

102ND ANNUAL REPORT OF THE STATE GEOLOGIST

of

INDIANA GEOLOGICAL SURVEY  
DEPARTMENT OF NATURAL RESOURCES

for

July 1, 1977 - June 30, 1978

GEOLOGICAL SURVEY  
ONE HUNDRED AND SECOND 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  
Gordon S. Fraser . . . . . Geologist  
(From January 12, 1978)  
Walter A. Hasenmueller . . . . . Geologist  
Nelson R. Shaffer . . . . . Geologist  
John F. Hickman . . . . . Geological Assistant  
(To August 18, 1977)  
Paul N. Irwin . . . . . Geological Assistant  
(From August 18, 1977)  
Bonnie Burks . . . . . Secretary  
Pamela Carter . . . . . Secretary  
(To August 5, 1977)  
Debra Martindale . . . . . Secretary  
(From August 22, 1977)

Drafting and Photography Section

William H. Moran . . . . . Chief Draftsman and Head  
Richard T. Hill . . . . . Geological Draftsman  
Robert E. Judah . . . . . Geological Artist-Draftsman  
(To July 15, 1977)  
Roger L. Purcell . . . . . Senior Geological Draftsman  
George R. Ringer . . . . . Photographer  
Wilbur E. Stalions . . . . . Geological Artist-Draftsman

Educational Services

Reevan Dee Rarick . . . . . Geologist

Geochemistry Section

Richard K. Leininger . . . . . Geochemist and Head  
Margaret V. Golde . . . . . Instrument Analyst  
Joseph G. Hailer . . . . . Geochemist  
Louis V. Miller . . . . . Coal Chemist  
Pamela Carter . . . . . Secretary  
(To August 5, 1977)  
Debra Martindale . . . . . Secretary  
(From August 22, 1977)  
(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  
(To December 30, 1977)  
Gerald L. Carpenter . . . . . Geologist and Head  
(From January 1, 1978)  
Andrew J. Hreha . . . . . Geologist  
Stanley J. Keller . . . . . Geologist  
Dan M. Sullivan . . . . . Geologist  
Pat Hall . . . . . Secretary and Curator of Records  
Wilma Fisher . . . . . Senior Records Clerk  
(To October 7, 1977)  
Peggy Ritchie . . . . . Senior Records Clerk  
(From October 26, 1977)

Sherry Cazee . . . . . Geological Assistant  
James T. Cazee . . . . . Geological Assistant  
William Hamm . . . . . Geological Assistant

Publications Section

Gerald S. Woodard . . . . . Editor and Head  
Pat Gerth. . . . . Senior Sales and Records Clerk

Other Personnel

Coal and Industrial Minerals Section

Monica Bauer . . . . . Laboratory Assistant  
(August 22, 1977 to June 30, 1978)  
Jack Briegel . . . . . Laboratory Assistant  
(January 25, 1978 to April 15, 1978)  
Michael Deeter . . . . . Field Assistant  
(January 3, 1978 to January 25, 1978)  
David Fishbaugh. . . . . Laboratory Assistant  
(January 23, 1978 to April 29, 1978)  
John Mackey . . . . . Field Assistant  
(July 1, 1977 to December 10, 1977)  
Richard Nelinson . . . . . Field Assistant  
(July 1, 1977 to July 23, 1977)  
Joseph Reed. . . . . Laboratory Assistant  
(January 18, 1978 to April 30, 1978)  
Synthia Smith. . . . . Laboratory Assistant  
(July 1, 1977 to April 15, 1978)  
Gail Trout . . . . . Laboratory Assistant  
(July 1, 1977 to November 12, 1977)  
Licia Weber. . . . . Laboratory Assistant  
(August 21, 1977 to June 30, 1978)

Drafting and Photography Section

Marcia Prins . . . . . Drafting and Photographic Assistant  
(February 16, 1978 to June 30, 1978)  
Earl W. Starks . . . . . Drafting and Photographic Assistant  
(July 1, 1977 to June 30, 1978)

Geochemistry Section

Diane Bader. . . . . Laboratory Technician  
(July 1, 1977 to August 3, 1978)  
Dorene Budnick . . . . . Laboratory Technician  
(August 26, 1977 to December 23, 1977)  
Gary Day . . . . . Laboratory Assistant  
(July 1, 1977 to June 30, 1978)

Stephanie Frederick . . . . . Laboratory Assistant  
 (August 24, 1977 to October 1, 1978)  
 Dan Honeycutt . . . . . Laboratory Assistant  
 (July 1, 1977 to April 29, 1978)  
 Bonnie Murchie. . . . . Laboratory Assistant  
 (May 1, 1978 to June 30, 1978)  
 William Roy . . . . . Laboratory Assistant  
 (August 22, 1977 to June 30, 1978)

