

101ST ANNUAL REPORT OF THE STATE GEOLOGIST

of

INDIANA GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES

for

July 1, 1976 - June 30, 1977

GEOLOGICAL SURVEY
ONE HUNDRED AND FIRST ANNUAL REPORT OF THE STATE GEOLOGIST

PERSONNEL

Permanent Personnel

Administration

John B. Patton. State Geologist
Maurice E. Biggs. Assistant State Geologist
Mary Beth Fox Mineral Statistician

Coal and Industrial Minerals Section

Donald D. Carr. Geologist and Head
Curtis H. Ault. Geologist and Associate Head
Harold C. Hutchison Geologist and Associate Head
Pei-Yuan Chen Geologist
Donald L. Eggert. Geologist
Walter A. Hasenmueller. Geologist
Michael C. Moore. Geologist
Nelson R. Shaffer Geologist
John F. Hickman Geological Assistant
Bonnie Burks. Secretary
Pamela Carter Secretary

Drafting and Photography Section

William H. Moran. Chief Draftsman and Head
Richard T. Hill Geological Draftsman
Robert E. Judah Geological Artist-Draftsman
Roger L. Purcell. Senior Geological Draftsman
George R. Ringer. Photographer
Wilbur E. Stalions. Geological Artist-Draftsman
(From April 26, 1977)

Educational Services

Reevan Dee Rarick Geologist

Geochemistry Section

Richard K. Leininger. Geochemist and Head
Margaret V. Golde Instrument Analyst
Joseph G. Hailer. Geochemist
(From September 15, 1976)
Louis V. Miller Coal Chemist
Pamela Carter Secretary
(Shared with Industrial Minerals Section)

Geology Section

Robert Shaver Paleontologist and Head
Ned K. Bleuer Glacial Geologist
Henry H. Gray Head Stratigrapher
Edwin J. Hartke Environmental Geologist
John R. Hill Glacial Geologist
Carl B. Rexroad Paleontologist
Martha N. Smith Secretary

Geophysics Section

Maurice E. Biggs. Geophysicist and Head
Robert F. Blakely Geophysicist
John R. Helms Driller
Marvin T. Iverson Geophysical Assistant
Joseph F. Whaley. Geophysicist
Rebecca Covey Secretary

Petroleum Section

Leroy E. Becker Geologist and Head
Gerald L. Carpenter Geologist and Associate Head
Andrew J. Hreha Geologist
Stanley J. Keller Geologist
Dan M. Sullivan Geologist
Pat Hall. Secretary and Curator of Records
Wilma Fisher. Senior Records Clerk
Sherry Cazee. Geological Assistant
James T. Cazee. Geological Assistant
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Gerald S. Woodard Editor and Head
Marsha L. Rohleder Senior Sales and Records Clerk
(To November 18, 1976)
Pat Gerth Senior Sales and Records Clerk
(From December 6, 1976)

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(August 22, 1976 to January 22, 1977)
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(July 1, 1976 to June 30, 1977)
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 (July 1, 1976 to April 16, 1977)
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 (July 1, 1976 to May 14, 1977)
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 Beverly Monts. Laboratory Assistant
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 (August 8, 1976 to May 29, 1977)
 Laura Taylor Laboratory Assistant
 (July 1, 1976 to August 20, 1976)
 Allen Trout. Laboratory Assistant
 (July 1, 1976 to March 19, 1977)
 Amy Wiltshire. Laboratory Assistant
 (June 3, 1977 to June 30, 1977)

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 Paul Friesen Programming Assistant
 (July 1, 1976 to August 7, 1976)

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(May 25, 1977 to June 30, 1977)

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(July 1, 1976 to July 24, 1976)
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Steve Loner. Laboratory Assistant
(March 6, 1977 to June 30, 1977)

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(September 19, 1976 to November 27, 1976)

Kim Mack Laboratory Assistant
(September 5, 1976 to April 30, 1977)

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John Nasser. Laboratory Assistant
(July 1, 1976 to March 19, 1977)

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(February 28, 1977 to June 30, 1977)

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(August 24, 1977 to August 26, 1977)

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(July 11, 1976 to August 21, 1976)

STATISTICAL SUMMARY OF ACTIVITIES FOR FISCAL 1976-77

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

Projects in Progress	47
Projects completed	9
Conferences with visitors to the Survey.	801
Telephone conferences.	1,315
Man days of field work	1,305
Incoming letters	3,759
Outgoing letters	2,368
Special mailings	277
Total number of Survey vehicles.	20
Total number of miles traveled in Survey vehicles.	209,681
Thickness of stratigraphic sections measured	5,027
Number of stratigraphic sections measured.	116
Public lectures (total).	39
Civic	5
Industrial	1
School	19
Other	14
Papers presented at professional meetings	11
Field trips for the public	10
In connection with conferences	13
Educational	9
Industrial	1
Special field trips (conference).	76
News releases submitted	16
Attendance at professional meetings	66
Exhibits prepared for special occasions	8
Samples received or collected	870
Rocks, Minerals	664
Fossils	206
Identifications (Rocks, Minerals, Fossils)	300
Packets of geologic education material sent	78
Special rock sets for teachers	10
Rock and mineral sets sent	40
Heavy mineral separations made	141
Rock analyses (magnetic, mineralogical, textural and physical)	3,110
Spectrographic analyses (qualitative).	2,420
Spectrographic analyses (quantitative)	63
Fluid-inclusion analyses	4
Brightness tests	2
X-ray chemical analyses	76
X-ray mineralogic analyses	354

Seismic refraction shots	387
Feet of hole drilled	3,692
Feet of core recovered	1,398
Feet of hole augered	2,200
Feet of core described	2,308
Oil wells field checked (current drilling)	486
Well cutting sets catalogued and filed	201
Well cores catalogued and filed	10
Strip logs made (wells).	201
Feet represented on strip logs	293,988
Camara copies made	773
Field photographs	115
Black and white prints	938
Diazo prints	6,300
Color transparencies	130
Film prints	343
Color slides	130
Black and white slides	28
Photomicrographs	83
Scribecoat	8
Color proofs of maps	4
Peelcoat films	25
Stripping film prints of typematter	54
Environmental questionaires	80
Memorandum reports on special projects	11
Reports completed for official publication (now in editorial process).	3
Special reports	2
Published reports	4
Bulletins	5
Mineral Economic Series	2
Guidebooks	5
Special Reports	3
Occasional Paper	11
Published Maps (total)	11
Miscellaneous (new)	9
Miscellaneous (revised)	2
Petroleum Exploration Maps (Revised)	62
Petroleum Exploration Maps (Checked without revision).	45
Publications list:	1
Published reports sold	6,244
Published maps sold	13,531
Publications office customers	3,204
Publications announcements mailed	2,209
Outside publications	10
Abstracts	4
Complete reports	8
Reports completed and sent to editors for outside publication	16
Abstracts	1
Complete reports	5

COAL AND INDUSTRIAL MINERALS SECTION

Introduction

With the continued emphasis being placed on expanded coal production and use as the immediate interim solution for easing the Nation's oil and natural gas dilemma a growing percentage of the Coal Section personnel's work load has been diverted to answering requests for information. Such requests for services pertaining to coal come from a broad range of interested parties: coal companies, consulting firms, governmental agencies, private individuals, etc. These requests cover a broad range of topics, namely: 1) stratigraphy and general geology associated with the coal measures of Indiana; 2) location, extent, quantity, and quality of coal reserves in both the strippable and underground mineable categories; 3) location and extent of previously mined areas of coal; 4) ecological and environmental aspects of coal mining; 5) general economics of the coal industry; 6) coal utilization; and 7) marketing and transportation of coal.

