

98th ANNUAL REPORT OF THE STATE GEOLOGIST

of

INDIANA GEOLOGICAL SURVEY  
DEPARTMENT OF NATURAL RESOURCES

for

July 1, 1973 - June 30, 1974

GEOLOGICAL SURVEY  
NINETY-EIGHTH 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 Section

Charles E. Wier. . . . . Geologist and Head  
(On leave since May 10, 1974)  
Donald Eggert. . . . . Geologist  
(From June 17, 1974)  
Harold C. Hutchison . . . . . Geologist  
Marvin T. Iverson . . . . . Geological Assistant  
Richard L. Powell . . . . . Geologist  
(From November 1, 1973)  
. . . . . Acting Head  
(Since May 10, 1974)  
Bonnie Burks . . . . . Secretary  
(From September 10, 1973)

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

Educational Services

Reevan Dee Rarick . . . . . Geologist

### Geochemistry Section

Richard K. Leininger . . . . . Geochemist and Head  
Carrie Foley . . . . . Laboratory Technician  
Margaret V. Golde . . . . . Instrumental Analyst  
Louis V. Miller . . . . . Coal Chemist  
Patricia N. White . . . . . Secretary  
(Shared with Industrial Minerals Section)  
(From September 4, 1973)

### 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  
Clarence Haskins . . . . . Driller  
John R. Helms . . . . . Geophysical Assistant  
Joseph F. Whaley . . . . . Geophysicist  
Julie A. Royster . . . . . Secretary

### Industrial Minerals Section

Donald D. Carr . . . . . Geologist and Head  
Curtis H. Ault . . . . . Geologist  
George S. Austin . . . . . Geologist  
Michael C. Moore . . . . . Geologist  
Patricia N. White . . . . . Secretary  
(From September 4, 1973)  
(To August 24, 1973)

Petroleum Section

T. A. Dawson . . . . . Geologist and Head  
(To April 5, 1974)  
Leroy E. Becker . . . . . Geologist  
(On leave September 17-November 15, 1973)  
M. Ruth Butcher . . . . . Secretary and Curator of Records  
(To May 31, 1974)  
Gerald L. Carpenter . . . . . Geologist  
Acting Head  
(April 8, 1974 to June 20, 1974)  
James T. Cazee . . . . . Geological Assistant  
Wilma Fisher . . . . . Senior Records Clerk  
(From November 2, 1974)  
Patsy Hall . . . . . Secretary and Curator of Records  
(From June 10, 1974)  
William Hamm . . . . . Geological Assistant  
Andrew Hreha . . . . . Geologist  
Stanley J. Keller . . . . . Geologist  
Vivian McGuire . . . . . Senior Curator of Records  
(To August 15, 1973)  
Sherry Slusher . . . . . Senior Records Clerk  
(From September 4, 1973 to November 2, 1973)  
Geological Assistant  
(From November 2, 1973)  
Dan M. Sullivan . . . . . Geologist  
James Thrasher . . . . . Geological Assistant  
(To September 26, 1973)

Publications Section

Gerald S. Woodard . . . . . Editor and Head  
Donna C. Schultz . . . . . Senior Sales and Records Clerk

Seasonal Personnel

Coal Section

Larry Cutrone . . . . . Laboratory Assistant  
(July 1, 1973 to August 25, 1973)  
Abhijit Basu . . . . . Geological Assistant  
(August 26, 1973 to September 8, 1973)  
Vaughn Winslow . . . . . Research Assistant  
(January 27, 1974 to May 4, 1974)

Geochemistry Section

Dale Benzer . . . . . Laboratory Assistant  
(July 1, 1973 to July 14, 1973)  
Charles Betz . . . . . Laboratory Assistant  
(February 24, 1974 to May 4, 1974)  
Nolly Deis . . . . . Laboratory Assistant  
(January 13, 1974 to May 4, 1974)  
Robert Hartsaw . . . . . Laboratory Assistant  
(July 1, 1973 to February 23, 1974)  
Dan Honeycutt . . . . . Laboratory Assistant  
(September 9, 1973 to March 9, 1974)  
Elizabeth Kelley . . . . . Laboratory Assistant  
(July 1, 1973 to August 25, 1973)  
Judi Kowal . . . . . Laboratory Assistant  
(January 13, 1974 to January 26, 1974)  
Elizabeth McVeety . . . . . Laboratory Assistant  
(September 9, 1973 to May 4, 1974)  
Sheila Mulhall . . . . . Laboratory Assistant  
(July 1, 1973 to August 25, 1973)  
Diane Nichols . . . . . Laboratory Assistant  
(June 2, 1974 to June 30, 1974)  
Thomas E. Parkey . . . . . Laboratory Assistant  
(November 4, 1973 to December 15, 1973)  
Robert Rodewald . . . . . Laboratory Assistant  
(October 2, 1973 to June 29, 1974)  
Lita Sager . . . . . Laboratory Assistant  
(January 13, 1974 to May 4, 1974)  
Louis Schultz . . . . . Laboratory Assistant  
(January 13, 1974 to April 20, 1974)  
Carla Vehling . . . . . Laboratory Assistant  
(July 1, 1973 to August 11, 1973)  
Dean Wade . . . . . Laboratory Assistant  
(May 19, 1974 to June 30, 1974)  
Colette Walls . . . . . Laboratory Assistant  
(June 2, 1974 to July 13, 1974)  
Betty Williams . . . . . Laboratory Assistant  
(June 2, 1974 to August 10, 1974)  
Debra Woolley . . . . . Laboratory Assistant  
(July 1, 1973 to August 11, 1973)

Geology Section

Sandra Alleyne . . . . . Laboratory Assistant  
(September 4, 1974 to October 11, 1974)  
Paula Barbour . . . . . Laboratory Assistant  
(January 14, 1974 to March 26, 1974;  
June 20-30, 1974)

Geology Section (continued)

Alan Barker . . . . .Laboratory Assistant  
(March 25, 1974 to June 30, 1974)  
Mary Barker . . . . .Laboratory Assistant  
(January 9, 1974 to June 30, 1974)  
Robert Bonebrake . . . . .Laboratory Assistant  
(October 23, 1973 to April 14, 1974)  
Donald Brawley . . . . .Laboratory Assistant  
(June 10, 1974 to June 30, 1974)  
Charles Braxton . . . . .Laboratory Assistant  
(January 2, 1974 to June 14, 1974)  
Michael Brown . . . . .Laboratory Assistant  
(June 3, 1974 to June 30, 1974)  
Michael Canganelli . . . . .Laboratory Assistant  
(May 16, 1974 to June 30, 1974)  
Terry Cox . . . . .Laboratory Assistant  
(September 6, 1973 to December 23, 1973)  
Thomas Devine . . . . .Laboratory Assistant  
(September 17, 1973 to May 4, 1974)  
Gerald Dudzik . . . . .Laboratory Assistant  
(December 3, 1973 to May 4, 1974)  
Christine Havens . . . . .Laboratory Assistant  
(May 21, 1974 to June 30, 1974)  
Wilbur Hawkins . . . . .Laboratory Assistant  
(July 1, 1973 to August 10, 1973)  
David Kazmirski . . . . .Laboratory Assistant  
(November 9, 1973 to April 25, 1974)  
Alice Losch . . . . .Laboratory Assistant  
(July 9, 1973 to August 13, 1973)  
Margaret Rhodes . . . . .Laboratory Assistant  
(December 11, 1973 to June 5, 1974)  
Charlotte Sue Shelton . . . . .Laboratory Assistant  
(August 10, 1973 to November 15, 1973)  
Janice Tharp . . . . .Laboratory Assistant  
(May 30, 1974 to June 30, 1974)  
Arthur Thomas . . . . .Laboratory Assistant  
(October 31, 1973 to March 1, 1974)  
Barbara Tully . . . . .Laboratory Assistant  
(July 1, 1973 to August 22, 1973)  
Clark Varneil . . . . .Laboratory Assistant  
(July 1, 1973 to August 15, 1973)

Geophysics Section

Michael Ardeel . . . . .Research Assistant  
(September 9, 1973 to April 20, 1974)  
Linda Case . . . . .Key Punch Operator  
(June 17, 1973 to August 26, 1973)

Geophysics Section (continued)