Geology Section

Dialekti Brown. . . . . Laboratory Assistant  
 (July 8, 1977 to August 20, 1977)  
 Susan Elder . . . . . Laboratory Assistant  
 (November 4, 1977 to May 13, 1978)  
 Sam Frushour. . . . . Laboratory Assistant  
 (July 1, 1977 to June 30, 1978)  
 Tyrie James . . . . . Laboratory Assistant  
 (August 26, 1977 to April 15, 1978)  
 Doug Kayes . . . . . Laboratory Assistant  
 (August 31, 1977 to May 5, 1978)  
 Eric Lomax . . . . . Laboratory Assistant  
 (May 8, 1978 to June 30, 1978)  
 Barry Loshin. . . . . Laboratory Assistant  
 (July 1, 1977 to June 30, 1978)  
 Scott Lyford. . . . . Laboratory Assistant  
 (April 30, 1978 to June 10, 1978)  
 Robert Mills. . . . . Laboratory and Field Assistant  
 (August 26, 1977 to June 30, 1978)  
 William Mills . . . . . Laboratory and Field Assistant  
 (July 1, 1977 to August 6, 1977)  
 Eric Nigh . . . . . Laboratory Assistant  
 (September 19, 1977 to November 12, 1977)  
 Cynthia Pearlman . . . . . Laboratory Assistant  
 (July 1, 1977 to August 20, 1977)  
 Deborah Ryle. . . . . Laboratory Assistant  
 (October 19, 1977 to April 29, 1978)  
 Allen Trout . . . . . Laboratory Assistant  
 (July 7, 1977 to August 20, 1977)  
 Amy Wiltshire . . . . . Laboratory Assistant  
 (July 1, 1977 to December 23, 1977)

Geophysics Section

Charles Arnold . . . . . Programming Assistant  
 (July 1, 1977 to August 20, 1977)  
 James T. Bain . . . . . Programming Assistant  
 (August 30, 1977 to April 15, 1978)  
 Barbara Beeman . . . . . Clerk Typist  
 (May 24, 1978 to June 30, 1978)

Ed Billys . . . . . Laboratory Assistant  
(August 30, 1977 to December 9, 1977)

Thomas Bretthauer . . . . . Digitizer  
(June 5, 1978 to June 30, 1978)

James Dillard . . . . . Programming Assistant  
(May 19, 1978 to June 30, 1978)

Kim Faulkenburg . . . . . Keypunch Operator  
(July 1, 1977 to June 30, 1978)

Jeffrey Forbes . . . . . Laboratory and Field Assistant  
(August 31, 1977 to June 30, 1978)

Scott Gorham. . . . . Laboratory and Field Assistant  
(April 30, 1978 to June 30, 1978)

Doug Kayes. . . . . Laboratory and Field Assistant  
(May 9, 1978 to June 30, 1978)

Barbara Lewis . . . . . Laboratory Assistant  
(May 8, 1978 to June 30, 1978)

Helen Liebrick . . . . . Keypunch Operator  
(November 15, 1977 to April 1, 1978)

Don McKay . . . . . Programming Assistant  
(July 1, 1977 to September 3, 1977)

Nancy Martin. . . . . Laboratory Assistant  
(July 1, 1977 to August 3, 1977)

Linda Mongold . . . . . Laboratory Assistant  
(July 1, 1977 to August 3, 1977)

Sandra Phillips . . . . . Keypunch Operator  
(July 1, 1977 to October 15, 1978)

Albert J. Rudman . . . . . Geophysicist  
(May 1, 1978 to June 30, 1978)

Marty Schilke . . . . . Programming Assistant  
(February 22, 1978 to April 29, 1978)

Louis Schultz . . . . . Field Assistant  
(July 1, 1977 to May 27, 1978)

Charles Starks. . . . . Programming Assistant  
(August 9, 1977 to June 30, 1978)

Mike Swain. . . . . Programming Assistant  
(July 1, 1977 to February 3, 1978)

Robert Yost . . . . . Field Assistant  
(July 1, 1977 to September 3, 1977)

Petroleum Section

Hazel Barnes. . . . . Laboratory Assistant  
(August 29, 1977 to March 18, 1978)

Victor Berry. . . . . Laboratory Assistant  
(October 3, 1977 to April 15, 1978)

Helen Bowman. . . . . Laboratory Assistant  
(May 23, 1978 to June 30, 1978)

Sandra Cassidy. . . . . Laboratory Assistant  
(February 6, 1978 to February 14, 1978)

Robert Cook . . . . . Laboratory Assistant  
(July 1, 1977 to August 6, 1977)