Several companies were drilling exploratory core holes for high-calcium limestone and sphalerite mineralization this year in partial response, at least, to Survey research projects. Land has been leased by two companies on a large reef containing high-calcium limestone near Camden, Carroll County. The limestone was discovered by Survey test drilling in 1975 and 1976, part of a continuing study of Silurian reefs in northern Indiana by Curtis Ault and Robert Shaver. The companies have now drilled additional test holes in the reef, which has the potential to be a major commercial source of chemical stone.

Industry interest also continued in Nelson Shaffer's project on fluorite, sphalerite, and barite mineralization in Indiana. We received reports of exploration drilling in at least three areas.

The past trend of an increasing rate of service requests was again evident this year. We reached an all time high of 654 requests for the year which is more than double the number of request per year we received prior to 1970. The loss of Mike Moore from our staff of four geologists increased the service load for the remaining geologists, but we managed to hold our own with our research projects. Geologic mapping in Putnam County by Mike Moore, John Mackey and John Hill was eighty percent complete. Work continued on the crushed-stone resources of reefs in Indiana with an emphasis on possible sources for chemical-quality stone. Nearly 400 copies of Miscellaneous Map 22, "Map of Indiana showing thickness of Silurian rocks and locations of reefs and reef-induced structures," published this year, were distributed or sold. Final results of chemical analyses were received for the project on crushed-stone resources of the limestones of the Blue River Group. A manuscript on the peat resources of Indiana is in the editorial process.

During fiscal year 1976-77 a total of 599 requests for information were handled by members of the Coal Section, an increase of 146 over the previous year. In addition to the telephoned and personal conferences conducted by the section's members, 296 letters, many of these in answer to written requests for information, were posted.

Even with the increased time consumed by requests for information, the section's personnel were able to continue work on their major projects of basic research as listed below. Eleven (11) publications resulted from this basic research along with four (4) file memorandum reports. Three field trips for outside groups were conducted during the year, and four public lectures were delivered. In addition a total of 22 professional meetings were attended.

Research Projects in Progress

Strippable Coal Resources

This project is an ongoing and continuing compilation of the strippable coal resources of the State. Strip-minable coal reserves are periodically revamped as new drilling information becomes available and areas are depleted by currently active strip mining. During the year major strip-mined areas were brought up to date and additional drilling information was plotted and evaluated. These data enable the Section to keep a running account of available strip-minable coal tonnages of the State.

Preliminary Coal Maps of Greene, Owen, and Putnam Counties

These projects are a continuation of our county reconnaissance type mapping of the distribution, structure, and mined areas of coals. Seventeen counties have been mapped and published to date, and with the completion of these three counties and Posey County a complete survey of the Indiana Coal Field will have been realized.

Little work was done on these projects during the year. A small amount of compilation work was done on the coal map of Greene County. Work on the coal map of Owen County was focused on gathering drilling, mining, and outcrop information. These data have been plotted on work maps and will be used in the interpretation of the bedrock surface, the surface of Mississippian rocks, coal structures, and past and current coal mining activities. About 40% of the field mapping and 30% of the compilation for the coal map of Putnam County has been completed. The data and work maps for these counties are on open file in the Coal Section, and thus are available for answering requests for information concerning the areas.

Distribution of Acid-Forming Materials in Overburden

This project is a study of the pyrite content in different types of overburden materials in active coal strip mines. Analysis of samples collected from high walls of active strip mines, along with core drill hole samples from locations in advance of the mining operation, provides the data necessary for planning the handling of obvious acid-producing materials in a selective manner. The objective of this planning is to place the acid-forming materials at depth and cover them by lithologies more suited for plant growth. This selective handling of materials can also assure precipitation runoff of a non-acid nature. Data from this study have been successfully applied to acid spoil problems at several mines in various coal seams in southwestern Indiana.

The results of this project describing a small intensively drilled area in Greene County that provided the basic data for expansion of this project to broader application both stratigraphically and geographically were published during the year.

Rock Weathering and Distribution of Acid-Forming Materials in Cast Overburden

Rock size and rates of disintegration of various overburden materials involved with reclamation of strip mined lands have become of increased importance as more and more of the reclaimed lands are being placed into row crop use. A study of the various types of rocks present in active strip mine highwalls and core samples from drill holes in advance of the mining operation provide a projection of the rock size and disintegration rates of the lithologies involved. This data acts as a guide to selective spoil handling to insure that large, slow-weathering materials will be buried to a sufficient depth so as not to interfere with farming machinery.

The initial intensively studied area for this project was located in central Pike County. A detailed report of the findings has been conveyed to the interested company, and an article for the general public has been prepared and will soon be released. The basic data derived from this work is currently being expanded to other geographic and stratigraphic areas of the coal field, and a new outdoor laboratory to study rock weathering rates was opened on the outskirts of the I.U. Bloomington campus. Recently a continuation of the study of acid-forming materials in overburden was incorporated into this project, thus insuring additional research that will aid mining companies in handling overburden materials so that maximum use can be made of the land when mining is complete. This project is about 90 percent complete, but has already resulted in a published article in Outdoor Indiana Magazine. In the future the emphasis of this study will be placed on the acid-forming materials in coal overburden.

Active Coal Mine Map

The 1977 annual revision of the "Map of Southwestern Indiana Showing Locations of Active Coal Mines" (Misc. Map No. 7) was completed and published during March 1977. A total of 125 sites were visited with 99 of them active.

Deep Drilling Program for Coal

This project is an ongoing and continuing program to obtain information on Indiana's underground minable coals in the deeper part of the coal basin in the extreme southwestern part of the State. Knowledge of the thickness, quality, reserves, and mineability of the deeper-lying coal seams is the goal of this project. Information on roof and floor conditions associated with each minable seam is obtained as well. During the year 780 feet were drilled in one drill hole in southern Knox County. All coal seams were measured, described, and carefully prepared for chemical analysis including float/sink determination on all of the major coal seams. In addition to the above information a test for methane content of each of the major coal seams was initiated. Originally this test was conceived to function as a mining safety precaution to determine whether the coal seam's methane content warranted a degasification program ahead of underground mining, but in the nation's search for new energy sources emphasis is now being placed on the possibility of commercial production of methane from coal beds. Thus a two-fold advantage for bleeding methane from coal would be realized.

In the approximately four years that this project has been in existence a total of 5,864 feet has been drilled in eight (8) holes that range in depth from 372 feet to 880 feet. These holes have been drilled on approximately six (6) mile centers commencing in southern Sullivan County and progressing southward to the south edge of Knox County.

A much better interpretation of available electric logs from oil tests in this area has been realized as a result of the drill holes. In addition, phase two, consulting with coal company personnel concerning drilling information in their files, has been commenced. To this point we have been successful in obtaining information from them that ties in very well with our own drilling information.

Phase three of this project, analytical work on the materials that form the roof and floor of the coals, has been started, but it is being carried on in this report under the title of "Characterization of Potential Roof and Floor Rocks Associated with Indiana Coals." A further discussion of this facet of the study is presented below.

Characterization of Potential Roof and Floor Rocks Associated with Indiana Coals

With the exception of two small underground coal mines, all of Indiana's coal is produced by stripping operations. This situation should change in the future, however, because about 7/8 of Indiana's recoverable reserves will probably be recovered by underground mining methods. In anticipation of this eventuality, a project was started to add fundamental knowledge on the physical and chemical properties of rocks that will be affected by the underground mining of coal, mainly the roof and floor materials.

The first phase of the study, the petrographic description of lithologies, was begun using cores from Survey drill holes and rocks collected from active mines. Accurate descriptions of rocks are important to correlations of both stratigraphy and mechanical properties of the rocks. A second phase, identifying the composition of the different lithologies by thin-section and X-ray diffraction analysis, has been initiated. During the year numerous thin sections of roof rock materials have been prepared and petrographically analyzed, in conjunction with X-ray mineralogical analyses on some 22 additional samples.

