in value of material produced for paving purposes, and a 2.85 percent gain over 1966 in value for material produced for all purposes.

Construction materials accounted for 64.79 percent and fuels accounted for 34.75 percent of the total value of minerals produced in Indiana in 1967.

The continued increase in coal production offset declining production of petroleum and natural gas for an overall increase of 4.31 percent in value of fuels.
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<td>- 5.04</td>
<td>- 5.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay and Shale (Raw material) (Mfd. products)</td>
<td>1,500,931T</td>
<td>48,186,723.00</td>
<td></td>
<td>1,457,531T</td>
<td>41,306,202.00</td>
<td>- 2.89</td>
<td>- 14.28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone, dimension</td>
<td>5,406,734 cf</td>
<td>16,792,091.00</td>
<td></td>
<td>11,850,155 cf</td>
<td>20,364,538.00</td>
<td>+119.17</td>
<td>+ 21.27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone, crushed</td>
<td>23,873,448T</td>
<td>30,396,591.00</td>
<td></td>
<td>26,298,817T</td>
<td>34,451,767.00</td>
<td>+ 10.15</td>
<td>+ 13.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand and Gravel</td>
<td>26,526,056T</td>
<td>24,545,068.00</td>
<td></td>
<td>25,627,542T</td>
<td>25,245,336.00</td>
<td>- 3.39</td>
<td>+ 2.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Gas</td>
<td>115,245,230 cf</td>
<td>18,439.00</td>
<td></td>
<td>84,041,000 cf</td>
<td>13,026.00</td>
<td>- 27.00</td>
<td>- 29.36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peat</td>
<td>38,111T</td>
<td>456,444.00</td>
<td></td>
<td>42,962T</td>
<td>441,000.00</td>
<td>+ 12.73</td>
<td>- 3.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marl</td>
<td>72,580 cy</td>
<td>49,605.00</td>
<td></td>
<td>44,482 cy</td>
<td>35,394.00</td>
<td>- 38.71</td>
<td>- 28.65</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Undistributed
Wetstones, Gypsum (crude), Cement (alumina), Quartz, crushed, Recovered sulfur, Dimension Sandstone, Lime.

TOTAL
285,135,549.00

TOTAL (adjusted to avoid duplication of values for clay, stone, sand used in cement manufacture)

$283,091,950.00

11,224,587.00

$293,218,511.00
Work in the Petroleum Section during the year followed lines adhered to for many years. It consisted of services, projects that recur annually, projects related to a long-standing program of records improvement and subsurface study projects.

Services

The files of the Petroleum Section contain records of approximately 50,000 wells. These comprehensive files are the principal media of studying the subsurface geology of Indiana, and they are used continuously by geologists of the Geological Survey and by the public.

All work related to the well-records files is considered to be service work. This work consists of correspondence and conferences about records in the files, continuous maintenance of the files and continuous expansion of the files. Expansion usually is directly related to the completion of new wells. At times, however, expansion comes about by acquisition of data on wells drilled long ago for which the Geological Survey had collected no records.

Service work consumes a very considerable portion of the total energies of the Petroleum Section.

Annual Projects

Five projects carried out by the Petroleum Section involve work of a nature that is repeated annually.

Indiana Drilling Statistics.--The official drilling statistics for the United States are compiled by the American Association of Petroleum Geologists' Committee on Statistics of Drilling. A Petroleum Section geologist has for many years served as a member of the AAPG-CSD; his duties are to tabulate statistics for all oil and gas industry drilling in Indiana by a standardized classification format. The statistics developed by the AAPG-CSD are published by the American Association of Petroleum Geologists and by the American Petroleum Institute. The published statistics show drilling by well categories, by states. The statistics most recently compiled by the AAPG-CSD are for the calendar year 1967.

Indiana Exploration Developments.--Papers dealing with oil and gas exploration within the United States, and significant developments resulting therefrom, are prepared at the close of each calendar year and published by the American Association of Petroleum Geologists. A Petroleum Section geologist compiles the annual paper on oil and gas exploration in Indiana. The most recently compiled paper is for the calendar year 1967.

Indiana Oil Production.--Statistics on oil production in Indiana are prepared annually, on a calendar year basis, in the Petroleum Section. These statistics, which show oil production by fields, have been published
by the Geological Survey each year since 1954. Indiana oil production
statistics for 1967 were compiled after the close of the calendar year
and have been readied for publication.

Reserves.—The American Petroleum Institute annually compiles the
official crude oil reserves figures for the United States, by states.
This is accomplished by a national committee and numerous subcommittees.
The Petroleum Section has been represented on the national committee for
the past 5 years and on the Illinois-Indiana-Kentucky subcommittee for
18 years. The most recently compiled reserves statistics are for the
calendar year 1967 and have been published by the American Petroleum
Institute.

Petroleum Exploration Map Series.—The Petroleum Exploration Map
Series consists of county well-location maps, scale 1 inch equals 1 mile.
These maps show wells by the standard classes (dry hole, oil well, gas
well, etc.) and total depths. The map series is most pertinent to the
study of Indiana subsurface geology and to exploration for subsurface
mineral deposits. It has been developed through 18 years of continuous
effort.