Michael Cramer . . . . . Laboratory Assistant  
 (July 1, 1977 to August 20, 1977)  
 Pamela Crenshaw . . . . . Laboratory Assistant  
 (January 23, 1978 to April 15, 1978)  
 Clarence Dillon . . . . . Field Assistant  
 (May 22, 1978 to June 30, 1978)  
 Mercedes Edwards . . . . . Laboratory Assistant  
 (March 31, 1978 to June 10, 1978)  
 Larry Enochs . . . . . Field Assistant  
 (July 1, 1977 to September 3, 1977)  
 (May 30, 1978 to June 30, 1978)  
 Lisa Haines . . . . . Laboratory Assistant  
 (July 1, 1977 to August 20, 1977)  
 Greg Hartsough . . . . . Research Assistant  
 (July 1, 1977 to October 29, 1978)  
 Jill Hill . . . . . Laboratory Assistant  
 (September 16, 1977 to January 21, 1978)  
 Jane Jackson . . . . . Clerk Typist  
 (July 1, 1977 to August 6, 1977)  
 Yanah Karp . . . . . Laboratory Assistant  
 (July 1, 1977 to July 9, 1977)  
 Michael Keller . . . . . Laboratory Assistant  
 (July 1, 1977 to August 6, 1977)  
 Beverly Kleckner . . . . . Laboratory Assistant  
 (October 25, 1977 to December 10, 1977)  
 John Krauhs . . . . . Laboratory Assistant  
 (January 10, 1978 to April 29, 1978)  
 Ralph LaMaster . . . . . Laboratory Assistant  
 (July 1, 1977 to August 20, 1977)  
 David Lisby . . . . . Laboratory Assistant  
 (July 1, 1977 to June 30, 1978)  
 Lynda McCall . . . . . Laboratory Assistant  
 (September 27, 1977 to February 18, 1978)  
 Ronald McDaniels . . . . . Laboratory Assistant  
 (August 30, 1977 to October 1, 1977)  
 Sheila Manning . . . . . Laboratory Assistant  
 (July 1, 1977 to July 25, 1977)  
 Joseph Oliver . . . . . Field Assistant  
 (July 1, 1977 to June 30, 1978)  
 Raymond Papka . . . . . Laboratory Assistant  
 (October 23, 1977 to January 21, 1978)  
 David Partida . . . . . Laboratory Assistant  
 (July 1, 1977 to July 25, 1977)  
 Ellen Polezoes . . . . . Clerk Typist  
 (May 26, 1978 to June 30, 1978)  
 Kathy Russ . . . . . Laboratory Assistant  
 (February 22, 1978 to March 18, 1978)  
 Andrea Sharp . . . . . Laboratory Assistant  
 (July 1, 1977 to July 23, 1977)  
 Ronald Strauser . . . . . Laboratory Assistant  
 (October 3, 1977 to June 30, 1978)  
 Mary Sturbaum . . . . . Clerk Typist  
 (July 1, 1977 to August 20, 1977)

David Tooley

Laboratory Assistant  
(July 1, 1977 to April 29, 1978)

Eric Vaughn

Laboratory Assistant  
(April 30, 1978 to June 10, 1978)

Betsy Wells

Clerk Typist  
(September 13, 1977 to April 15, 1978)

Michael Wilson

Laboratory Assistant  
(January 23, 1978 to February 18, 1978)



STATISTICAL SUMMARY OF ACTIVITIES FOR FISCAL 1977-78

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

Projects in Progress . . . . .	49
Projects completed . . . . .	13
Visitor Days . . . . .	506
Conferences with visitors to the Survey . . . . .	1,158
Telephone conferences . . . . .	324
Total service requests . . . . .	1,111
Man days of field work . . . . .	1,150
Incoming letters . . . . .	5,813
Outgoing letters . . . . .	2,175
Total number of Survey vehicles . . . . .	21
Total number of miles traveled in Survey vehicles . . . . .	206,994
Thickness of stratigraphic sections measured . . . . .	9,911
Number of stratigraphic sections measured. . . . .	35
Public lectures . . . . .	30
Civic . . . . .	6
Industrial . . . . .	10
School . . . . .	18
Technical . . . . .	4
Other . . . . .	8
Papers presented at professional meetings . . . . .	5
Field trips . . . . .	32
In connection with conferences . . . . .	6
Educational . . . . .	14
Tours of the Geology building . . . . .	12
News releases submitted . . . . .	5
Environmental questionnaires . . . . .	167
Attendance at professional meetings . . . . .	78
Exhibits prepared for special occasions . . . . .	17
Samples received or collected . . . . .	1,365
Rocks, minerals . . . . .	897
Fossils . . . . .	403
Miscellaneous . . . . .	65
Identifications (Rocks, Minerals, Fossils) . . . . .	352
Packets of geologic education material sent . . . . .	62
Special rock sets for teachers . . . . .	10
Rock and mineral sets sent . . . . .	64
Heavy mineral separations made . . . . .	272
Coal samples analyzed. . . . .	287
Rock analyses - magnetic, mineralogical, testural & physical . . . . .	2,466
Samples prepared for analysis (by crushing). . . . .	421
Chemical analysis of samples . . . . .	2,896
X-ray mineralogic analyses . . . . .	70