National Coal Data System

This project was initiated with the aid of a grant from the U. S. Geological Survey to increase the amount of specific chemical data on the minable coal seams in Indiana as an aid in the production of coal of a quality acceptable for the production of energy and for meeting current pollution control standards. The objective of this project was to collect channel samples of coal and channel or grab samples of partings, roof rock, floor rock at as many of the state's active mines as possible for subsequent detailed analysis by the U.S.G.S.

The analytical data compiled by the U.S.G.S. will be tabulated and isopached to form a basic data bank useful for evaluating the nature of coal currently being produced in Indiana.

During the year personnel of the Indiana Geological Survey visited 100 mine and permit sites in the state to collect 60 coal samples, 74 parting samples, and measure 1132 ft. of stratigraphic section to document these samples. These coal and parting samples, plus the documentation which accompanies them, completes the sampling phase of this project. The data tabulation and isopach maps will be prepared when the U.S.G.S. completes the analysis of the samples submitted by the Indiana Geological Survey and return copies of the results.

Feasibility Study for an Indiana Coal Data System

The objective of this study was to document the feasibility of computerizing the large amount of geologic data contained on the coals, coal-bearing rocks, and coal mining in Indiana in the Coal Section's open and confidential files. Such a study would provide an analysis of the existing file system in reference to computerization, identify alternative data handling systems, and recommend and outline projects to be carried out within the Section to provide a logical and efficient transfer of file data to a computerized data handling and mapping system. The feasibility study was completed and approved during the year and has led to the establishment of an Indiana Coal Data System with specific projects designed to begin its implementation.

Preliminary Coal Map of Posey County

This project is a continuation of our county reconnaissance type mapping of the distribution, structure, and mined areas of coals, and with its completion will give us complete geologic coverage of the Indiana Coal Field. The bulk of the stratigraphic data in Posey County is subsurface in nature; i.e., coal test drillings, oil and gas test drillings, and refraction and possibly reflection seismic shooting. Only relatively small scattered exposures of bedrock are available for study at the surface and these rocks are of the uppermost part of the Pennsylvanian System, far above the position of the first commercially minable coal in the county. No coal mining of any consequence has been carried on in Posey County, and it is doubtful that any strip mining will ever be done. Hence we are dealing strictly with coals that must be mined by underground methods.

To this point work on the project has centered on referencing previous geologic work that has been done in the area. In addition available coal and oil tests are being examined to provide a working knowledge of the stratigraphy for correlation purposes and for the location of a drill hole in order to observe lithologic variations first hand.

Low Sulfur Coal V, Warrick County

A new project designed to study the interrelationship of roof rock lithologies and their accompanying depositional environments with the sulfur content of the underlying coal, in this case Coal V, in northern Warrick County was commenced during the year. Data from surface exposures and coal test drillings incorporated into detailed geologic cross sections, isopach maps, and coal structure maps has led to an increased understanding of the occurrence of local areas of low sulfur coal in an otherwise medium to high sulfur coal seam. This study has now been expanded into adjacent areas in Gibson and Pike Counties.

DRAFTING AND PHOTOGRAPHY SECTION

The primary function of the Drafting and Photography Section is to provide service to the commodity and research sections of the Geological Survey. The services consist mainly of the final preparation of maps and illustrations for publication and talks, preparation of displays, mounting and framing of maps and photographs, typesetting, diazo printing, photo-copying, film processing and printing, photomacrography, field photography, color proofing of maps and artwork, and preparation of projection slides.

Jobs completed for publication by the Geological Survey include Bulletin 55, Reduction of Sulfur in Indiana Coal by Washability Techniques; Special Report 12, Environmental Geology of the Evansville Area, Southwestern Indiana; Mineral Economics Series 23, Oil and Gas Development and Production in Indiana During 1976; Occasional Paper 20, Pyrite in the Coxville Sandstone Member, Linton Formation, and Its Effect on Acid Mine Conditions Near Latta, Greene County, Indiana; Occasional Paper 21, Table of Key Lines in X-ray Powder Diffraction Patterns of Minerals in Clays and Associated Rocks; Occasional Paper 22, Fortran Program for Correlation of Earth Tide Gravity Values; State Park Guide 3, Geologic Story of McCormicks Creek State Park; State Park Guide 4, Geologic Story of Shades State Park; State Park Guide 5, Geologic Story of Turkey Run State Park; State Park Guide 6, Geologic Story of Versailles State Park; Miscellaneous Map 22, Map of Indiana Showing Thickness of Silurian Rocks and Location of Reefs and Reef-Induced Structures; Miscellaneous Map 23, Geologic Lineament Map of the 1° x 2° Danville Quadrangle, Indiana and Illinois; Miscellaneous Map 24, Geologic Lineament Map of the 1° x 2° Indianapolis Quadrangle, Indiana and Illinois; Miscellaneous Map 25, Geologic Lineament Map of the 1° x 2° Vincennes Quadrangle, Indiana and Illinois.

Other jobs finished include a set of 6 illustrated news items; displays for the Indiana State Fair, a meeting of the American Association of Petroleum Geologists, a meeting of the Illinois Oil and Gas Association, Historic New Harmony, Inc., and the Geology Building; revision of Miscellaneous Map 7, Map of Southwestern Indiana Showing Location of Active Coal Mines; revision of the petroleum exploration maps of Indiana counties; illustrations for 9 outside publications and for 10 talks; a large-scale wall map of southwestern Indiana showing oil and gas fields; and a map showing the status of published petroleum exploration maps.

Other jobs in progress are: Bulletin 57, Pre-Knox (Cambrian) Stratigraphy in Indiana; Special Report 13, Environmental Geology of Allen County, Indiana; artwork for illustrated news items; compilation of state and federal property boundaries on published base and petroleum exploration maps; and displays for the Indiana State Fair, Spring Mill State Park, museum at Boonville, and the Core Library Building.

Photographic items produced during the fiscal year consist of 773 camera copies, 115 field and laboratory photographs, 27 photomicrographs, 822 black and white prints, 343 film positives and duplicate negatives, 54 stripping film prints of stickup type^a and symbols, 8 scribesheets, 25 peelcoat films, 4 color proofs, 130 color and tinted slides, and 28 black and white slides.

Approximately 6300 prints were made on the diazo printer.

Drafting and photography items produced for the Department of Geology and for orders billed through the Publications Section are not included in this report,

EDUCATIONAL SERVICES

The Office of Educational Services was established by the State Geologist of Indiana to aid in the coordination of the Geological Survey's efforts in providing information about Indiana geology and mineral resources to the public. This office assists in the preparation of materials for newspapers, magazines, public schools, youth and adult groups, and all other groups and individuals who are interested in rocks, minerals, fossils and the earth. On request, he participates in radio and television shows which involve something of Indiana geology, minerals, etc. By means of news releases to Indiana's newspapers and articles sent to appropriate magazines, the Office of Educational Services not only aids in informing the public about the activities of the Indiana Geological Survey but also aids in the distribution of educational information to the public. In addition to giving public lectures and conducting special field trips, when requested, the Educational Services geologist works directly with teachers in public schools, college classes, geology clubs, rockhound clubs, Scout groups, 4-H clubs, conservation clubs, civic groups, and children and adults throughout the state on programs or projects concerning Indiana's geology and mineral resources. On occasion he serves as a guest lecturer and conducts special field trips for college classes. He identifies many of the rock, mineral, or fossil specimens sent to or brought in to the Geological Survey by Indiana citizens. The geologist in charge of Educational Services also aids in the preparation and installation of exhibits and displays for fairs, for professional meetings, for amateur rock shows, and for the displays in the Geology Building.

During the past fiscal year, the program for providing illustrated news items for Indiana newspapers was stalled for several weeks because of the retirement of the Survey's artist. Following the hiring of another artist, the program is continuing. It is hoped that the newspaper series can continue indefinitely. The total number of units produced to date has increased to 60 during the past fiscal year. A total of 277 mailings of the series were made to Indiana's newspapers during the past 12 months. Currently, six more illustrated news items are in process.