Helen Duncan . . . . . Clerk-Typist  
(February 10, 1974 to March 9, 1974)  
Nancy Hasenmueller . . . . . Geologist  
(July 1, 1973 to June 30, 1974)  
Rebecca Jane Hoadley . . . . . Clerk-Typist  
(May 5, 1974 to June 30, 1974)  
Barry Hunt . . . . . Clerk-Typist  
(November 4, 1973 to April 6, 1974)  
Mark Mercer . . . . . Clerk-Typist  
(October 7, 1974 to December 29, 1974)  
Albert Rudman . . . . . Geophysicist  
(July 1, 1973 to August 11, 1973;  
May 5, 1974 to June 30, 1974)  
Madan Varma . . . . . Geophysicist  
(June 17, 1973 to August 26, 1973;  
May 5, 1974 to June 30, 1974)

Industrial Minerals Section

Phillip Caserotti . . . . . Laboratory Assistant  
(September 23, 1973 to June 29, 1974)  
Ed Crisp . . . . . Laboratory Assistant  
(May 22, 1974 to June 28, 1974)  
Steve Lutter . . . . . Laboratory Assistant  
(May 13, 1974 to June 30, 1974)  
Constance Pacay . . . . . Laboratory Assistant  
(June 2, 1974 to June 30, 1974)  
Gregory Wahlman . . . . . Laboratory Assistant  
(July 1, 1973 to August 25, 1973)

Petroleum Section

Frank Cioffi . . . . . Geological Assistant  
(June 3, 1974 to July 1, 1974)  
Paul Dubois . . . . . Geological Assistant  
(September 1, 1973 to May 16, 1974)  
Larry Enochs . . . . . Geological Assistant  
(July 3, 1973 to August 20, 1973;  
June 10, 1974 to July 1, 1974)  
Elizabeth Neiman . . . . . Secretary  
(July 16, 1973 to July 27, 1973)  
Joyce Warren . . . . . Clerk-Typist  
(November 30, 1973 to May 4, 1974)

Publications Section

Faul M. Black . . . . . Clerk  
(to July 2, 1973)  
David Hinton . . . . . Clerk  
(July 15, 1973 to March 29, 1974)  
Sharon Anne Russell . . . . . Clerk  
(from January 21, 1974)



STATISTICAL SUMMARY OF ACTIVITIES FOR FISCAL 1973-74

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

Projects in Progress . . . . .	40
Projects completed . . . . .	4
Special field trips (Conferences . . . . .	88
Conferences with visitors to the Survey . . . . .	1,615
Man days of field work . . . . .	1,013
Incoming letters . . . . .	4,983
Outgoing letters . . . . .	2,998
Total number of Survey vehicles . . . . .	20
Total number of miles traveled in Survey vehicles . . . . .	182,755
Thickness of stratigraphic sections measured . . . . .	7,025
Public lectures	
Civic . . . . .	23
Industrial . . . . .	7
School . . . . .	26
Other . . . . .	4
Chairmanships at professional meetings . . . . .	1
Papers presented at professional meetings . . . . .	17
Field trips for the public . . . . .	20
In connection with conferences . . . . .	9
Educational . . . . .	17
News releases submitted . . . . .	14
Illustrated news items . . . . .	7
Meetings sponsored by the Geological Survey . . . . .	11
Exhibits prepared for special occasions . . . . .	4
Samples received or collected . . . . .	1,057
Rocks, Minerals . . . . .	560
Fossils . . . . .	621
coal . . . . .	26
Water . . . . .	54
Sandstone . . . . .	161
Lake Sediments . . . . .	125
Identifications (Rocks, Minerals, Fossils) . . . . .	382
Packets of geologic education material sent . . . . .	146
Special rock sets for teachers . . . . .	1
Rock and mineral sets sent . . . . .	117
Rock Analyses (magnetic, mineralogical, textural & physical) . . . . .	1,557
X ray mineralogic analyses . . . . .	336
Physical tests . . . . .	318
Seismic refraction shots . . . . .	74
Feet of hole drilled . . . . .	2,231
Feet of core recovered . . . . .	2,134
Number of holes augered . . . . .	24
Feet of hole augered . . . . .	790
Feet of core described . . . . .	2,238

Oil wells field checked	
Current drilling . . . . .	429
Well cutting sets catalogued & filed . . . . .	210
Well cores catalogued & filed . . . . .	18
Strip logs made (wells) . . . . .	195
Feet represented on strip logs . . . . .	267,197
Camera copies made . . . . .	940
Field photographs . . . . .	54
Black and white prints . . . . .	799
Diazo prints . . . . .	6,000
Film prints . . . . .	536
Color slides . . . . .	301
Black and white slides . . . . .	152
Photomicrographs . . . . .	29
Scribecoat . . . . .	2
Color proofs of maps . . . . .	8
Memorandum reports on special projects . . . . .	43
Reports completed for official publication (in editorial process)	
Bulletins . . . . .	5
Regional Geologic Maps . . . . .	1
Miscellaneous Maps . . . . .	5
Reports of Progress . . . . .	2
Outside papers sponsored for Survey publication . . . . .	2
Special Reports . . . . .	3
Mineral Economic Series . . . . .	1
Occasional Papers . . . . .	8
State Park Guide . . . . .	2
Published Reports	
Bulletins . . . . .	5
Mineral Economic Series . . . . .	2
Guidebooks . . . . .	4
Special Reports . . . . .	1
Occasional Papers . . . . .	1
Displays . . . . .	2
Published Maps . . . . .	1
Miscellaneous (new) . . . . .	1
Miscellaneous (revised) . . . . .	1
Petroleum Exploration Maps	
New . . . . .	2
Revised . . . . .	115
Checked without revision . . . . .	97
Regional Geologic Maps supplemental chart published . . . . .	1
Published reports sold . . . . .	5,697
Published maps sold . . . . .	11,737
Publications Office customers . . . . .	4,457
Publications announcements mailed . . . . .	1,058
Outside Publications	
Abstracts . . . . .	6
Complete reports . . . . .	16
Review . . . . .	1

Reports completed and sent to editors	
for outside publication . . . . .	4
Abstracts . . . . .	4
Complete reports . . . . .	5

## COAL SECTION

### Deep Drilling Program

An increasing number of requests concern information on underground mineable coals in areas where our information does not extend to sufficient depth. These come from coal companies, oil companies, consultants representing large investment companies, federal and state organizations, and private individuals. With the realization that large acreages of strippable coal resources in Indiana are no longer available, these companies, agencies, and people are looking for the large, almost completely untapped tonnages of deep coal reserves that represent our future energy source for the next several decades. Their questions concern 1) depth and thickness, 2) quality, 3) mineability (roof, floor, and water conditions, partings in coal, etc.), 4) technological and economic feasibility of producing the coal, 5) uses to which the coal may be put (electric utilities, coal gasification, etc.), 6) environmental and ecological aspects of its use, and 7) "how much is it worth to me?" These reserves represent blocks of coal under an area of 10 to 20 square miles and containing up to 500,000,000 tons, in which five or more underground mines might work to produce in the neighborhood of 10,000,000 tons of coal a year. Most large mines now produce from 1 to 2 million tons per year.

There are some indications that we may find significant bodies of thick coals that are low in sulfur--currently in demand owing to air pollution regulations.

During the past year a total of 2,231 feet of holes were drilled at three locations spaced at approximately 6 mile intervals from southern Sullivan County near the town of Carlisle southward to just north of Vincennes in Knox County. A combined total of 67.6 feet of coal was drilled, the thickest individual seam encountered being 7.2 feet. Samples of all of the major coal beds - Coals VII, VI, V, and III - from each of the holes were crushed and sieved to appropriate sizes, and washability determinations at 4 specific gravities were run. Chemical analyses to determine heating value (B.t.u.) and ash and sulfur content for each float-sink fraction are currently being conducted.

The study of deep coal resources is being supplemented by data acquired from electric logs. The identification of coals on electric logs is difficult, but identification is aided by cores and drillers logs, such as the Survey drill holes, which serve as reference sections. Thus far, 1356 control points have been plotted from electric logs in Knox County to extend the data received from our drill holes to cover a broader area.

## Current Projects

### Active Coal Mine Map

In January 1974, the "Map of Southwestern Indiana showing the location of Active Coal Mines" (Misc. Map No. 7) was revised. At that time 55 active mines were in operation--2 underground mines and 53 strip mines. Coal from the larger strip mines was run through 17 coal preparation plants, and coal was loaded on barges in the Ohio River at 2 loading docks.