Seismic refraction shots . . . . .	241
Feet of hole drilled . . . . .	2,940
Feet of core recovered . . . . .	1,672
Feet of hole augered . . . . .	4,866
Number of holes augered . . . . .	138
Feet of core described . . . . .	1,851.4
Oil wells field checked . . . . .	699
Current drilling. . . . .	699
Well cutting sets catalogued and filed . . . . .	232
Well cores catalogued and filed . . . . .	12
Strip logs made (wells). . . . .	232
Feet represented on strip logs . . . . .	481,106
Sketches for News Items . . . . .	18
Camera copies made . . . . .	928
Field photographs. . . . .	254
Black and white prints . . . . .	1,061
Diazo prints . . . . .	7,000
Film prints. . . . .	664
Color slides . . . . .	305
Black and white slides . . . . .	32
Photomicrographs . . . . .	18
Scribecoat . . . . .	12
Color proofs of maps . . . . .	45
Peelcoat films . . . . .	184
Stripping film prints of typematter. . . . .	149
Memorandum reports on special projects . . . . .	15
Reports completed for official publication . . . . .	11
Bulletins . . . . .	1
Regional Geologic Maps . . . . .	1
Miscellaneous Maps . . . . .	1
State Park Guides . . . . .	2
Special Reports . . . . .	4
Preliminary Coal Map. . . . .	1
Outside papers sponsored for Survey publication . . . . .	1
Published Reports. . . . .	24
Bulletins . . . . .	8
Mineral Economic Series . . . . .	2
State Park Guide. . . . .	7
Special Reports . . . . .	2
Occasional papers . . . . .	4
Directories . . . . .	1
Published Maps . . . . .	2
Miscellaneous (revised) . . . . .	2
Petroleum Exploration Maps . . . . .	315
New . . . . .	10
Revised . . . . .	175
Checked without revision. . . . .	130
Published reports sold . . . . .	4,416
Published maps sold. . . . .	12,503
Publications Office customers . . . . .	4,078
Publications announcements mailed . . . . .	1,212
Special mailings . . . . .	793

Outside Publications . . . . .	21
Abstracts . . . . .	3
Complete reports . . . . .	18
Reports completed and sent to editors for . . . . .	
outside publication . . . . .	5
Complete reports . . . . .	3
Maps. . . . .	1

## COAL AND INDUSTRIAL MINERALS SECTION

### Introduction

A total of 622 requests for coal information was handled by members of the Section, an increase of 4 percent from 1976-77. This is twice the number of requests handled by the Section only 5 years ago. Despite the large amount of time devoted to providing service, some notable accomplishments were made in research.

Industry interest in our research on limestone and dolomite resources continued high this year. A 280-foot section of dolomite was penetrated in Survey drill hole (SDH) 286, drilled in a suspected large reef and underlying rocks near Andrews, Huntington County. The dolomite appears suitable as a source of high-quality aggregate and may be suitable for chemical stone. Data from this test and other articles on our projects were compiled for later distribution in a Survey Newsletter. Test drilling by stone-producing companies for high-calcium limestone in the Camden reef, discovered by Survey drilling in 1975 and 1976, continued this year with results of chemical analyses of test-core samples indicating the high potential for commercial development of the deposit.

We continue to receive requests for information on high-calcium limestone in other parts of Indiana from numerous companies and individuals. Much of our drilling and data gathering for chemical-quality limestone and dolomite is in anticipation of the increasing demand for these resources.

Dr. Gordon Fraser joined our staff in January and has increased greatly our research and service capabilities in Pleistocene geology and sand and gravel resources. Gordon began mineral resource investigations in Vigo and Vanderburgh Counties as part of an overall study of the resources of the Ohio and Wabash River systems. He began an extensive program of familiarization of sand and gravel resources by visiting and examining all active sand and gravel operations in the state. The acquisition of the new truck-mounted power auger by the Survey has helped with data collection for Gordon and will be a tool of great value for his future research, some of which will be in conjunction with other ongoing projects at the Survey.

Nelson continued to receive many requests from industry for information on his project to study mineralization. The manuscript for this study is in the final editorial stage. He presented two papers and a poster session as part of the project at professional meetings.

Nelson gathered, described, and analyzed many samples for several of his projects, including his study of carbonate rock fillers and whitings and a review of the industrial minerals applications of underclays. He devoted much time to the DOE-funded New Albany Shale project by making detailed descriptions of cores, helping with well-site geology, making detailed mineralogical analyses, and preparing a paper on results of the project.