During the fiscal year 1976-77, the geologist in charge of Educational Services spent $33\frac{1}{2}$ days in the field and traveled more than 9,640 miles. In answer to requests received from the public, 15 public lectures were given and 6 special field trips and 8 tours of the Geology Building were conducted during the 12-month period.

Public lectures, laboratory demonstrations, and film showings were made to the following groups: Outdoor Education Conference for counselors conducting day camps in Marion and adjacent counties; the Michiana Rock and Gem Society, South Bend; the "All School Science Fair" conducted by Broadview School of Bloomington at Spring Mill State Park; 5th grade class, Eastern School, Greene County; 5th grade class, Broadview School, Bloomington; annual Rock Festival of the 7th and 8th grades at Shawsick School, Lawrence County; 4th grade and 5th grade classes of Grandview School, Monroe County; and the Bloomington Chapter of the American Business Women's Club.

Special field trips, collecting field trips, and tours were conducted for the following groups: members of the I. U. Biology Department's summer garden program for children; members of the Education 543 class, Indiana University; participants of the Walker Chapel Summer Bible School, Monroe County; members of an earth science class, Manchester College, North Manchester, Indiana; members of 4-H clubs in Decatur County; and counselors attending an Outdoor Education conference in Marion County (Indianapolis).

The Educational Services geologist again served as the Geological Survey's representative of the State Fair Committee, Indiana Department of Natural Resources, for the 1977 Indiana State Fair.

Articles submitted and published in OUTDOOR INDIANA included: "Underground Indiana--Five Famous Caves," by Carl B. Rexroad (July-August 1976); "Is it a Well or Just a Hole in the Ground," by G. L. Carpenter and Homer R. Brown (September 1976); "Paper Coal: Hoosier Mineral Curiosity," by R. Dee Rarick (December 1976-January 1977); "Hoosiers Think Zinc," by Nelson Shaffer (March 1977); "Indiana's Early Lime Burners," by Curtis H. Ault (April 1977); and "Carrying Coals to Newcastle: Low-Sulfur Coal in Indiana," by Donald D. Carr and Donald L. Eggert (June 1977). Articles submitted to the editor of OUTDOOR INDIANA which have not yet been published include: "Indianaite--The Rock With a Past," by Nelson Shaffer; and 2 articles by R. Dee Rarick about Pleistocene wood and Pleistocene pollen studies.

Exhibits prepared by the Indiana Geological Survey for public display included a major exhibit for the 1976 Indiana State Fair; an exhibit for a regional meeting of the American Association of Petroleum Geologists held at Lexington, Kentucky; an exhibit to the 1977 Oilmen's Outing held at Olney, Illinois; and a pre-existing State Fair exhibit which was placed on display at New Harmony, Indiana.

The Educational Services geologist participated in the Careers Day program with Professor Noel Krothe of the Indiana University Department of Geology at Bloomington North High School last spring. Also, he served as a member of the Indiana University Staff Council Scholarship Selections Committee.

During the past fiscal year, the Educational Services geologist submitted 5 news releases about Geological Survey activities. Also, he participated in a Channel 4 TV program "INDIANA OUTDOORS" and was interviewed about Indiana geodes.

During the 1976 4-H Fair season, geology and weather exhibits were judged for the Decatur County 4-H Fair and the Monroe County 4-H Fair.

Tours of the Geology Building were conducted for the members of the Educational 543 class, Indiana University; 2 groups of 4th graders, Childs Elementary School, Bloomington; a group of more than 100 students from Stoney Creek Elementary School and Junior High School, Noblesville, Indiana; the 7th grade class, University Middle School, Bloomington; the 7th grade class, Eastern School, Greene County; and 2 groups of children from the Christian Center, Bloomington.

Three issues of the Survey Newsletter were compiled and distributed by the Educational Services geologist during the past fiscal year.

Professional meetings attended during the last 12 months included a regional meeting of the American Association of Petroleum Geologists held at Lexington, Kentucky; the Oilmen's Outing held at Olney, Illinois; and the 1977 EARTHWATCH Scholarship Program, the Indiana portion of the national program, which is sponsored by the Indiana Department of Public Instruction. The Educational Services geologist served as a member of the selections committee.

GEOLOGY SECTION

The Section's accomplishments may be summarized as follows: Members of the Section worked actively on 12 formal projects but completed none of them. One of these projects was new (Cass Co. environmental geology). Six of these projects are efforts to obtain basic information (Paleozoic and Pleistocene physical stratigraphy and Paleozoic biostratigraphy), as was an informal project to summarize the stratigraphy of Carboniferous rocks. Six projects are more practically oriented, including three geographically defined environmental projects (Cass, Grant, Monroe Cos.), one other environmental project, and two mapping projects (Indianapolis 1° x 2° RGM, U. S. Geol. Survey Quaternary map).

Three of our geographically oriented environmental reports were published, those for Morgan and Johnson Counties and for the Evansville area, and two basic stratigraphic and biostratigraphic reports and a map were published as well, those on the Detroit River Formation, Silurian reef locations, and remnant magnetism in Pleistocene sediments.

Additional reports in basic geology were completed and submitted for publication: Middle Ordovician conodont biostratigraphy, upper Chesterian stratigraphy, Pleistocene stratotypes, Silurian reefs and stratigraphy, and Mississippian conodont phylogeny.

Our publication effort also extended to educational and professional service reports, both published and submitted for publication: Versailles State Park, Indiana caves, and upper Mississippian conodont biostratigraphy.

The Section had a total of 7 reports, 2 abstracts, and 1 map published, 4 of these reports and the map being published by the Survey. They total 171 pages and 47 illustrative materials, which is less than half of last year's output and also less than a 5-year average for the Section. Tempering this evaluation, however, is the fact that 9 reports by the Section that are more than 1 year old remained in obscurity at the end of the year. They total 264 pages and 125 illustrations, which is significantly higher than the more-than-one-year-old backlog of a year ago.

Members of the Section submitted for publication 6 reports and 1 abstract that remained unpublished (total of 197 p., 36 illus.). These reports, when added to the nine remaining from more than one year, bring the overall backlog to 15 reports and 1 abstract (461 p., 161 illus.), which is about the same as one year ago.

We prepared 5 memorandum reports, 3 being requested for planning purposes, 1 in connection with a landfill, and 1 unidentified for purpose.

Geologists of the Section gave or conducted 24 papers, talks, tours, and field trips. Of the talks and papers, 10 were essentially scientific or technical and were given at professional assemblies, and 10 were educational (classes, camps, public, or other). The field trips were given for Indiana University, Audubon Society, North-Central Section of Geological Society of America, and Amoco Production Co. geologists.

Members of the Section were involved in 450 conferences and conference-type field trips of record, of which most were calls upon us for information. This is the highest level of activity of this kind yet recorded by the Section. Although it is little higher than last year's activity of this kind, it continues the large increase in such calls during the past few years.

The volume of correspondence (1244 pieces in and out), much of which was to provide geologic information upon request, was down somewhat, but we filed a larger number (80) of environmental questionnaires, nearly all of which concerned road improvement and construction.

The accomplishments of the section may be typified in three ways:

1. Probably the largest effort was placed on environmental or otherwise practical matters, and there was an increase in the part of that effort that was in direct response to requests for information. The part of this effort directed within formal environmental projects decreased during the year from its former level.

2. We produced a significant amount of basic geologic information, and probably the effort of this kind directed within formal projects increased some at the expense of efforts in formal practically oriented projects, including mapping endeavors.