### Distribution of acid-forming material in overburden materials

Work continued during the past year in an attempt to characterize the chemical and physical composition of sandstone and shales that overlie Indiana's coal beds. Increased emphasis in recent years has been placed on evaluating acid-forming minerals in the overburden rocks in active strip mines. This overburden material is the source of much of the sulfuric acid that pollutes run-off waters. The acid also makes some of the man-made land surface too acid to sustain normal growth of vegetation planted in accordance with regulations on the reclamation of abandoned strip mined areas.

An intensive study of a small (approximately 4 square mile) area has provided basic data necessary for expansion of this project to broader applications, both geographically and stratigraphically. This local study determined the relationship of the concentration of pyrite (iron sulfide) to the different kinds of sandstone and shale in overburden rocks. The lower few feet of sandstones, particularly in the channel phase of sandstone deposition, has proven thus far to be the main contaminator. Both weathered and unweathered materials were studied. A variety of sulfate minerals were found to be present in the weathered material and to be major contributors to an acid environment.

The results of this detailed study have been successfully applied to acid spoil problems at several mines in various coal beds in southwestern Indiana. "Selective strip mining" of overburden materials has proven possible in assuring that the identified acid forming minerals are buried by less acid overburden. A report on this work is in the final draft stage.

### Preliminary Coal Map

Little work has been accomplished on the preliminary coal maps for Greene, Owen, and Putnam Counties, which stands as 60 percent complete. The data are on open file, as work maps, however, and is available to answer requests for information in those areas.

## Satellite Imagery Interpretation

The Coal Section continued as a Principal Investigator for the evaluation of multi-sensor scanning (MSS) imagery from NASA's Earth Resources Technologic Satellite (ERTS) and photography from Skylab. A few sets of essentially cloud-free images and photographs are on file.

The study of the relationship of lineaments (line-like markings) detectable on MSS imagery and serial photographs in relation to roof falls in underground mines was terminated. Lineament maps were completed for the Danville, Indianapolis and Vincennes regional quadrangles. Two maps, the Vincennes and Indianapolis regional quadrangles, showing the location of large gob (refuse) piles associated with abandoned underground mines have been prepared and estimates made on the cost of gob pile reclamation.

A preliminary study of underground mine subsidence from aerial photography has been made and a more comprehensive study is considered for a future project. Areas susceptible to subsidence may be determined from maps of underground mines, but maps are lacking for some mines.

## DRAFTING AND PHOTOGRAPHY SECTION

The Drafting and Photography Section has the responsibility for the final preparation of maps and illustrations for geologic publications, for talks, and for displays. Work involves negative scribing, free hand drawing, diazo printing, copying, film developing and printing color proofing, photomicrography, field photography, lantern slide preparation, and many other tasks.

The Section, which continually works under pressure of deadlines, had an exceptionally productive year. During that time they completed drafting for 7 reports, redrew Petroleum Exploration Maps for two counties, revised the Petroleum Maps for all counties, revised Miscellaneous Map 9, prepared a highly detailed Supplemental Chart for the Regional Geologic Maps, illustrated 3 Guidebooks, prepared drawings for 24 illustrated newspaper articles, planned and executed 3 exhibits, and did the drafting and photography for slides to illustrate about fifty talks.

Drafting jobs completed for publication are: Regional Geologic Map Chart 1, Properties and uses of geologic materials in Indiana; Petroleum Exploration Maps 54 and 54A (Posey County); Bulletin 42-J The lime industry of Indiana; Bulletin 49, Characteristics of late Wisconsinan tills in eastern Indiana; Bulletin 50, Silurian and

Devonian rocks in Indiana southwest of the Cincinnati Arch; Report of Progress 31, Some Kirkbyacean ostracods of Indiana and midcontinent series terminology; Special Report 8, The Indiana Dunes--legacy of sand; Mineral Economics Series 20, Oil development and production in Indiana during 1973; Occasional Paper 1, Glacial Lake sediments in Salt Creek Valley near Bedford, Indiana; Occasional Paper 2, Haney Limestone in Indiana; Occasional Paper 3, The Muscatatuck Group in Indiana; and State Park Guide 1, Geologic story of Pokagon State Park, legacy of Indiana's ice age.

The series of petroleum exploration maps were revised to include data thru 1973. Miscellaneous Map 7, Map of southwestern Indiana showing active coal mines was revised. The illustrations for two guidebooks, an environment study of Allen County, and a sedimentation study of Lake Lemon were finished. A base map was prepared for use in revising Regional Geologic Map 1 (Indianapolis Sheet). Sketches were made for eighteen news items and two displays were completed.

Other jobs in progress include Occasional Paper 4, Age and origin of stone quarried near Fort Wayne in the mid-1800's; Occasional Paper 5, Age of the Detroit River Formation in Indiana; Occasional Paper 6, Dictionary of masonry materials and terms; Bulletin \_\_\_\_, Stratigraphy of the Detroit River Formation of northern Indiana; Bulletin \_\_\_\_, Geology of the Catlin-Mansfield area, Parke and Putnam Counties, Indiana; Bulletin \_\_\_\_, Crushed stone resources of the Blue River Group in Indiana; Special Report 9, Pyrite in the Springfield Coal Member (V), Petersburg Formation, Sullivan County, Indiana; Miscellaneous Map 19, Environmental geology of the New Albany area, Indiana; Miscellaneous Map 20, Environmental geology of the Jeffersonville area, Indiana; a display for the Indiana State Fair; sketches of Indiana's state geologists; and a portrait drawing of Col. Lieber.

Photographic items produced during the year consist of 964 camera copies, 54 field photographs, 747 black and white prints, 414 film positives and duplicate negatives, 122 stripping film prints of stickup type, 2 scribesheets, 9 peelcoat films, 8 color proofs, 152 black and white slides, and 301 color and color tinted slides.

Approximately 5500 prints were made on the diazo printer.

## EDUCATIONAL SERVICES

The Office of Educational Services was established by the State Geologist 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 groups, adult groups, and all persons interested in rocks, minerals, fossils 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 aids in informing 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, the Educational Services geologist works directly with teachers in public schools, geology clubs, Scout groups, 4-H clubs, conservation clubs, civic groups, and children throughout the State on programs or projects concerning Indiana's geology and mineral resources. On occasion he serves as guest lecturer and conducts field trips for college classes. He identifies many of the rock and mineral specimens sent to the Indiana Geological Survey through the mail from Indiana citizens. The geologist in charge of Educational Services also aids in the preparation and installation of exhibits for fairs, for professional meetings, for amateur rock shows, and for the displays in the Geology Building.

A new program initiated by the Geological Survey during the past fiscal year was the preparation of illustrated news items about Indiana geology, mineral resources, and current research programs being carried out by the Survey. These news items, a continuing series, have been sent to every newspaper in the state.

Interest created by the illustrated news series has resulted in numerous requests from radio and television stations for copies to use in their programming. In addition, the Geological Survey has been asked by several newspapers and stations for further material on selected subjects for feature stories and public interest programs.

During the fiscal year of 1973-74 the geologist in charge of the Office of Educational Services spent 59 days in the field and traveled more than 18,900 miles. In answer to requests received from the public, 8 public lectures were given and 9 special field trips and 6 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: 4-H group from Marion County; Camp Riley, Bradford Woods; Bloomington Gem and Mineral Club; Peru Y.M.C.A. Rocks and Minerals Club; 4th grade class, Broadview School, Bloomington; student teacher group, I.U. School of Education, Bloomington; visiting lay group from Chattanooga, Tenn.; White River Geological Society; Education 540, I.U. summer school class



in conservation education; and Dr. Droste's summer school class in geology.

Special field trips, collecting hikes, and tours were conducted for the following groups: 4-H group from Marion County, Bradford Woods; Education 540, I. U. summer school class in conservation education; 4th grade class, Childs School, Bloomington; 3rd grade, McCalla School, Bloomington; Arlington School Weblos, Bloomington; Rogers School Cub Scout group, Bloomington; 2nd and 3rd grade classes, McCalla School, Bloomington; and a visiting college professor from Canada.

The Educational Services geologist also assisted in the conducting of the Geological Survey sponsored field trips in the Fort Wayne area, the Brazil-Terre Haute area, and the Jeffersonville-New Albany area.

Articles submitted and published in OUTDCOR INDIANA included: "Petroleum and the Energy Crisis," by R. Dee Rarick (September 1973); "Prehistoric Rocks Reveal Much about Indiana's Earlier Years--A Geologist Revisits Clifty Falls State Park," by Carl B. Rexroad (December 1973-January 1974); "Indiana's Abandoned Quarries--Environmental Problem or Community Assets," by Curtis H. Ault (March 1974); and "Rockhounding--An Exhilarating Hobby," by R. Dee Rarick (April 1974).