The individual maps of the Petroleum Exploration Map Series are
kept up to date on a daily basis in the Petroleum Section. At the close
of each calendar year these up-to-date maps are turned over to the Drafting
Section so that the master transparencies can be updated. Copies of the
updated transparencies then are made available to the public through the
Publications Section. The Petroleum Exploration Maps, thus, are available
to the public at all times on an essentially current-status basis.

There are 91 county maps in the Petroleum Exploration Map Series.
Of these, 89 were maintained during the year and two were added during
the year. The maps added were for Madison and Hamilton Counties. The
one county for which there is not yet a well-location map is Tipton.

Records Improvement Program

A program of upgrading well records has been conducted by the
Petroleum Section for 18 years. This program has been dictated by
the fact that for the many years during which the Geological Survey
received little financial support care of well records was neglected.
Well records that have not been accurately catalogued, and for which
correct location and elevation determinations have not been made, serve
little purpose.

Work in upgrading well records consists of field-checking well
locations and elevations and reviewing all well data (samples, cores,
geophysical logs, drillers logs, drilling-time logs, scout tickets, etc.)
The upgrading program is carried out on a county-project basis, and at
this time projects covering 82 of Indiana's 92 counties have been
completed. Projects worked on during the past year are reported below.

Madison County.—The Madison County project, involving approximately
1300 wells, was completed. The well-location map resulting from this
project was added to the Petroleum Exploration Map Series.
Hamilton County.--The Hamilton County project, involving approximately 850 wells, was completed, and the well-locatation map resulting from the project was added to the Petroleum Exploration Map Series.

Tipton County.--Work on Tipton County, which involves about 475 wells, has been carried to an advanced stage and should be completed within two months.

Howard County.--Howard County records were upgraded in 1962. Subsequent to completion of that 1962 project, however, a large group of logs from old Howard County wells became available to the Geological Survey, necessitating a second Howard County project. This second project, involving approximately 200 wells, has been started and will be completed within two months.

Jay County.--Most of the oil-producing area of the old Trenton Field lies in 7 counties—Adams, Wells, Huntington, Jay, Blackford, Grant and Delaware. In the well-records upgrading program, these counties have been left to the last because there is considerable question as to the degree of success that can be realized in field checking the tens of thousands of wells drilled in them. Most wells drilled in the Trenton Field have been abandoned for 40 or 50 years with the result that there is seldom conspicuous surface evidence of well locations. Furthermore, few people are alive today who have personal knowledge of wells drilled in the Trenton Field.

The Jay County project should be regarded as a pilot project; if the results of work in Jay County prove to be satisfactory, projects for other counties in the oil-producing area of the Trenton Field will be undertaken. Jay County was chosen from the Trenton Field oil-producting counties as a starting place because of current interest in exploration for Knox oil in the southwestern part of the county. Improvement of Jay County well records would facilitate any exploration effort within the county.

Work in Jay County is barely under way, being only 5 percent completed.

Trenton Field Sample Sets.--The sample library, a part of the Petroleum Section well-records files, contains approximately 250 sample sets from wells drilled in the Trenton Field. Because of the importance of these records, and because of the amount of time that will be involved in upgrading all records for the Trenton Field (if such proves to be feasible), it was decided to upgrade all records pertaining to the 250 sample-set wells as a separate project. There is little doubt but that this can be done effectively and that the project can be carried to completion during the coming year. At this time the project is 20 percent completed.

Subsurface Studies

Indiana Brines.--Brines from Indiana wells have been collected periodically for 9 years. These brines have been analyzed by the Geochemistry Section, and they have been collected in groups, and at times, designated by the Geochemistry Section. The brine-collection project is being brought to a close; only two brine samples were added in the past year.
The analyses of the brines collected, 232 in all, plus many brine analyses collected from the oil and gas industry, comprise significant subsurface data. They will permit interpretation of the approximate character of brines in undrilled areas and should be, therefore, the basis of a very worthwhile publication.

Devonian and Silurian. -- Study of the Devonian and Silurian rocks of the Illinois Basin part of Indiana was initiated in 1962. Work on the project has been delayed from time to time, but it is now near completion. Results of the study will be published by the Geological Survey as a bulletin.

Most of the rocks of the Devonian and Silurian in the Illinois Basin are comprised of a thick sequence of carbonates as much as 1400 feet in thickness. Only a small part of this carbonate sequence crops out in Indiana, and thus it can be studied comprehensively only in the subsurface. Maps compiled in studying the Devonian and Silurian will show for the first time the thickness and areal extent in Indiana of the individual units that comprise the carbonate sequence. The publication conveying the findings of the Devonian-Silurian study will be very useful.

Studies similar to the Devonian-Silurian subsurface study would be appropriate for several parts of the Indiana rock column.

PUBLICATIONS SECTION

The Indiana Geological Survey publishes maps and reports to inform the public of the results of field and laboratory investigations. Geologic reports are issued currently as Bulletins, Circulairs, Guidebooks, Mineral Economics Series, Reports of Progress, and Special Reports. Maps are issued currently as Atlas of Mineral Resources of Indiana Maps, Petroleum Exploration Maps, Base Maps, Preliminary Coal Maps, Miscellaneous Maps, and Regional Geologic Maps.