Considerable progress was made this year on Curt Ault's and Bob Shaver's reef project in northern Indiana due to information obtained from the Survey's drilling program. Curt is compiling and writing a major report on the mineral resources of reefs and associated rocks in Indiana, but also has spent considerable time on the NRC-funded faulting project in southwestern Indiana. The data from this project is of value for several other Survey studies, including Don and Curt's coal mapping in Posey County.

The basic research of the Section has continued to supply data necessary for the future discovery and exploitation of mineral resources in Indiana. Our file of basic geologic information continues to be one of our most valuable assets for providing mineral resource data to industry and for providing a foundation for continued research.

Lastly, the professional vitality of our staff was much in evidence this year with several professional papers presented at major professional meetings, an assortment of articles appearing in outside publications, participation of Section geologists in leadership roles of professional organizations, and numerous other professional and service activities.

#### Research Projects in Progress

##### Strippable Coal Resources

This project is one that is continued year by year by various members of the Section and includes an inventory of the strippable coal resources of the State. The reserve figures for coal that may be strip mined are periodically revised as new drilling information becomes available, and as areas are depleted by currently active strip mining. During the year data for some of the major strip mine areas were brought up to date and additional drilling information was plotted and evaluated, but because of personnel restrictions most of this work was put aside. This is a project that we hope to continue in the future because it enables the section to keep an inventory of available coal reserves of the State.

##### Preliminary Coal Maps of Greene, Owen, Putnam, and Posey 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; with the completion of these 4 counties, a complete survey of the Indiana coal fields will have been realized. The Putnam County sheet was completed this year and is now in the editorial process. Not much work was accomplished on the other three counties because of the large number of service requests that were handled.

##### Distribution of Acid-Forming Materials in Overburden

The major part of this study was completed last year, but the Section maintains an interest in acid-forming materials and collects samples from highwalls and core drill holes where possible to update information

on these materials. Data from this work have been successfully applied to acid-spoil problems at mines in various coal seams in southwestern Indiana. The information we have obtained from these studies is kept on open file and available for the public to use.

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

This project was completed last year with the publication of an article in Outdoor Indiana on "Geologic Considerations in Surface Mine Reclamation" (vol. 42, no. 5, p. 36-38). The basic data derived from this work, including the data from the outdoor rock-weathering laboratory on the outskirts of the I.U. Bloomington Campus, have been placed on open file.

#### Active Coal Mine Map

The usual annual revision of Miscellaneous Map 7, "Map of Southwestern Indiana showing locations of active coal mines," was not made this year due to a long coal strike during the first part of the year when the mine check is normally made.

#### Deep Drilling Program for Coal

This is a continuing project to obtain information on Indiana's underground mineable 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 mineable seam is obtained as well. During the year, 960 feet were drilled in one test hole in Posey County. All coal seams are measured and described in detail and prepared for chemical analysis, including float-sink determinations on all of the major coals. In addition to the above, methane content of each major coal seam is determined.

#### Characterization of Potential Reef and Floor Rocks Associated with Indiana Coals

The first phase of this study, the detailed petrographic description of lithologies of coal-bearing formations was begun with cores from 30 Survey drill holes and with rocks collected from active mines. The geology of the Peabody Coal Company Spur mine was examined as a case history. Progress also was made on a second phase, identification of the textures and mineral composition of different lithologies by thin sections and by x-ray diffraction analysis, and on a third phase, a microfabric study by electron microscopy. The petrographic properties of the roof and floor rocks will be used to develop an understanding and mine-rock stability.

#### National Coal Data System

The purpose of the study, which was initiated in 1975 with the aid of a grant from the U.S. Geological Survey, is to increase the amount of chemical data on the mineable coal seams in Indiana as an aid in determining

the quality acceptable for production of energy and for meeting current pollution control standards. Channel samples of coal and channel or grab samples of partings, roof rock, and floor rock at as many of the State's active coal mines as possible were collected for subsequent analysis by the U.S. Geological Survey. Although grant funds were depleted for collection of coal samples, the U.S. Geological Survey continued to provide analytical work. We hope to analyze the chemical data to see if trends in coal composition are apparent as soon as all of the data are received from the U.S. Geological Survey.

#### Indiana Coal Data System

Last year a feasibility study was completed to consider computerizing the large amount of geologic data contained from the Section files. This year, special effort has been made to try to implement some of the recommendations in the feasibility report. Two parts of the study were initiated and are in progress: (1) a compilation of all of the abandoned underground mines; and (2) a computerization of all of the coal chemical files.

#### Low-Sulfur Springfield Coal Member (V) Warrick County

A project to study the interrelationship of roof rock lithologies and their accompanying depositional environment with sulfur content of the overlying coal in northern Warrick County was completed this year. The low-sulfur phase of the Springfield Coal Member was found to be associated with a distributary channel that crossed the northwestern part of Warrick County into Gibson County. The study has been extended to trace the channel in Gibson County. Data from electric logs obtained from oil well tests, and coal test information from the confidential files of coal companies are being incorporated into this study.