During the past fiscal year the geologist in charge of Educational Services submitted 14 news releases to Indiana's newspapers about the activities of the Geological Survey. Also, he participated in 3 radio and television shows concerning the Survey's activities in the field of mineral resources and Indiana geology.

Exhibits prepared by the Indiana Geological Survey for public display included a major exhibit for the 1973 Indiana State Fair and a smaller one that was taken to the 1974 Oilmen's Outing at Mt. Vernon, Illinois. Other Survey exhibits were installed at the Glendale Shopping Center, Indianapolis; The College Mall Shopping Center, Bloomington; the annual show of the Midwest Federation of Mineralogical and Geological Societies, Cincinnati, Ohio; Freshman Day, IUPUI Center at Fort Wayne; the State House, Indianapolis; the 1974 annual rock show of the Wabash Valley Gem and Mineral Society, Lafayette; the 1974 rock show of the Kyana Geological Society, Louisville, Kentucky; and McCormick's Creek State Park.

During the 1973 4-H Fair season, geology and weather exhibits were judged at the Marion County 4-H Fair and the Boone County 4-H Fair. Assistance was given to several 4-H geology exhibitors prior to the 4-H fair season and to a few exhibitors who were preparing exhibits for the 1973 Indiana State Fair.

## GEOCHEMISTRY SECTION

The Geochemistry Section is one of three research sections of the Geological Survey. Because of diminished staff, however, the work of the section is almost entirely restricted to routine analyses for other sections. The volume of material collected by Survey geologists has exceeded the analytical capacity of the Section despite the restriction on its work, and now several tons of material are awaiting analysis.

This testing program is important because through it geologists gain information about the chemical and mineral composition of potential resources, and also determine whether these materials contain potentially toxic elements such as mercury and other heavy metals. On the other hand a strong research program is important because the techniques of analysis must constantly be improved to save time and reagents and to gain accuracy. New staff is required for the section to decrease the backlog of samples and to undertake the development and testing of analytical methods.

A joint paper with Dr. George Austin of the Industrial Minerals Section was presented at the regional Geological Society of America meeting and another joint paper is being written for presentation in October at the meeting of the Clay Minerals Society on studies of an X-ray technique involved in clay mineral analysis. Mr. Leininger attended two technical meetings: the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, and the Industrial Minerals Forum. Mr. Miller served as President of "Indiana Geologists" and chaired that group's ten meetings. He served as Secretary-Treasurer of the Indiana Mining and Technical Society and attended its six meetings. He also attended two meetings of the Indiana and Kentucky Geological Society, one of the Indiana Academy of Science, and one of the Indiana Mining Institute. At Indiana University Mr. Miller is Treasurer of the Staff Council. Mrs. Foley has been active with the Bloomington Gem and Mineral Club and has handled that group's Newsletter.

The Geochemistry Section has continued routine analysis of samples submitted by other sections of the Survey. Those projects for which the largest numbers of samples were obtained were the relatively deep drilling for coal (Coal), investigation of sulfur content of overburden sandstones (Coal), study of Silurian reefs of northern Indiana (Industrial Minerals), search for cement raw materials in Ordovician Rocks (Industrial Minerals), and study of sedimentation of Lake Lemon (Geology). Additional projects that have involved analysis are the study of core-samples of Pre-Cambrian (basement) rocks, standardization of source clay minerals in cooperation with the Clay Minerals Society, study of a technique

for measuring amounts of clay minerals in samples, and the routine analysis of cores of carbonate rocks. With the aid of students in the Work Study program, considerable progress has been made in bringing up to date the punched card file of analyses of carbonate rocks. Rewriting of a code to refer to the geologic formation represented in whole or part by samples was accomplished; the resulting version is being used for all samples, old and new.

In conjunction with the Industrial Minerals section, a short time has been spent in the field in search of locations for exploitation of high calcium limestone deposits. Anticipated demand for high quality limestone is expected to be greater than the present supply due to utilization for stack-gas treatment. Also jointly, a core was sampled and prepared for study of the two thickest shales of the State, the New Providence and the New Albany. A cooperative program of the Bureau of Mines was to have provided analyses but was cancelled after the contracted commercial laboratory was found to have failed to meet the specified accuracy; we now expect to do the work.

#### GEOLOGY SECTION

The Geology Section's accomplishments during 1973-74 may be summarized:

The Geology Section worked actively on 13 formal projects and completed one (Lake Lemon sedimentation) of them. Four of the 13 were begun as new projects, all four being classified as applied or environmental projects (Lake Lemon sedimentation, LaPorte County, Hendricks County, Indianapolis Regional Geologic Map revision).

Members of the section had 20 reports and 1 RGM Supplementary Chart published (not including the one book of 380 pages and 128 figures that one of us edited). Four of the 20 reports are abstracts, and together the 20 reports total 366 pages and 111 illustrative exhibitions. These figures (for total volume) are up by about 150 percent over the preceding year's output, but nearly all the increase is owed to the special effort on guidebooks produced for the series of public field trips, and these figures must be shared with other sections of the Survey.

Thus, most of the scientific and applied output was in outside media, and Survey publication of the Section's reports was no more significant than it was for the preceding year. Although the past

two years embraced a virtual 22-month dearth in Survey publication, the bright side is that the dam appeared to be broken at the end of the 1973-74 fiscal year.

Members of the Geology Section submitted for publication 14 new reports, of which four are abstracts. These reports total 273 (estimated in small part) printed pages and 81 figures, which is approximately the same as last year's total (567 typescript pages) in this category, but 183 of these printed pages are constituted in the series of public guidebooks mentioned above. Thus, our regular output is significantly down, and only one of the 10 reports exclusive of the public guidebook series was submitted for Survey publication. Only two of the reports submitted for outside publication during the year remained unpublished.

The section also prepared eight file reports in answer to specific requests for aid. These reports total 75 pages and 35 exhibits, which is down by three reports from the preceding year but remains about the same in page volume.

A backlog of 20 reports and two Miscellaneous Maps, totalling about 860 typescript pages and 136 illustrations, awaited publication. These totals include the three new reports submitted that remained unpublished during the year as well as the 17 reports and two Miscellaneous Maps totalling about 794 pages and 110 illustrations that were submitted in earlier years and remained unpublished. The overall backlog is down at this reporting time by about 10 percent, which is encouraging, but the volume of two-years-old-and-older reports more than doubled (376 vs. 794 pages), which is not encouraging. The most disconcerting aspect of this is that our concentrated environmental effort of several years has not yet resulted in much publication of the planned reports. The one significant exception during 1973-74 is the chart on "Properties and uses of geologic materials in Indiana," RGM Suppl. Chart 1.

The section's staff gave or conducted 25 papers, talks, and field trips, which is up some from last year, particularly in our field trip effort that was devoted to both public and professional groups. In the professional realm, the Kentucky Geological Society and the Michigan Basin Geological Society benefitted particularly from our efforts, whereas in the public education domain a large effort was expended as essentially a new program for the Survey.

The staff was involved in 253 conferences of record, most of which were for requests for information made to us; also, we recorded 88 special field trips of conference type, perhaps half or more of these resulting from requests to us. This activity increased by 25 percent over the preceding year, which year in itself had registered a 25-percent increase. This volume appears

to reflect a still-increasing interest, need, or awareness on the part of many persons, organizations, and businesses in relation to geology, whether immediate objectives are educational, scientific, ecological, or economic (including engineering) in nature. The variety of need seems to be increasing, although volume in some areas of once-concentrated requests (e.g., on solid waste disposal) has decreased.

A notable increase in this kind of effort during the year that is not reflected in these conference statistics (because of reporting method) is lodged in the many Environmental Impact Statements (mostly highway-construction related) that we began to file during the year under a new arrangement.

These summaries suggest that the Section had no one milestone kind of accomplishment to point to during the year such as we had for the preceding year (publication of the last sheets in the RGM series); our accomplishments are respectable enough but represent routine continuations of established programs. These two trends may have some significance: (1) increased outside requests in variety for applied information and (2) our turning more and more to outside outlets for publication as the Survey backlog remained at a high level.

#### GEOPHYSICS SECTION

During the 1973-74 fiscal year the Geophysics Section maintained a program of field work, laboratory measurements, and development of computer programs to assist the interpretation of geophysical data. Because of a rather substantial backlog of field and laboratory data and because of budgetary restrictions, comparatively little field work was undertaken during the year.