The Publications Section conducts the publishing program of the Indiana Geological Survey. This section, in cooperation with the Drafting and Photography Section, prepares maps and reports for printing. To improve the appearance of the reports and to make them more attractive to readers, the Publications and Drafting and Photography Sections have changed the arrangement of text and headings on the page and the type faces and sizes used and have begun to use color and artwork and photography on the covers. And to help decrease typesetting, proofreading, and printing costs and thus to stretch printing dollars, the Indiana Geological Survey has purchased an IBM "Selectric" Composer. This machine enables typesetting for offset printing to be done in the Publications Section.

The Publications Section informs the public of new reports and maps as they are issued and handles all matters pertaining to the sale and distribution of publications. This section works with the Geology Library of Indiana University in carrying on an exchange program with geologic institutions in the United States and in foreign countries.
The Publications Section also handles the sale and distribution of maps published by the U. S. Geological Survey in cooperation with the Department of Natural Resources and the Indiana Geological Survey, such as topographic quadrangle maps and total intensity aeromagnetic maps; supervises the operation and maintenance of a Xerox 2400 copier for the Geological Survey and the Indiana University Department of Geology; and operates and maintains a postage meter machine for the Geology Building at Indiana University.

During the past fiscal year the Publications Section sold 8,944 reports and 6,605 maps. The section sent 455 reports and maps on exchange to institutions in the United States and in foreign countries. It also distributed without charge 740 reports and 1,647 maps to members of its own organization and to individuals, libraries, and companies in the United States and abroad. The Publications Section sent one general publications announcement to companies, schools, and individuals; served 2,873 office customers; and handled 2,465 letters pertaining to geologic reports and maps.

Publishing new reports and maps and sending announcements of new publications were curtailed especially during the latter half of the fiscal year because of uncertainty regarding the availability of printing and binding funds. Eight reports and one map were reprinted during the fiscal year. The best seller of Indiana Geological Survey publications is Circular 5, "Let's Look At Some Rocks," by William J. Wayne. Since it was published in the fall of 1958, 23,000 copies have been printed. Its excellent sales record is due in part to its use by the Agricultural Extension Service of Purdue University for 4-H clubs in Indiana.

Publications Released by The Geological Survey During 1967-68

Base Maps


Miscellaneous Maps


Petroleum Exploration Maps

Well location maps showing total depth of wells for the following counties were revised as of December 31, 1967: Warrick County (3A), Sullivan County (4A), Vigo County (5A), Greene County (13A), Clay County (14A), Parke County (15A), Vermillion County (16A), Owen County (18A), Dubois County (21A), Knox County (23A), Lawrence County (25A), Daviess County (26A), Crawford County (28A), Harrison County (30A), Spencer County (39A), Perry County (40A), White County (42A), Clinton County (44A), Boone County (45A), Jennings County (46A), Scott County (48A), Clark County (49A), Floyd County (50A), Pike County (51A), Vanderburgh County (52A), Noble County (57A), Dekalb County (58A), Allen County (59A), Kosciusko County (61A), Marshall County (64A), Fulton County (65A), Cass County (66A), Pulaski County (67A), LaPorte County (69A), Jasper County (71A), Newton County (72A), Lake County (73A), Miami County (74A), Wabash County (75A), Switzerland County (84A), Ripley County (87A), Franklin County (88A), Fayette County (90A), Randolph County (92A), Henry County (93A), Hancock County (94A), Decatur County (95A), Shelby County (96A), and Rush County (97A).

Well location maps for the following counties were revised as of December 31, 1967: Warrick County (3B), Sullivan County (4B), Vigo County (5B), Greene County (13B), Clay County (14B), Dubois County (21B), Knox County (23B), Daviess County (26B), Harrison County (30B), Spencer County (39B), Perry County (40B), Pike County (51B), Vanderburgh County (52B), Gibson County (53B), Posey County (54B), Huntington County (76B), Wells County (77B), Adams County (78B), Jay County (79B), Delaware County (81B), and Grant County (82B).

Well location maps showing total depth of wells for the following counties were checked without revision as of December 31, 1967: Martin County (12A), Fountain County (17A), Putnam County (19A), Montgomery County (20A), Jackson County (22A), Monroe County (24A), Orange County (27A), Washington County (29A), Brown County (31A), Bartholomew County (32A), Hendricks County (33A), Marion County (34A), Morgan County (35A), Johnson County (36A), Tippecanoe County (37A), Warren County (38A), Benton County (41A), Carroll County (43A), Jefferson County (47A), Steuben County (55A), Lagrange County (56A), Whitley County (60A), Elkhart County (62A), St. Joseph County (63A), Starke County (68A), Porter County (70A), Howard County (83A), Ohio County (85A), Dearborn County (86A), Union County (89A), and Wayne County (91A).

Well location maps for the following counties were checked without revision as of December 31, 1967: Martin County (12B) and Blackford County (80).