#### IX-ICC

Members of the Section have put considerable effort into preparing for an international meeting of coal geologists, entitled the "Ninth International Congress of Carboniferous Stratigraphy and Geology" (IX-ICC). The meeting will be May 10 to June 2, 1979 in Washington, D.C. and Urbana, Illinois. This is the first time the ICC has met in this country. Members of the Section prepared a manuscript on the "Geology of the Springfield Coal Member (V) in Indiana--A Review." This paper will be published in a guidebook entitled "Depositional and Structural History of the Pennsylvanian of the Illinois Basin," which will be used for a field trip through southwestern Indiana, western Kentucky, and southern Illinois. The Section also spent time helping to organize symposia on "Depositional Models for Low Sulfur Coals" and on "Clays Associated with Coals in Carboniferous Rocks," and to prepare for a one-day field trip on "Environments of Plant Deposition--Coal Balls, Paper Coal, and Gray Shale Floras--in Western Indiana."

## 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 service consists 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, photocopying, 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 42-0, Peat Resources of Indiana; Bulletin 56, Polypora M'Coy from the Devonian of Southeastern Indiana; Bulletin 57, Pre-Knox Stratigraphy in Indiana; Special Report 13, Environmental Geology of Allen County, Indiana; Special Report 15, The Search for A Silurian Reef Model; Great Lakes Area; Occasional Paper 23, Fortran Program for Reduction of Gravimeter Observations to Bouguer Anomaly; Occasional Paper 24, Silurian and Devonian Sedimentologic History of Southwestern Indiana; Mineral Economic Series 24, Oil and Gas Development and Production in Indiana During 1977; Petroleum Exploration Maps 53, 53A and 53C (Gibson Co.), 21C (Dubois Co.), and 26C (Davies Co.); revision of the series of petroleum exploration maps of Indiana counties, and revision of Miscellaneous Map 15, Strip Mine Map of Southwestern Indiana.

Other jobs finished include 18 sketches for illustrated news items, displays for the Indiana State Fair, Oil Men's Outing, Spring Mill State Park, Midwest Federation of Gem and Mineral Show and Convention, Institute on Lake Superior Region Geology, Core Library, and Geological Survey Building; illustrations for 11 outside publications and 6 talks; a set of 18 regional maps and 8 other maps and illustrations for printing in color in the Governor's Water Resources Study Commission report; a map showing the status of published petroleum exploration maps of Indiana counties; updating state and U.S. government property boundaries on the series of petroleum exploration maps; and mounting and framing sketches of past and present State Geologists of Indiana for display in the Museum Room. Also completed were several jobs for the ERDA and NRC projects.

Other jobs in progress are: Special Report 14, Environmental Study of LaPorte County, Indiana; Special Report 16, Conodonts from the Louisville Limestone and Wabash Formation in Clark County, Indiana and Jefferson County, Kentucky; Special Report 17, The Plummer Field, Greene County, Indiana; Special Report \_\_, Geology for Environmental Planning in Marion County, Indiana; Special Report \_\_, Aggregate Resources of Big Blue River Valley, East-Central Indiana; Occasional Paper 25, Buffalo Wallow Group -- Upper Chesterian of Southern Indiana; State Park Guide 7, Geologic Story of Spring Mill State Park; State Park Guide 8, Geologic Story of Indiana Dunes State Park; Regional Geologic Map 1, Geologic Map of the Indianapolis 1° x 2° Quadrangle, Indiana and Illinois; Petroleum Exploration Map 23C, Map of Knox County, Indiana, Showing Control on the Base of the Beech Creek Limestone (Barlow);



artwork for a set of 6 illustrated news items; and an exhibit for the 1978 Indiana State Fair.

Photographic items produced consist of 928 camera copies, 254 field and laboratory photographs, 18 photomicrographs, 1061 black and white prints, 664 film positives and duplicate negatives, 149 stripping film prints of stickup type and symbols, 12 scribesheets, 184 peelcoat films, 45 color proofs of maps and covers, 305 color and color-tinted slides, and 32 black and white slides.

Approximately 7,000 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 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 about 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, in college classes, with 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, when requested, he serves as guest lecturer and conducts special field trips for college classes. He identifies many of the rock, mineral, or fossil specimens sent through the mail or brought 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 Indiananewspapers was continued and, with the assistance of Survey staff members and the Survey artist, 18 additional news items were added to the series and mailed to all newspapers throughout the state. The total number of the series currently is 84 -- another six are in process.

During the 1977-78 fiscal year the geologist in charge of Educational Services spent 29 1/2 days in the field and traveled more than 7,900 miles. In answer to requests received from the public, he gave 6 public lectures and conducted 7 educational field trips and 12 tours of the Geology Building during the 12-month period.