Because of a growing public awareness that the design of major structures such as nuclear power plants must take into account possible ground motions, the Geophysics Section has been heavily involved in earthquake studies during the past year. Although historically Indiana has suffered few earthquakes, a few have occurred within the boundaries of the State, others have originated in adjacent States, and the largest earthquake of historic times took place not far from the southwestern tip of Indiana. Using all of these recorded earthquakes, maps are being produced to show probable magnitude and intensity for a quake at any location in the State.

Members of the section also are involved in some nationally recognized applications of high speed computers to the solution of geophysical problems. These efforts are intended to provide fundamental information needed for the interpretation of seismic surveys for the exploration for oil and gas.

Several seismic refraction surveys were made during the year by geophysical field parties to measure depths to bedrock in connection with geological projects. One of these, in Decatur County, was done for the Division of Water to aid interpretation of ground-water conditions. Others in Marion and Hendricks Counties were done to provide information for environmental geology studies.

#### INDUSTRIAL MINERALS SECTION

Members of the Industrial Minerals Section have the responsibility for knowing the location of different non-fuel mineral commodities, their composition, and their present and probable future uses. All of this information has great economic significance for Indiana, particularly if it can be disseminated rapidly and applied to the practical problems of the mineral economy.

During 1973-74 requests for information reached an all-time high of 535, up 7.6% from the previous year. About 47 percent of the requests came from industry, the remainder about equally divided between private individuals, government agencies, and educational institutions.

In an effort to bring geology to the public eye, members of the Section helped organize and lead public field trips in the New Albany-Jeffersonville, Fort Wayne, Terre Haute, and Lake Michigan shore areas. The Section also helped conduct a field trip for the spring meeting of the Indiana Academy of Science, spent one day instructing 27 educators from the Saudi Arabian Ministry of Education on the geology of Indiana, emphasizing Indiana's building stone industry, and guided numerous field trips for scouts and other small groups. The Section instructed 16 persons from an aggregates company both in classroom and field on how geology relates to the quarrying and construction industries.

As Program Director of the Industrial Minerals Division of the Society of Mining Engineers for 1973-74, Donald Carr was responsible for organizing the programs at SME national meetings in Pittsburgh, Pennsylvania and Dallas, Texas. He was also Chairman of a technical session at the Dallas meeting. For 1974-75, Donald Carr was elected Membership Chairman of the Industrial Minerals

Division, SME. George Austin presented talks at the Great Lakes Section, Society of Economic Paleontologists and Mineralogists meeting and the North-Central Section, Geological Society of America meeting. Michael Moore acted as faculty advisor for the Indiana University Spelunking Club and helped edit the Bloomington Indiana Grotto Newsletter. Curtis Ault was elected secretary-treasurer of Indiana Geologists.

#### MINERAL STATISTICIAN

In 1973, although fuel shortages and difficulties in meeting Environmental Protection Agency standards created problems, the total value of minerals produced in Indiana was \$263,565,231.00 (reported at first stage of salability), an increase of 11.12 percent over the previous year. This increase resulted from higher unit prices, because only two of the seven major commodities produced in the state showed increased volume of production (see table attached). The fuels -- coal, petroleum, and natural gas -- accounted for 65.87 percent of the total value of mineral production, and the construction materials -- crushed limestone, sand and gravel, dimension limestone, clay and shale, gypsum, and dimension sandstone -- accounted for 33.96 percent.

A combination of the closing of two large mines and the delays inherent in the opening of other mines resulted in a 2.3 percent decrease in the amount of coal produced during the year, but the total value showed an increase of 13.8 percent.

Although oil production was reported from seven more fields than in the previous year, the total amount produced continued to decline.

Considerable interest was aroused in the building limestone district with the beginning of fabrication, including a large amount of carving, of a monumental stone portico for the Mother Church of the Christian Scientist faith in Boston. Three stone companies are involved in this project.

Quarrying and crushing of limestone for agricultural purposes, construction and maintenance projects, cement manufacturing, and other uses increased substantially over 1972.

Increased production of sand and gravel for road construction, paving, and fill more than offset a slight decline in production reported for structural purposes.

Pike, Sullivan, and Warrick Counties accounted for 42.9 percent (not including oil and gas) of the total value of all mineral commodities produced in Indiana in 1973. The following counties led in production of minerals (excluding oil and gas):

<u>County</u>	<u>Value-Raw Materials</u>	<u>Value-Including Manufactured Products</u>	<u>Mineral Commodities (in alphabetical order)</u>
<u>\$20 million+</u>			
Warrick	\$51,224,307	-----	Coal
Pike	35,161,138	-----	Coal, crushed lime- stone
Sullivan	26,798,474	-----	Coal, crushed lime- stone, sand and gravel
<u>\$10 - \$20 million</u>			
Vermillion	19,011,459	C	Clay and shale, clay products, coal, sand and gravel
<u>\$5 - \$10 million</u>			
Clay	8,158,231	15,598,462	Clay and shale, clay products, coal
Green	6,333,591	C	Clay and shale, clay products, coal, sand and gravel
Hamilton	5,700,025	-----	Crushed limestone, sand and gravel
Lawrence	5,374,212	18,722,661	Cement, clay and shale, crushed lime- stone, dimension limestone, dimension sandstone

In 17 counties, including 4 listed above, additional processing of and manufacture of products from mineral resources added millions of dollars to the total value of mineral production.



	<u>1972</u>		<u>1973</u>	
	<u>Quantity</u>	<u>Value</u>	<u>Quantity</u>	<u>Value</u>
Coal	25,809,742 tons	\$134,210,658	25,207,269 tons	\$152,756,048
Crushed limestone	27,014,125 tons	40,392,432	30,604,496 tons	48,175,634
Sand and gravel	24,221,792 tons	28,580,200	25,173,871 tons	31,998,239
Petroleum	6,129,539 bbls	20,963,023	5,312,096 bbls	20,823,416
Dimension limestone	3,794,111 cu.ft.	7,145,229	2,337,552 cu.ft.	3,698,792
Clay and shale	1,362,680 tons	1,456,351	1,322,412 tons	1,522,744
Peat	129,373 cu.yd.	484,793	112,951 cu.yd.	386,290
Natural gas	355,100,000 cu.ft.	55,500	276,400,000 cu.ft.	38,400
Undistributed - includes dimension sandstone, gypsum, marl, and whetstones		<u>3,902,958</u>		<u>4,165,668</u>
TOTAL		\$237,191,144		\$263,565,231
Value added for additional processing of dimension limestone and manufacture of clay products and cement				\$92,030,522

## 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 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 466 conferences during the fiscal year. In addition to the conferences, 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 Production.--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 Institute.

Review of Petroleum Exploration Map Series.--The individual county petroleum map transparencies were up-dated at year's end. Thirty-nine maps were revised and 53 were checked with no revisions necessary.

Potential Gas Estimates.--The Section participates in the activities of the Potential Gas Committee. The estimate of the potential supply of natural gas in Indiana is a part of the Potential Gas Committee Report on the Potential Supply of Natural Gas in United States.

## Records Improvement

County Strat Test Project.--Work continued on processing the County Strat Tests. This involves 2,579 well records in 58 counties. As of July 1, over 2,000 wells have been processed. The tentative completion date for processing the remaining strat tests is December 1, 1974. After the wells have been processed, they will be selectively field checked or reviewed. The strat tests will be incorporated into the permanent well file in the Section.

Gibson County.--With additional field personnel, it has been possible to accelerate the field checking procedure in the Gibson County well record upgrading project.

The total project is approximately 35 percent completed.

## Subsurface Studies

Work continues on the study of the Pre-Knox rocks in Indiana. This project, started July 1, 1970, has been interrupted several times by the urgency of routine work and other projects.

In Indiana, 121 wells have completely penetrated the Knox Dolomite. In addition to the Indiana wells, about 50 deep tests in the bordering states are being studied. It is estimated that the project is about 50 percent completed.

## Special Projects

Mt. Simon Project.--Early in 1974 the Ohio River Valley Water Sanitation Committee (ORSANCO) requested the eight member states of the Commission study the Mt. Simon Sandstone and its equivalents. The Mt. Simon Sandstone and its equivalents are used as an injection zone for underground waste disposal in Northern Indiana. The geological investigation of the Mt. Simon has been completed and maps have been submitted on the thickness, structure and lithology of the Mt. Simon and its confining unit.

Pipe Line Map.--During the year a map of Indiana showing oil, gas and products pipelines was published. The map was prepared by Stanley J. Keller.