3. We continued to participate in professional, technical, and educational meetings at a rather visible level.

MINERAL STATISTICIAN

Mineral production in Indiana for the year 1976 reached a total value of \$557,937,489.00 (reported at first stage of salability), an increase of 27.8 percent over the previous year. The fabrication of limestone for building purposes, and the manufacture of cement and clay products from raw materials produced in the state, increased the value of mineral products by more than \$120,000,000.00. Related industries such as the manufacture of lime, recovery of sulfur from petroleum, and processing of perlite -- all from materials imported from other parts of the country -- increased the value of Indiana's mineral industry by several millions of dollars.

The fuels -- coal, petroleum, and natural gas -- accounted for 80.63 percent of the total value, and coal alone accounted for 71.57 percent. The 40.48 percent increase in total value for coal largely reflected the substantially higher unit price, as the quantity produced was less than 1 percent more than in 1975. Sixty-two percent of all the coal mined in the state was in Pike and Warrick Counties.

Although total drilling for the year increased by 85 wells, and the percentage of successful exploratory wells improved from 13.4 to 16.8, the amount of oil produced remained essentially the same as in 1975.

Construction materials -- crushed and dimension limestone, sand and gravel, clay and shale, gypsum, and dimension sandstone -- accounted for 19.2 percent of the total value of minerals produced. Although almost all of these commodities showed total value increases, only crushed limestone, clay and shale, and gypsum showed total quantity increases.

The apparent decrease (17.78 percent) in tonnage of stone for construction and maintenance is largely due to the fact that one major producer provided only total stone figures, which could be entered only in the "Other" category. Crushed limestone for agricultural purposes and in the manufacture of cement increased 33.48 percent and 14.76 percent respectively.

The quantity of clay and shale mined in 1976 increased 5.69 percent over 1975, and the total value of the products manufactured from clay and shale increased 25.29 percent.

Increases of nearly 10.0 percent in volume and 20.0 percent in total value were reported for gypsum, used in the manufacture of wallboard, insulation, and other building materials.

Although both the quantity and total value of rough blocks of limestone declined, the value added for fabricating the stone for building purposes increased sufficiently to show an overall gain for the industry of 2.23 percent.

Of the major mineral producing and related manufacturing/processing industries, cement showed the greatest gains -- 22.2 percent in volume and 27.6 percent in value.

Sales of sand and gravel in all use categories remained approximately the same in 1976 as in 1975 with the exception of material for highway and bridge construction, which declined 32.5 percent.

Pike and Warrick Counties accounted for 44.3 percent, and Greene, Sullivan, and Vermillion Counties for 19.4 percent (not including oil and gas) of the total value of all mineral commodities produced in Indiana during 1976. The following counties led in production of minerals (excluding oil and gas):

<u>County</u>	<u>Value-Raw Materials</u>	<u>Value (incl. mfd. products)</u>	<u>Mineral Commodities (in alphabetical order)</u>
	<u>\$50 million+</u>		
Warrick	\$155,420,811.00	----	Coal
Pike	91,971,574.00	----	Coal

\$25-50 million

Vermillion	43,247,503.00	C	Clay and shale, Clay products, Coal, Sand and gravel
Sullivan	36,127,912.00	----	Coal, Crushed limestone, Sand and gravel
Greene	29,236,966.00	C	Clay and shale, Clay products, Coal, Sand and gravel

\$5-25 million

Clay	21,343,322.00	31,206,848.00	Clay and shale, Clay products, Coal
Spencer	9,117,801.00	----	Coal
Putnam	6,328,839.00	C	Cement, Clay and shale, Crushed limestone, Dimension limestone, Sand and gravel
Marion	6,006,904.00	----	Crushed limestone, Sand and gravel
Hamilton	5,933,797.00	----	Crushed limestone, Peat, Sand and gravel
Lawrence	5,688,506.00	28,265,411.00	Cement, Clay and shale, Crushed limestone, Dimension limestone, Dimension sandstone
Crawford	C	----	Crushed limestone
Martin	C	----	Coal, Gypsum
Clark	5,323,339.00	C	Cement, Clay and shale, Crushed limestone, Sand and gravel

	<u>1975</u>		<u>1976</u>	
	<u>Quantity</u>	<u>Value</u>	<u>Quantity</u>	<u>Value</u>
Coal	25,269,159 tons	\$284,278,039.00	25,354,912 tons	\$399,339,864.00
Crushed limestone	27,418,844 tons	55,215,341.00	28,227,358 tons	57,657,307.00
Sand and gravel	22,951,928 tons	36,211,683.00	22,170,809 tons	38,495,392.00
Petroleum	4,632,282 bbls	48,824,252.00	4,629,737 bbls	50,421,000.00
Dimension limestone	2,941,701 cu.ft.	4,936,653.00	2,310,261 cu.ft.	4,179,402.00
Clay and shale	1,193,804 tons	1,841,484.00	1,261,728 tons	1,867,442.00
Peat	153,373 cu.yd.	702,327.00	252,439 cu.yd.	801,906.00
Natural gas	346,300,000 cu.ft.	134,900.00	187,485,000 cu.ft.	97,492.00
Undistributed - includes dimension sandstone, gypsum, marl, and whetstones		<u>4,264,760.00</u>		<u>5,077,684.00</u>
TOTAL		\$436,409,439.00		\$557,937,489.00
Value added for additional processing of dimension limestone and manufacture of clay products and cement		\$100,033,594.00		\$120,306,385.00

GEOCHEMISTRY SECTION

Samples collected by all of the sections of the Geological Survey are analyzed to determine their chemical composition. Spectrographic, x-ray, atomic absorption, and wet chemical methods have been used in these routine analyses in order to learn what minerals and elements are present in the samples, what uses might be made of these materials, and whether potentially dangerous substances are present in them.

The work of the Geochemistry Section expanded sharply during the year as preliminary steps were taken to handle analyses of samples of the New Albany Shale for a project sponsored by the U. S. Department of Energy. To facilitate this analytical work an induction coupled plasma-optical spectrometer was ordered, as well as a low temperature asher and carbon, hydrogen, nitrogen analytical equipment. After installation, an extensive program of work with standards is planned in order to calibrate the equipment.

During the year a large number of samples was processed and determinations made. Included in this work were: in the coal laboratory 262 samples of coal, ash, peat, and overburden were prepared and analyzed, yielding 1321 determinations; in the spectrographic laboratory 505 samples were analyzed to yield 3,389 determinations; and in the wet chemistry laboratory 727 determinations were made.

On September 15, Mr. Joseph Hailer began work as a Geochemist/Analyst. Mr. Hailer did his graduate work at George Washington University in Washington, D. C., and had been working as a geochemist with the U. S. Geological Survey. By coincidence, his work with the U.S.G.S. involved the analysis of coal samples collected by the Indiana Geological Survey.

GEOPHYSICS SECTION

During the 1976-77 fiscal year the Geophysics Section continued to maintain a program of field work, laboratory measurements, and development of computer programs to assist in the interpretation of geophysical data.

A seismic refraction crew worked during periods of good weather throughout the year on field surveys to measure the thickness of unconsolidated material above bedrock. These projects were done mainly in connection with studies of the glacial geology along the Teays Valley and in cooperation with the Division of Water to explore for geologic conditions suitable for the development of ground water resources. Seismic refraction surveys were made in Jay, Grant, Huntington, Blackford, Benton, Warren Counties and in the Flatwoods area of Monroe and Owen Counties. In addition, a seismic refraction survey was made in the vicinity of some known

faults in the Wabash River valley to determine if those faults could be detected seismically. This work required 346 shots and has not yet been completed.

In other activities, Bob Blakely continued with preliminary programming for the development of an INDYMAP computer drawn map of Indiana, and he and Al Rudman as editors completed two additional publications dealing with computer programs for geophysical operations. Bob also brought the computer programs to handle the petroleum data file to a point near completion, and began a study of the thermal properties of various types of Indiana building stones.