Public lectures were made to the following groups: 2nd grade class, Lakeview School, Monroe County; 3rd grade class, Lakeview School, Monroe County; 3rd grade class, Grandview School, Bloomington; Wabash Valley Gem and Geology Society, Lafayette summer class, Warren Central High School, Indianapolis; and a special children's workshop, Monroe County Public Library.

Special field trips (educational) and collecting field trips were conducted for the following groups: children gardeners, Hilltop Gardens (Dr. Schaluka, U.U.), Bloomington -- two trips; Indiana University Education 540 class (Conservation Education) -- two trips; geology class, Manchester College; Monroe County Soil and Water Conservation group (supervisors and their wives); and Decatur County 4-H exhibitors.

Tours of the Geology Building were conducted for the following groups: children gardeners from Hilltop Gardens, Bloomington; children from the Christian Center, Bloomington; 4th grade class, Childs Elementary School, Bloomington; high school group from South Chicago; geology class from I.U.P.U.-Fort Wayne; members of the University Women's Club, Bloomington; visitors from Greensburg, Decatur County; 3rd grade class 4th grade class, and 5th grade class from Grandview School, Bloomington (3 tours); and visitors from University of Louisville, Louisville, Ky. A tour of the Glenn Black Laboratory of Archaeology was conducted following a tour of the Geology Building for the visitors from Greensburg, Decatur County.

The Educational Services geologist again served as the Geological Survey representative of the Department of Natural Resource's State Fair Committee for the 1978 Indiana State Fair.

Articles submitted and published in OUTDOOR INDIANA during the last fiscal year included: "Indiana's Burning Hill: Energy Sources for the Future," by D. D. Carr, R. K. Leininger, and J. B. Patton (September 1977); "Mineral Wool: Historic Indiana Industry," by R. Dee Rarick and Curtis H. Ault (October 1977); "Indiana's Post-glacier Forests: They Reveal Extent of Early Ice Sheets," by R. Dee Rarick and G. K. Guennel (Dec. 1977-Jan. 1978); "Indianaite: The Rock With a Past," by Nelson R. Shaffer (April 1978); and "Indiana Meteorites: Close Encounters From Outer Space," by Nelson R. Shaffer (June 1978).

Exhibits prepared by the Indiana Geological Survey for public display included the following: a major exhibit for the 1977 Indiana State Fair; an exhibit for the Nature Center, Spring Mill State Park; a portable exhibit of energy-oriented publications of the Geological Survey for the Bloomington Energy Fair; a pre-existing exhibit was refurbished and installed in the Nature Center, Wesselman Park, Evansville; a petroleum exhibit for the Oilmen's Outing, Mt. Carmel, Illinois; and a geode exhibit for the Survey lobby in the Geology Building. The Educational Services geologist also assisted in the preparation of copy for an exhibit in the Geological Survey's new core building.

The Educational Services geologist and members of the Survey's Drafting Section attended the Graphic Arts Conference held in the Convention Center, Cincinnati, Ohio.

During the past fiscal year, the Educational Services geologist submitted 3 news releases about Geological Survey activities and the availability of new Survey publications. Also, he served as a member of the Indiana University Staff Council Scholarship Selections Committee.

During the 1977 4-H Fair season, 4-H geology and weather exhibits were judged for the Decatur County and the Martin County 4-H Fairs.

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

The Educational Services geologist also attended the Graphic Arts Conference in Cincinnati and the Oilmen's Outing in Mt. Vernon, Illinois.

#### GEOLOGY SECTION

The Section's accomplishments may be summarized as follows: During the year the Section listed 15 separate formal projects in its monthly reports. Thirteen of these were substantially active, and two were mostly or wholly inactive. The inactive projects were studies of the environmental geology of Monroe County and of the valley fill of upper Salt Creek.

Seven of the active projects are practically oriented, including three geographically defined environmental projects (Grant, Cass, and Vigo Counties). The other four included revision of the Indianapolis 1° x 2° Regional Geologic Map, a Quaternary Map of Indiana (with the U.S.G.S.), mapping in Putnam County, and an investigation of the engineering properties of unconsolidated deposits.

The other six active projects consist of efforts to obtain basic information. These included geologic investigations of the glacial stratigraphy of west-central Indiana, the Teays Valley, the Characteristics of Indiana tills, the tills of northwestern Indiana, the middle Paleozoic geology of northern Indiana, and the Silurian reefs of northern Indiana.

Two of the above projects were completed, and one project is new. In addition, the Section planned and submitted prospectuses for two new projects, one of which has not yet been started and one of which has not yet been approved for lack of funding. These are preparation of a bedrock geologic map of Indiana (scale 1:500,000; to be compiled mostly from existing 1:250,000 mapping), and mapping of potential coal-stripping areas including geologic and reclamation characteristics of Quaternary strata and geologic and reclamational characteristics of Pennsylvanian strata.