Field Trip.--Stanley Keller was a contributor to the guide book "An Environmental Geology Field Trip of the Terre Haute-Brazil, Indiana Area."

Oil and Gas Field Data Bank and Map Project.--At the annual AAPG meeting held in Anaheim, California in early 1973, the AAPG Committee on Statistics of Drilling was approached about accepting responsibility for undertaking the compilation of data for construction of an oil and gas field map of North America and an associated data bank of geologic information concerning these oil and gas fields. The project, entitled "AAPG Oil and Gas Field Data Bank and Map Project of North America," is sponsored by the AAPG Research Committee with support for the project provided by the Department of Interior and the USGS. The Indiana portion of the project, compiled by G. Carpenter and Paul Dubois is well along and should be finished during September, 1974.

#### Programs, Committees, Societies

Technical Programs.--T. A. Dawson presented a paper on Petroleum at an energy conference sponsored by the Evansville Chamber of Commerce and University of Evansville at Evansville, Indiana, November 8, 1973.

G. L. Carpenter presented a talk on oil production in Indiana at a meeting of the Indiana Geologists held in Mooresville, Indiana, March 6, 1974.

D. M. Sullivan spoke to a visiting group of Saudi-Arabian educators on the history of oil and gas developments in Indiana.

Andrew Hreha spoke to a mineral resources class from Ball State University on the activities of the Petroleum Section.

In addition, G. L. Carpenter participated in a television program (WTTV) on energy needs and supplies of Indiana and U.S. October 9, 1973. He also participated in a panel discussion related to energy, needs, and supplies which was televised from studios of the I.U. Radio and Television Service, December 11, 1973.

Technical Committees.--API National Committee on Reserves and Productive Capacity. T. A. Dawson served as a member of API's 13-man National Committee on crude reserves until his death April 5, 1974.

Dan. M. Sullivan was selected to replace Mr. Dawson on the National Committee. He attended the National Meeting held March 19-23 in Victoria, British Columbia.

API Subcommittee, Tri States Area.--Dan M. Sullivan is a member of the subcommittee that gathers reserves data for Illinois, Indiana, and Kentucky.

AAPG Committee on Statistics of Drilling.--Gerald Carpenter develops oil and gas drilling statistics for Indiana. He attended the Committee's meeting at San Antonio, Texas April 3-4, 1974.

Potential Gas Committee.--Leroy E. Becker is a member of the Potential Gas Committee. The Committee members develop potential or undiscovered gas reserves for their specific area.

Professional Societies.--All the geologists in the Petroleum Section are members of the Indiana-Kentucky Geological Society. Stanley J. Keller is Treasurer of the Society.

Three geologists in the Section are long-standing members of the AAPG and one geologist is a member of the Geological Society of America.

#### PUBLICATIONS SECTION

During the past fiscal year the Publications Section sold 5,697 reports and 11,137 maps. The section sent 2,158 reports and 567 maps on exchange to institutions in the United States and in foreign countries. It also distributed without charge 2,606 reports and 2,795 maps to members of its own organization and to individuals, libraries, and companies in the United States and abroad. The Publications Section served 4,457 office customers, handled 2,336 letters pertaining to geologic reports and maps, and sent out 1,058 announcements of new publications.

The fiscal year 1973-74 was a better publishing year than the previous fiscal year because more money was available for printing and binding publications. Thirteen reports, four new maps, 116 revised maps, and a publications list were issued. In addition, two reports and two maps were reprinted. A new series, Occasional Papers, was introduced late in the fiscal year; the first number in this series was published in June 1974. Occasional Papers, in general, are to consist of short reports of immediate interest and are to receive less formal treatment in the editorial process and in preparation for printing.

## REPORTS AND MAPS PUBLISHED BY THE GEOLOGICAL SURVEY

### Bulletins

Ault, C. H., Rooney, L. F., and Palmer, M. V., 1974, The lime industry of Indiana: Bull. 42-J, 62 p., 1 pl., 18 figs., 1 table.

Carr, D. D., 1973, Geometry and origin of oolite bodies in the Ste. Genevieve Limestone (Mississippian) in the Illinois Basin: Bull. 48, 81 p., 36 figs., 7 tables.

Gooding, A. M., 1973, Characteristics of late Wisconsinan tills in eastern Indiana: Bull. 49, 28 p., 8 figs., 1 table.

Sullivan, D. M., 1972, Subsurface stratigraphy of the West Baden Group in Indiana: Bull. 47, 31 p., 5 pls., 6 figs., 3 tables.

Wier, C. E., 1973, Coal resources of Indiana: Bull. 42-I, 40 p., 19 figs., 6 tables.

### Guidebooks

Ault, C. H., and others, 1973, Guidebook to the geology of some Ice Age features and bedrock formations in the Fort Wayne, Indiana, area: 62 p., 9 figs. (unnumbered publication).

Austin, G. S., and others, 1973, Guidebook to the geology of the New Albany-Jeffersonville area of southern Indiana: 63 p., 8 figs. (unnumbered publication).

Hill, J. R., 1973, Geology for the public: A field guide to the Lake Michigan shore in Indiana: 31 p., 12 figs. (unnumbered publication).

Wiram, V. P., and others, 1973, An environmental geology field trip of the Terre Haute-Brazil, Indiana, area: 60 p., 5 figs. (unnumbered publication).

### Mineral Economics Series

Carpenter, G. L., and Keller, S. J., 1973, Oil development and production in Indiana during 1971: Mineral Economics Ser. 18, 20 p., 3 figs., 5 tables.

Carpenter, G. L., and Keller, S. J., 1974, Oil development and production in Indiana during 1972: Mineral Economics Ser. 19, 20 p., 3 figs., 5 tables.

### Occasional Papers

Gray, H. H., 1974, Glacial lake sediments in Salt Creek valley near Bedford, Indiana: Occasional Paper 1, 10 p., 7 figs.

### Special Reports

Powell, R. L., 1972, Coal strip-mined land in Indiana: Spec. Rept. 6, 18 p., 12 figs., 3 tables.

### Miscellaneous Maps

Hutchison, H. C., 1962, rev. 1974, Map of southwestern Indiana showing location of active coal mines: Misc. Map 7.

Keller, S. J., 1973, Map of Indiana showing oil, gas, and product pipelines: Misc. Map 18.

### Petroleum Exploration Maps

Sullivan, D. M., and Cazez, J. T., December 31, 1972, Well location map of Posey County, Indiana: Petroleum Explor. Map 54.

Sullivan, D. M., and Cazez, J. T., December 31, 1972, Well location map of Posey County, Indiana, showing total depth of wells: Petroleum Explor. Map 54A.

### Regional Geologic Maps

Gray, H. H., compiler, 1973, Properties and uses of geologic materials in Indiana: Regional Geol. Map Supp. Chart 1.

PAPERS PUBLISHED IN SCIENTIFIC JOURNALS

Austin, G. S., 1972, The Sioux Quartzite, southwestern Minnesota: in P. K. Sims, G. B. Morey, editors, Geology of Minnesota: A centennial volume, Minnesota Geological Survey, p. 459-473.

Austin, G. S., 1972, Paleozoic lithostratigraphy of southeastern Minnesota: in P. K. Sims and G. B. Morey, editors, Geology of Minnesota: A centennial volume, Minnesota Geological Survey, p. 459-473.

Austin, G. S., 1972, Cretaceous rocks: in P. K. Sims and G. B. Morey, editors, Geology of Minnesota: A centennial volume, Minnesota Geological Survey, p. 509-512.

Austin, G. S., 1973, Clay and shale resources of Spencer County, Indiana: Ind Acad. Science for 1972, Proc., p. 281-289.

Bleuer, N. K., 1974, the historic Stone Creek section, a key to the glacial stratigraphy of west-central Indiana (Abs.): Geol. Soc. Am. Abstracts with Programs, v. 6, p. 492-493.

Bleuer, N. K., 1974, Buried till ridges in the Fort Wayne Area, Indiana, and their regional significance: Geol. Soc. America Bull., v. 85, p. 917-920, 4 figs.

Carpenter, M. C. and Austin, G. S., 1973, The stratigraphy of the clays and shales of Spencer County, Indiana; Ind. Acad. Science for 1972, Proc., (abstr.) p. 266.

Carr, Donald D., 1974, Industrial Minerals: Geotimes, v. 19, n. 1, p. 18-19.