A project to check and encode data from several thousand gravity stations was begun during the year. At the time the gravity stations were originally occupied, topographic maps were not available for all of Indiana, so that latitudes and longitudes and elevations for most of the stations had to be taken from a variety of sources. Each station now is being checked for accuracy of location by latitude and longitude, and elevations as originally determined from bench marks and altimeter readings are being verified.

PETROLEUM SECTION

The chief functions of the Petroleum Section consist of (1) services, (2) projects that are performed annually, (3) projects that are related to records, (4) subsurface study projects, and (5) special projects.

Services

The services offered consist mostly of requests, conferences, and correspondence about subsurface records such as well locations, driller's logs, geophysical logs, samples, cores, and interpretations made from these data. The section handled 357 visitors during the fiscal year. In addition to the visitors, requests for subsurface information is received daily by correspondence or telephone.

Annual Projects

Indiana Drilling Statistics -- Drilling statistics were compiled for wells drilled in Indiana during the year. These statistics comprise a part of the nationwide totals compiled by the American Association of Petroleum Geologists and the American Petroleum Institute.

Indiana Exploration Development -- An annual review of exploration activity in the state was compiled for inclusion in the Bulletin of the American Association of Petroleum Geologists.

Indiana Oil Projection -- Preparation of the annual oil production statistics by fields in the Survey's Mineral Economic Series was completed.

Indiana Oil Reserves -- The Section participated in the program sponsored by the American Petroleum Institute of formulating statistics on remaining oil reserves and oil recovery. The statistics are a part of the nationwide figures published by the American Petroleum Insitutue.

Review of Petroleum Exploration Map Series -- The individual county petroleum map transparencies were updated at year's end. Fifty maps were revised and 42 were checked with no revisions necessary.

Records Improvement

Upgrading County Exploration Maps -- Field checking and upgrading the County Exploration Maps was completed in March with the exception of Gibson County. Seven counties (Huntington, Wells, Adams, Grant, Blackford, Jay and Delaware) in the old Trenton area have not been checked. During the field checking and upgrading of the County Exploration Maps, it was determined that the Petroleum Section had some information on 1,436 wells that were not in the Division of Oil and Gas files. Well data cards of these wells showing their status were sent to the Division of Oil and Gas. From the Division of Oil and Gas monthly Oil and Gas Drilling Report, the Section now maintains up-to-date well symbolization on County Exploration Maps.

Gibson County Well Records -- Field work involved in the Gibson County Exploration Map was completed and virtually all typing of the new Well Data Cards has been completed. This project, which began in April 1973, involved field checking and preparing new Well Data Cards on more than 6,150 wells.

Master File Indexing -- A special project of indexing on master file envelopes information available on each well and typing permit numbers on the master file was completed in October. This project, which began in September 1975, involved indexing more than 36,000 wells.

Subsurface Studies

A report, "General Sedimentological History of Late Silurian and Early Devonian Events in Southwestern Indiana," by Leroy E. Becker and John B. Droste, was completed and sent to the Publications Section.

Miscellaneous Map No. 22, entitled "Map of Indiana Showing Thickness of Silurian Rocks and Location of Reefs and Reef-Induced Structures" was received from the printer 7 December 1976. Stanley Keller and Leroy Becker participated in the project.

Geological Survey Occasional Paper 19, entitled "Silurian Reefs in Southwestern Indiana and Their Relation to Oil Accumulation," by Leroy E. Becker and Stanley J. Keller was received from the printer 13 September 1976.

A copy of ORSANCO report: "Evaluation of the Ohio Valley Region Basal Sandstone as a Wastewater Injection Interval," was received 22 September, 1976. Andrew Hreha and Leroy E. Becker contributed material to the preparation of the report.

Stanley Keller and Leroy Becker are conducting a study on the stratigraphy and petroleum possibilities of the Mississippian Borden and Sanders Groups. The Section has received many inquiries as to Salem and Harrodsburg oil possibilities, particularly in Gibson, Posey, Pike, and Knox Counties. The results of the study will be published as a special report or bulletin.

Dan Sullivan and Gerald Carpenter are conducting a study of the natural gas fields in Indiana. An important part of the report will be comments on the future of natural gas exploration in Indiana.

The Petroleum Section began stratigraphic and structural investigations of the Devonian New Albany Shale in Indiana. Geologists Nancy Hasenmueller and John Bassett began work on the project during September 1976, and Marilyn Ryerson, draftsman, was assigned to the project November 1976. Leroy Becker is an investigator participating in the project.

Special Projects

Sample Consolidation -- The project to consolidate well samples in order to create additional storage space in the existing well sample library continued during the year. About 7,100 wells have been converted to the new system. It is estimated that the project is 70 percent complete and has provided sample storage for an additional 15 years.

Reviewing Process for County Strat Tests -- During the year 86 strat tests from Clay, Morgan, and Fountain Counties were added to the master file.

Geology of the New Madrid Area -- Dan Sullivan is co-principal investigator of a project to study the geology and faulting of the New Madrid seismic area, a 200-mile radius which includes part of southwestern Indiana. The project is under the sponsorship of the Nuclear Regulatory Commission.

Evaluation of Oil and Gas Potential Beneath Indiana State Parks, State Forests, and State Fish and Wildlife Areas -- The Petroleum Section evaluated the oil and gas potential of the land controlled by the Department of Natural Resources. Included in this study were 22 State Parks, 33 Fish and Wildlife Areas, 12 State Forests, and 1 Memorial. A map showing areas of state ownership was compiled and a brief description of the potential of each individual area was prepared.

Map Editor -- Stanley Keller is Map Editor for the Indiana Geological Survey. During the year he reviewed 7 manuscripts.

Core Storage Building -- The Geological Survey was given custody of the new Core Storage Building 19 November 1976. Moving all the cores from the old quonset hut was completed during May 1977 and the facility was opened to the public. Most of the old shelving in the quonset hut has been disassembled and moved to the new building. The move was made by work-study students under the supervision of William Hamm.

Northern Indiana Cores -- Cores from 5 wells drilled by NIPSCO in northern Indiana were transferred from NIPSCO's Royal Center warehouse to the Survey's new Core Building in Bloomington. In addition to the Petroleum Section wells, the section assisted in the transfer of 20 other test wells for other sections and the Department of Geology. NIPSCO donated about \$1,500 worth of core boxes to the Survey.

PUBLICATIONS SECTION

During the past fiscal year the Publications Section sold 6,244 reports and 13,531 maps. The section sent 3,473 reports and 133 maps on exchange to institutions in the United States and in foreign countries. It also distributed without charge 3,596 reports and 1,736 maps to members of its own organization and to individuals, libraries, and companies in the United States and abroad. The Publications Section served 3,204 office customers, handled 1,785 letters pertaining to geologic reports and maps, and sent out 2,209 announcements of new publications.

Eleven reports, four new maps, and 63 revised maps were issued during the fiscal year. In addition, two reports were reprinted. A new series, Occasional Papers, which was introduced late in the fiscal year 1973-74, was an active series in 1976-77 as it was in 1975-76. Six reports were issued as Occasional Papers during 1976-77. A new publications list was also issued during the fiscal year.

REPORTS AND MAPS PUBLISHED BY THE GEOLOGICAL SURVEY

Bulletins

Doheny, E.J., Droste, J.B., and Shaver, R.H., 1975, Stratigraphy of the Detroit River Formation (Middle Devonian) of northern Indiana: Bull. 53, 86 p., 3 pls., 7 figs., 2 tables.

Hutchison, H.C., 1976, Geology of the Catlin Mansfield area, Parke and Putnam Counties, Indiana: Bull. 54, 57 p., 4 pls., 5 figs., 2 tables.

Wier, C.E., and Hutchison, H.C., 1977, Reduction of sulfur in Indiana coal by washability techniques: Bull. 55, 61 p., 15 figs., 8 tables.