Foley, C. F., Leininger, R. K. Herring, W. C., Bleuer, N. K., 1973, Strontium and other notable chemical constituents of well-water of Allen County, Indiana: Indiana Acad. Sci. Proc., p. 274-280, 3 figs.

Gray, H. H., and Bleuer, N. K., 1974, p. 8-16, in Late Cenozoic geologic features of the middle Ohio River valley: Kentucky Geol. Survey and Geol. Soc. Kentucky Spring Field Conf. 1974, 25 p.

Moore, M. C., and Bleuer, N. K., 1973, An exposure of pre-Wisconsinan drift near Fort Wayne, Indiana: Indiana Acad. Sci. Proc., v. 82, p. 265.

Nicoll, R. S., and Rexroad, C. B., 1974, Llandovery (Silurian) conodonts from New South Wales: Geol. Soc. America Abstracts with Programs, v. 6, p. 534-535.

Patton, J. B., and Gray, H. H., 1973, Statewide geologic maps of Indiana: Indiana Acad. Sci. Proc., v. 82, p. 303-309.



Patton, J. B., and Carr, D. D., 1974, Dimension Stone: Mining Engineering, v. 26, n. 2, p. 107-108.

Patton, J. B., The Immortal Clay: 1973, The Review, v. XV, no. 4, p. 9-17. Alumni Association of the College of Arts and Sciences - Graduate School, Indiana University.

Patton, J. B., Comments in panel on Coal, in Proceedings of the Purdue Energy Conference of 1973: 1974, p. 99-104.

Patton, J. B., Energy Realities for Tomorrow: 1974, The Review, v. XVI, no. 3, p. 20-30. Alumni Association of the College of Arts and Sciences - Graduate School, Indiana University.

Pollock, C. A., and Rexroad, C. B., 1973, Conodonts from the Salina Formation and the upper part of the Wabash Formation (Silurian) in north-central Indiana: *Geologica et Palaeontologica*, v. 7, p. 77-90, 1 pl., 3 figs., 2 tables.

Roy, D. C., and Rexroad, C. B., 1974, A late Llandoveryan (Silurian) conodont faunule from the Frenchville Formation, Aroostock County, Maine, (Abs.): *Geol. Soc. America Abstracts with Programs*, v. 6, p. 541.

Shaver, R. H., Colloque sur la paleoecologie des ostracodes, edited by H. J. Oertli (a review): *Jour Paleontology*, v. 47, p. 1129-1131.

Shaver, R. H., 1974, Structural evolution of northern Indiana during Silurian time, in Kesling, R. V. (ed.), *Silurian reef-evaporite relationships: Michigan Basin Geol. Soc. Ann. Field Conf. 1974*, p. 55-77, 89-97, 102-109, 14 figs.

Shaver, R. H. (co-editor with Dott, R. H., Jr.) 1974, Modern and ancient geosynclinal sedimentation: *Soc. Econ. Paleontologists and Mineralogists Special Pub. 19*, 380 p., 128 figs.

Shaver, R. H., 1974, The Silurian reefs of northern Indiana: reef and interreef macrofaunas: *Am. Assoc. Petroleum Geologists Bull.*, v. 58, no. 6.

REPORTS PUBLISHED IN OUTDOOR INDIANA

Ault, C. H., 1974, Indiana's Abandoned Quarries - Environmental Problems or Community Assets?: *Outdoor Indiana*, v. 39, n. 2, p. 4-9.

Rarick, R. D., September 1973, Petroleum and the Energy Crisis, *Outdoor Indiana*.

Rarick, R. D., April 1974, Rockhounding--An Exhilarating Hobby, *Outdoor Indiana*.

Rexroad, C. B., 1974, The Rockford Snake Rocks: *Outdoor Indiana*, v. 39, no. 6, p. 7-12.

Rexroad, C. B., 1973, Prehistoric rocks reveal much about Indiana's earlier years: a geologist revisits Clifty Falls State Park: *Outdoor Indiana*, v. 38, no. 10, p. 4-11, 9 figs.

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Ault, C. H., and Shaver, R. H., Origin, growth, geometry, and industrial significance of Silurian reefs in northern Indiana (Abs.): *Geol. Soc. America Abstracts with Programs*, 1 p.

Droste, J. B., and Shaver, R. H., The Jeffersonville Limestone (Middle Devonian) of Indiana: stratigraphy, sedimentation, and relationship to Silurian reef-bearing rocks: *Am. Assoc. Petroleum Geologists Bull.*, 42 p., 11 figs.

Hartke, E. J., and Hill, J. R., Sedimentation in Lake Lemon, Monroe County, Indiana: *Indiana Geol. Survey Occas. Paper*, 23 p., 14 figs.

Shaver, R. H., Structural evolution of northern Indiana during Silurian time: *Michigan Basin Geol. Soc. Ann. Field Conf.*, 1974, 75 p., 15 figs., 1 table.

## MEMORANDUM REPORTS

Bleuer, N. K., June 1974, Regulation of industrial waste disposal by deep well injection in Indiana, 9 p., 7 exhibits. (for Indiana Senate Environmental Committee's Solid Waste Task Force)

Gray, H. H., 1973, "Geology of Portland Arch, Fountain County, Indiana", 3 p., Oct. 16 (for Div. Nat. Preserves)

Gray, Bleuer, Carr, Moore, and Rexroad, Indiana Geol. Survey, February 14, 1974, Geology of Wayne County, Indiana, 12 p., 3 figs., 3 supplementary illus. (for Director, Dept. Nat. Res.)

Hartke, E. J., and Hill, J. R., February 5, 1974, Sedimentation in Lake Lemon, Monroe County, Indiana: 34 p., 13 figs., 4 tables. (for City of Bloomington.)

Hartke, E. J., March 14, 1974, A preliminary geologic evaluation of four proposed power plant sites along the Ohio River in southeastern Indiana, 5 p., 1 fig. (for Ind. Dept. Nat. Res.)

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Rexroad, C. B., January 7, 1974, Identification of stratigraphic units in structurally disturbed area, Charlestown Ordinance Depot, Clark County, Indiana, 2 p. (for Sargent & Lundy, Inc.)

Rexroad, C. B., July 2, 1974, Preliminary geologic investigation of the Strain Ridge Road school property, Monroe County, Indiana: 7 p., 3 figs. (for Monroe County Commun. School Corp.)

## PAPERS PRESENTED AT PROFESSIONAL MEETINGS

Austin, G. S., Effects of heat-treating mixed-layer illite-smectite as related to quantitative clay mineral determinations (abstr.): Geological Society of America, North-Central Section meeting, May 9, 1974.

Bleuer, N. K., The historic Stone Creek section, a key to the glacial stratigraphy of west-central Indiana: North-Central GSA meeting, Kent State University, May 9, 1974.

Rexroad, C. B., Llandovery (Silurian) conodonts from southern New South Wales: North-Central GSA meeting, May 9, 1974.

Rexroad, C. B., A late Llandoveryan (Silurian) conodont fauna from the Frenchville Formation, Aroostock County, Maine: North Central GSA meeting, May 9, 1974.

Shaver, R. H., Indiana Silurian reef and interreef biostratigraphy: Silurian Biostratigraphy Field Conference, Bruce Peninsula, Owen Sound, Ontario, September 28, 1973.

Shaver, R. H., The Niagaran (Middle Silurian) macrofauna of northern Indiana: review appraisal, and inventory: Indiana Acad. Sci., October 26, 1973.

Shaver, R. H., The facies relationship between the Silurian reef- and evaporite-bearing rocks, southern Michigan Basin: Michigan Basin Geol. Soc. Ann. Field Conf., Wapakoneta, Ohio, May 17, 1974.

Shaver, R. H., The Silurian reeflike complex at Rockford, Ohio: North-Central GSA, May 9, 1974.

Wier, C. E., Fossil fuels and the energy crisis: R. L. Powell read the paper at the annual meeting of the Indiana Academy of Science, Oct. 26, 1974.

Wier, C. H., Relationship of roof fall in underground coal mines to fractures mapped on ERTS-Imagery: Third ERTS Symposium in Washington, D.C., Dec. 1973.

Wier, C. E., Application of ERTS Imagery to Indiana coal mining problems: The 9th International Symposium on Remote Sensing on Environment at Ann Arbor, Michigan, April 19, 1974.

Wiram, V. P., Physical and chemical characteristics of an acid producing sandstone warrant preferential strip and burial mining methods: National Coal Association Symposium, Oct. 22-24, 1974.

## PUBLIC LECTURES

Bleuer, N. K., August 2, 1973, Environmental Education, Indiana University class.

Bleuer, N.K., October 4, 1973, Solid Waste Disposal, Midwest Groundwater Conference, Urbana, Illinois.

Gray, H. H., October 5, Energy, resources, man, and the land in southern Indiana, Knob and Valley Chapter of the Audubon Soci., New Albany.

Hartke, E. J., Hill, J. R., December 18, Lake Lemon sedimentation findings, Bloomington City Utilities Board.

Hill, J. R., May 1, 1974, Lake Michigan shoreline erosion in Indiana, Indiana Geologists, Mooresville, Indiana.

Patton, J. B., Sept. 21, 1973, Does Anybody Have a Match? -- Mascnry Materials for Restoration:, Historic Preservation Conference, Bloomington.

Patton, J. B., Oct. 2, 1973, Energy Crisis, Kiwanis Club, Bloomington.

Patton, J. B., Nov. 8, 1973, Environmental Problems of the Bloomington Region - in course Environment and Man, Indiana University, Bloomington.

Patton, J. B., Nov. 8, 1973, Energy from Fuels with Special Reference to Fossil Fuels, Continuing Education course, Indiana University, Bloomington.

Patton, J. B., Jan. 17, 1974, Energy Sources, in panel on How Energy Crisis Affects Local Economy, sponsored by Chamber of Commerce, Columbus, Ind.

Patton, J. B., Jan. 23, 1974, Where is the Fuel Shortage, Kiwanis Club, Marion, Ind.

Patton, J. B., Jan. 24, 1974, History of the Mineral Industries of Monroe County, Monroe County Historical Society.

Patton, J. B., Jan. 28, 1974, Geology of Oil and Gas in Indiana, Scientech Club, Indianapolis.

Patton, J. B., Feb. 20, 1974, Mineral Resources Crisis, Colloquium at Indiana University-Kokomo.

Patton, J. B., Mar. 8, 1974, Indiana's Fuel Resources and the Prospects for Other Energy Supplies, Geology Club, Indiana University-Fort Wayne.

Patton, J. B., Mar. 20, 1974, Fuel for Future Power Needs in the Midwest, combined annual meeting of National Association of Power Engineers, Marion Engineers Club, Institute of Electrical and Electronic Engineers, and Delta Chapter of Indiana Society of Professional Engineers, at Taylor University, Upland.

Patton, J. B., Mar. 21, 1974, History and Prospects of Indiana Oil and Gas, Shrine Club, Richmond, Ind.

Patton, J. B., April 6, 1974, This State of Ours, Retired Officers Club, Crane, Ind.

Patton, J. B., May 16, 1974, Midwest Fuel and Energy Prospects, Seminar sponsored by Indiana University Bureau of Public Discussion and Bloomington Chamber of Commerce.

Patton, J. B., June 18, 1974, The Energy-Environment Balance: Society Cannot Have the Best of Two Worlds, But Need it be the Worst?, Marathon Oil Company Executive Training Program, Bloomington.

Patton, J. B., Presentation on energy situation before Advisory Council on Water and Mineral Resources, Indiana Department of Natural Resources, Nov. 2, 1973.

Patton, J. B., Nov. 29, 1973, served as panel member at Purdue Energy Conference.

Patton, J. B., Dec. 13, 1973, appeared on WFIU television program on energy situation.

Powell, R. L., May 13, 1974, talk and slide show to Land and Water conference at Purdue on coal mining.

Rexroad, C. B., Nov. 2 and 5, 1973, lectures to graduate micro-paleontology class, I.U.

Shaver, R. H., March 25, 1974, Silurian reefs of the southern Great Lakes area, to I.U. Dept. Geology Colloquium.

Wier, C. E., Nov. 1, 1973, Energy Crisis, to the Kiwanis Club, Brazil.

Wier, C. E., Feb. 21, 1974, Coal and the Energy Crisis, Indiana Central College.

Wier, C. E., March 1, 1974, Fuels: Origin and Distribution, to Dr. Davis' environmental geology class.

Wier, C. E., April 2, 1974, Coal and the Energy Crisis in Indiana, to science seminar at Indiana Central College.

Wier, C. E., April 20, 1974, Future of Coal Supply, to conference on surface coal mining at Ball State University.

Wiram, V. P., July 7, 1973, Coal reserves of Sullivan County, meeting of the Sullivan County Farm Bureau in Sullivan.

Wiram, V. P., Sept. 12, 1973, A geological Field Trip of the Vigo-Clay County area, to the Indiana Geologists.

Wiram, V. P., Oct. 16, 1973, Geology of the Vigo County area, to John Cleveland's Economic Geology class, Indiana State University.

Wiram, V. P., gave a slide talk on The Key to Successful Reclamation-Identify the Bad Guys, Shoot'em Up, and Bury'em, to the Indiana Mining and Technical Society.

#### PUBLIC FIELD TRIPS

Bleuer, N. K., Hartke, E. J., Hill, J. R., Rexroad, C. B., Assisted in public field trip on geology of the New Albany-Jeffersonville area of southern Indiana, July 14, 1973.

Shaver, R. H., Participated in Silurian biostratigraphic field conference on Bruce Peninsula, Owen Sound, Ontario, Sept. 27-Oct. 1, 1973.

Bleuer, N. K., Hartke, E. J., Hill, J. R., Shaver, R. H., public field trip on geology of Fort Wayne, Indiana area, October 6, 1973.

Bleuer, N. K., Gray, H. H., public field trip on environmental geology of the Terre Haute-Brazil, Indiana area, October 20, 1973.

Bleuer, N. K., Gray, H. H., Combined field trip for the Sassafras Audubon Chapter and Indiana Covered Bridge Society on historic preservation and land-use problems, April 27, 1974.

Gray, H. H., helped conduct field trip for U.S. Geol. Survey personnel in karst area, Bloomington-French Lick, April 24, 1974.

Gray, H. H., with several persons representing U.S. Soil Conserv. Service and Purdue Univ. for in-field review of soils in Ohio and Dearborn Counties and to provide bedrock information, April 22, 1974.

Gray, H. H., Bleuer, N. K., conduct Indiana portion of annual spring field trip of Kentucky Geol. Survey and Geological Soc. of Kentucky, April 27, 1974.

Hartke, E. J., Hill, J. R., public field trip on field guide to Lake Michigan shore in Indiana, October 27, 1973.

Rexroad, C. B., helped conduct a field trip for public at the Falls of the Ohio, May 18-19, 1974.

Shaver, R. Y., Michigan Basin Geol. Soc. Annual Field Conf. on Silurian Reef-Evaporite Relationships in the Michigan Basin, May 17-19, 1974.

#### ACTIVITIES

Curtis Ault -- Elected secretary-treasurer of Indiana Geologists.

Donald Carr -- Program Director of the Industrial Minerals Division of the Society of Mining Engineers for 1973-74, also Chairman of a technical session at the Dallas meeting.

Elected Membership Chairman of the Industrial Minerals Division, SME.

John Patton -- Completed a three-year appointment on the Bloomington Environmental Quality and Conservation Commission, during all of which time served as Chairman.

Served on Science and Society Committee, and was chosen President-Elect for 1974 of the Indiana Academy of Science.

Completed a three-year term on the Advisory Screening Committee in Geology for the Committee on International Exchange of Persons (Fulbright-Hays Program).

Appointed chairman of the Indiana University Committee on Historic Preservation.

Continued membership in Committee C-18 Natural Building Stones, American Society for Testing and Materials.

Appointed to membership on the Governor's Energy Committee.

Appointed to membership on the Land Use Task Force for the Senate Committee on Ecology and Environment.

Continued membership on Research Committee, Interstate Oil Compact Commission.

Continued membership in Advisory Committee on Underground Injection of Wastewaters, Ohio River Valley Water Sanitation Commission. Was elected chairman of the Committee.



Accompanied Dr. Samuel Tuthill, State Geologist of Iowa, and Chairman of Energy Task Force, Midwest Governors Conference, on lecture tour to Gary, South Bend, and Fort. Wayne campuses of Indiana University, April 22-23, 1974.

Continued research project on masonry materials in historic Indiana structures under a grant received from the Bertha Lebus Charitable Trust (which was reported in 1972-1973);

Charles Wier -- Appointed to the I.U. Sub-Committee on Environmental Health and Safety.

Appointed by the Governor's Office to the Energy Resources Committee of the Interstate Oil Compact Commission.

Serving on the Sub-Committee on Water Quality of the University Committee on Environmental Quality.