Mineral Economics Series

Carpenter, G.L., and Keller, S.J., 1976, Oil development and production in Indiana during 1975: Mineral Economics Series 22, 25 p., 3 figs., 5 tables.

Occasional Papers

Becker, L.E., and Keller, S.J., 1976, Silurian reefs in southwestern Indiana and their relation to petroleum accumulation: Occasional Paper 19, 11 p., 9 figs., 1 table.

Chen, Pei-Yuan, 1977, Table of key lines in X-ray powder diffraction patterns of minerals in clays and associated rocks: Occasional Paper 21, 67 p., 21 app.

Hartke, E.J., and Hill, J.R., 1976, Environmental geologic maps for land use evaluations in Morgan County, Indiana: Occasional Paper 17, 10 p., 4 figs., 1 table.

Hill, J.R., 1976, Environmental geologic maps for land use evaluations in Johnson County, Indiana: Occasional Paper 18, 10 p., 4 figs.

Rudman, A.J., Ziegler, R., and Blakely, R.F., 1977, Fortran program for generation of earth tide gravity values: Occasional Paper 22, 14 p., 1 fig., 4 app.

Wiram, V.P., 1976, Pyrite in the Coxville Sandstone member, Linton formation, and its effect on acid mine conditions near Latta, Greene County, Indiana: Occasional Paper 20, 10 p., 7 figs.

Straw, W.T., Gray, H.H., and Powell, R.L., 1977, Environmental geology of the Evansville area, southwestern Indiana: Spec. Rept. 12, 8 p., 8 figs., 1 table.

Miscellaneous Maps

Ault, C.H., Becker, L.E., Droste, J.B., Keller, S.J., and Shaver, R.H., 1976, Map of Indiana showing thickness of Silurian rocks and location of reefs and reef-induced structures: Misc. Map 22.

Hutchison, H.C., 1977, Map of southwestern Indiana showing location of active coal mines: Misc. Map 7 (revised).

Wier, C.E., and others, 1974, Geological lineament map of the 1° x 2° Danville Quadrangle, Indiana and Illinois: Misc. Map 23.

Wier, C.E., and others, 1974, Geological lineament map of the 1° x 2° Indianapolis Quadrangle, Indiana and Illinois: Misc. Map 24.

Wier, C.E., and others, 1974, Geological lineament map of the 1° x 2° Vincennes Quadrangle, Indiana and Illinois: Misc. Map 25.

PAPERS PUBLISHED IN SCIENTIFIC JOURNALS

Bleuer, N.K., and Moore, Michael C., Basal till of so-called Kansan Age in the upper Wabash Valley, Indiana (abs.): Geol. Soc. America Abstr. with Programs, v. 9, no. 5, p. 576-577.

Bleuer, N.K., Remnant magnetism of Pleistocene sediments of Indiana: Ind. Acad. Sci. Proc., v. 85, p. 277-294, 6 figs.

Carr, Donald D., 1977, Industrial minerals: Geotimes, v. 22, no. 1, p. 26-27.

Chen, Pei-Yuan co-author, Beidellite clay from Chang-Yuon, Taiwan; Geology and mineralogy: Clay Minerals (1976), v. 11, p. 221-233.

Hafer, P.J., and Blakely, R.F., Type III - statistics of extremes analysis of modified mercalli earthquake intensities for the eastern United States: Indiana Academy of Science, v. 88, p. 260.

Knapp, R.W., Mead, J., and Blakely, R.F., A study of the geologic section at Bloomington, Indiana, using Rayleigh wave displacement amplitude ratios: Indiana Academy of Science, v. 88, p. 260.

Kwon, B.D., Blakely, R.F., and Rudman, A.J., 1977 An approach to automatic well-log correlation: Indiana Academy of Science, v. 88, p. 260.

Palmer, A.N., and Moore, M.C., Geomorphology and hydrology of the Indiana and Kentucky karst: a symposium; National Speleological Soc. Bull., 38:4, p. 73-73.

Rexroad, C.B., Lithofacies relations in Alexandrian and early Niagaran rocks (Silurian) in Indiana and parts of Illinois, Kentucky, and Ohio (abs.): Am. Assoc. Petroleum Geologists Bull., v. 60, p. 1623-1624.

Rexroad, C.B., and Fraunfelter, G.H., Upper Mississippian conodonts and boundary relations in southern Illinois, in C.O. Frank (ed.), Guidebook for field trips (North-Central Sec., Geol. Soc. America): Carbondale 1977, v. 2, p. 80-103, 8 figs.

Rexroad, C.B., Underground Indiana -- five famous caves promise adventure, romance, and beauty: The Republic, Columbus, Ind., republished from Outdoor Indiana.

Shaffer, N.R., and Faure, G., Regional variation of $^{87}\text{Sr}/^{86}\text{Sr}$ ratios and mineral compositions of sediment from the Ross, Sea, Antarctica: Geol. Soc. America Bull., v. 87, p. 1491-1500.

Shaffer, N.R., Possibility of Mississippi valley type ore deposits in Indiana (abs.): Geol. Soc. America Abstr. with Programs, v. 9, no. 5, p. 650.

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Ault, Curtis H., Indiana's early lime burners: Outdoor Indiana, v. 42, no. 3, p. 30-33, April 1977.

Carpenter, G.L., and Brown, H.R., Is it a well or just a hole in the ground: Outdoor Indiana, v. 41, no. 7, September 1976.

Carr, Donald D., and Eggert, Donald L., Carrying coals to Newcastle: low-sulfur coal in Indiana: Outdoor Indiana, v. 42, no. 5, p. 4-8, June 1977.

Eggert, D.L., Geologic considerations in surface mine reclamation: Outdoor Indiana, v. 42, no. 5, p. 36-38, June 1977.

Rarick, R. Dee, Paper Coal--Hoosier mineral curiosity: Outdoor Indiana, v. 41, no. 10, p. 41-44, December 1976-January 1977.

Rexroad, C.B., Underground Indiana -- five famous caves promise adventure, romance, and beauty: Outdoor Indiana, v. 42, no. 6, July-August 1976.

Shaffer, Nelson R., Hoosiers think zinc: Outdoor Indiana, v. 42, no. 2, p. 14-18, March 1977.

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Ault, C.H., and Moore, M.C., Aggregate resources of the Big Blue River Valley in Hancock and Rush Counties and parts of Henry and Shelby Counties.

Becker, Leroy E., and Droste, John B., General sedimentological history of late Silurian and early Devonian events in southwestern Indiana.

Bleuer, N.K., and Moore, M.C., Environmental geology of Allen County, Indiana.

Bleuer, N.K., Western Indiana till sheets, lobe origin and age, magnetic stratigraphy and the problematic classic Midwestern glacial sequence (abs.): Geol. Soc. America Abs. with Programs, 1 p.

Bleuer, N.K., and Moore, M.C., Applied geology of Allen County, Indiana: Spec. Rept., 56 p., 32 figs., 13 tbls., appendix.

Bridges, K., Geologic story of Shades State Park: State Park Guide, 5 p., 4 figs.

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PAPERS PRESENTED AT PROFESSIONAL MEETINGS

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Becker, L.E., and Droste, J.B., General sedimentological history of late Silurian and early Devonian events in southwestern Indiana: Eastern Section AAPG meeting, October 1976.

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Becker, Leroy E., and Droste, John B., General sedimentological history of late Silurian and early Devonian events in southwestern Indiana, Indiana-Kentucky Geological Society, February 1977.

Biggs, Maurice E., The burning hill - a hope for oil shale in Indiana, Indiana Buffalo Riders, June 1977.

Blakely, Robert F., The seismicity of Indiana, Indiana-Kentucky Geological Society, September 1976.

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Bleuer, N.K., History of classification of Pleistocene materials and current classification problems, Indiana University-Purdue University, Fort Wayne Geology Club, February 1977.

Carpenter, Gerald, Petroleum prospects underlying the Hoosier National Forest, WTTV television station, May 1977.

Carr, D.D., Indiana's coal resources, Institute held by the Rose-Hulman Center for Technology Assessment and Policy Studies, July 1976.

Carr, D.D., Coal resources of Indiana, Nature Study Club of Indiana, September 1976.

Carr, D.D., Indiana coal resources, Mining Technology Department colloquium, Indiana State University, April 1977.

Eggert, D.L., Geology of Sugar Creek area, Indiana University Continuing Education course, September 1976.

Gray, H.H., and Patton, J.B., History of geologic maps in Indiana, February 1977.

Hartke, E.J., Geologic requirements for a satisfactory sanitary landfill for the disposal (storage) of pesticides, Pesticide Disposal Symposium, Indianapolis, April 1977.

Hartke, E.J., Ideal geologic conditions for landfills, Terre Haute Committee for Area Progress, Terre Haute, Indiana, May 1977.

Hill, J.R., Brown County geology, Girl campers at Gnaw Bone Camp, July 1976.

Hill, J.R., Geology of the lower Wabash River, Indiana Chapter of Audubon Soc., New Harmony, October 1976.

Hill, J.R., Septic systems and geology, Indiana University Department Geology class, January 1977.

Hill, J.R., Seismological equipment and general geology, Indianapolis school children, Gnaw Bone Camp, June 1977.

Hreha, Andrew, Pre-Knox (Cambrian) rocks in Indiana, by Becker, Leroy, Hreha, Andrew, and Dawson, T.A., Geology colloquium, Indiana University, February 1977.

Moore, Mike, Indiana caves and caving safety and techniques, Children's Museum cave seminar, November 1976.

Patton, John B., Historically authentic masonry materials in the Renovation of Christ Church Cathedral, Indiana Academy of Science meeting at Valparaiso University, November 1976.

Patton, John B., I remember the winter of 1976-77, Rotary Club of Bloomington, January 1977.

Patton, John B., The immortal clay, Bloomington Chapter of the National Secretaries Association, February 1977.

Patton, John B., The energy situation, Downtown Kiwanis of Bloomington, February 1977.

Rarick, R. Dee, Indiana Geodes, WTTV television station program Outdoors Indiana.

Rarick, R. Dee, Various lectures to the Michiana Rock and Gem Society, South Bend; Bloomington Chapter of the American Business Women's Club; Outdoor Education Conference for counselors conducting day camps in Marion and adjacent counties.

Rexroad, C.B., Lithofacies relations in Alexandrian and Early Niagaran rocks (Silurian) in Indiana and parts of Illinois, Kentucky, and Ohio, Indiana University Department of Geology Colloquium, September 1976.

Shaffer, Nelson, Rocks and Minerals, Cub Scout troop, April 1977.

Shaffer, Nelson, Visitors from outer space - meteorites, Three Rivers Gem and Mineral Society, October 1976.

Shaffer, Nelson, Industrial minerals, Economic Geology class, Indiana University, November 1976.

Shaffer, Nelson, Pegmatites of the Spruce Pine area, North Carolina, Bloomington Gem and Mineral Club, November 1976.

Shaver, R.H., Midwestern Silurian Stratigraphy, Indiana University Geology Department stratigraphy class, November 1976.

Sullivan, Dan, Petroleum prospects underlying the Hoosier National Forest, WTTV television station, May 1977.

PUBLIC FIELD TRIPS

Bleuer, N.K., (with others), Geology and nature along Sugar Creek (by canoe) for noncredit adult education course at Indiana University, July 29, 1976.

Carpenter, Gerald, Road cuts in Crawford County, Indiana, for a group of Boy Scouts from Princeton, Indiana, November 1976.

Carr, D.D., Exposures of Ramp Creek, Harrodsburg, Salem, and St. Louis along SR 37 south of Bloomington, for students from Western Illinois University at Macomb, April 29, 1977.

Eggert, D.L., Canoe trip down Sugar Creek, for Continuing Education Studies, Indiana University, October 1976.

Hill, J.R., Geology of lower Wabash Valley and around New Harmony and the Old Dam, for Indiana Chapter of Audubon Society, October 23, 1977.

Hutchison, H.C., Amax Coal Company's Minnehaha Mine in eastern Sullivan Co., for Coal Geology class, Indiana University, November 1976.

Rexroad, C.B., and Fraunfelter, G.H., Upper Mississippian conodonts and boundary relations in southern Illinois, for North-Central Sec., Geological Society of America, April 30, 1977.

Shaver, R.H., Quarries and outcrops of New Albany (Antrim) Shale, for geologists of Amoco Production Company, June 27, 1977.

ACTIVITIES

Curtis Ault -- Salary Equity Review Committee for Administrative and Professional Personnel at Indiana University; Steering Committee for classification of Indiana University professional staff.

Leroy E. Becker -- Member of the Potential Gas Committee, to develop potential or undiscovered gas reserves for their specific areas.

Blakely, Robert F. -- Served as advisor to the Evansville Building Council.

Served as advisor to the State Administrative Building Council.

Gerald Carpenter -- Participated at the AAPG Committee on Statistics of Drilling, in connection with developing oil and gas statistics for Indiana.

Donald Carr -- Director-elect of the Society of Mining Engineers of AIME; Secretary-Treasurer (to February 1977), Chairman-elect (from February 1977), Industrial Minerals Division SME.

W.A. Hasenmueller -- Served on the Exhibitor's Committee of the Community Service Council which is planning an energy fair in Bloomington in the fall - 1977.

Michael Moore -- Central Area Correspondent for the National Speleological Society News.

Served on the Nominating Committee for the Association of Professional Geological Scientists.

John B. Patton -- Met with Energy Task Force of the Lt. Governor's Science Advisory Committee.

Attended meeting in Morgantown, West Virginia with ERDA personnel in connection with a project to investigate the energy resources of the New Albany Shale in Indiana. Subsequently a contract was agreed upon for this work.

Participated in a Historic Preservation Conference held on campus of Vincennes University.

Served as a member of an American Commission on Stratigraphic Nomenclature committee to make recommendations for possible revisions in the Code of Stratigraphic Nomenclature.

Participated in a meeting of the New Madrid Study Group that is considering the seismicity of the mid-continent region.

Participated in a meeting of Committee C-18, Natural Building Stones, of the American Society for Testing and Materials.

Participated in meeting of Interstate Oil Compact Commission as member of Research Committee and Energy Committee.

Attended an Agricultural Land Use Conference sponsored by the Midwest Governor's Conference Agricultural Resources Utilization Task Force, of which he is a member.

At the request of Lt. Governor Orr's office, attended a hearing on March 3 before the House Rules Committee on a bill to establish a severance tax on coal and establish an Energy Development Board in the Department of Commerce. On March 4 he appeared before the Ways and Means Committee regarding the altered bill from which severance tax provisions had been removed.

Met in Indianapolis with representatives from industries, research groups, universities, and state agencies concerning ways to coordinate energy research being undertaken throughout the state and establish energy policy for the State of Indiana.

At the request of Lt. Governor Orr, attended a hearing before the Senate Natural Resources Committee on House Bill 2189 (Energy Development Board), but did not testify.

Attended a meeting in Lexington, Kentucky, with Kentucky Geological Survey and U.S. Geological Survey personnel concerning geologic programs of those two organizations in Kentucky.

R. Dee Rarick -- Served as a member of the State Fair Committee for the 1977 Indiana State Fair.

Served as a member of the Indiana University Staff Council Scholarships Selection Committee.

Served as a member of the 1977 Selections Committee for the EARTHWATCH Scholarship Program, sponsored by the Indiana Department of Public Instruction.

Nelson Shaffer -- Secretary-Treasurer for Indiana Geologists for the year 1977-78.

Dan Sullivan -- Served as a member of the API's 13-man national committee on crude oil reserves.