For the completed projects (Indianapolis RGM and USGS Quaternary map), we submitted three sets of map materials and a report. As an adjunct effort to the USGS mapping, we submitted a new map for production of a page-size map of Indiana showing unconsolidated deposits. Although listed as anonymous, it results from the efforts of Bleuer, Bassett, and Gray.

Six reports on basic geology (for incomplete projects) were submitted for publication: Salina stratigraphy, Lower and Middle Silurian conodont biostratigraphy northeastern Indiana, Middle and Upper Silurian conodont biostratigraphy southwestern Indiana, Silurian reefs Great Lakes area, Carboniferous stratigraphy, and Silurian reef at Delphi. In addition, five basic geologic reports were published: Silurian reefs and evaporites Michigan Basin, Indiana-based stratotypes of Quaternary formations, Silurian reef at Delphi (abs.), Lower and Middle Silurian conodont biostratigraphy northeastern Illinois, and Silurian reef geometry. Of these, two had also been submitted during 1977-78.

For practically oriented projects remaining incomplete, we submitted one set of map materials (coals in Putnam Co.), and, for one project completed in earlier years, a peat resources report was published. Our publication effort also extended to six educational reports, both published and submitted for publication: Shades, Turkey Run, McCormicks Creek, Versailles, Indiana Dunes, and Spring Mill State Parks. And we sponsored two reports from non-Survey personnel for publication, one of which was published during 1977-78: Devonian bryozoans southeastern Indiana and Middle Devonian chitinozoans from Indiana.

The Section had a total of ten reports and one abstract published, six of these reports being published by the Survey. They total about 151 pages and 92 illustrative materials, which is about the same as for 1976-77 but which is still down from a 5-year average for the section. Seven reports, however, that had been submitted in earlier years remained in obscurity at the end of the year. This backlog totaled 318 pages and 102 illustrative materials, which is a slight increase over 1976-77.

Members of the Section submitted for publication 11 reports and 4 maps that remained unpublished at the end of the year (total of 476 p. and 88 illus.). These materials, when added to the backlog noted under II above, bring the overall backlog to 18 reports and 4 maps (794 p., 190 illus.), which is considerably higher than it was one year ago.

In addition, members of the Section prepared five memorandum reports, all being environmentally oriented, whether for planning, construction, or waste-disposal purposes; gave or conducted 20 papers, talks, lectures, and field trips, of which 10 were essentially scientific or technical and were presented to at least partially professional assemblies, and 10 were educational (classes and church groups); were involved in 444 conferences and conference-type special field trips of record, of which the greater part were calls upon us for information,

a total very slightly lower than the total for one year ago, and thus continues the overall large increase in such calls over the past few years; and handled a large volume of correspondence (1114 pieces in and out), much of which was to provide information upon request, but of which the number of environmental questionnaires more than doubled (to 167) during the year.

#### MINERAL STATISTICIAN

For the 1977, mineral production in Indiana reached a total value of \$539,951,881.00, an increase of 16.66 percent over the previous year (an adjustment in the 1976 figure was necessary because an incorrect figure had been reported). The processing of minerals produced in the state for the manufacture of cement and clay products, the fabrication of limestone for building purposes, and the addition of a new commodity -- gypsum as a by-product of pharmaceuticals production -- increased the value of mineral products by nearly \$116,000,000.00. The manufacture of lime, the recovery of sulfur from petroleum, and the processing of perlite, all from raw materials imported from out of state, increased the value of Indiana's mineral industry by several millions of dollars.

The fuels accounted for 78.43 percent of the total value of minerals production. Coal continued to be the dominant factor in the minerals economy, accounting for 66.14 percent of the value. Production increased 8.34 percent in volume and 17.37 percent in total value. Coal mining was reported in 16 counties, and Pike and Warrick Counties produced 57.35 percent of the total.

Increased drilling of exploratory and primary development wells during 1977 resulted in a 14.79 percent increase in oil production, the first increase reported since 1965. Although the amount of natural gas produced declined slightly, higher unit prices resulted in a gain of nearly 30 percent in total value.

Construction materials accounted for 21.14 percent of the total value of minerals produced. Crushed limestone and sand and gravel showed declines of 5.52 percent and 7.18 percent respectively in quantity produced, but increases in total value of 6.44 percent and 3.52 percent. Sales of agricultural limestone were only two-thirds of those reported for 1976, and those of stone for fluxing material increased by more than 80 percent. Because of a difference in the method of reporting, it is impossible to determine what changes in use of sand and gravel occurred.

Although reports show declines in the amounts of limestone sawed and cut for building purposes, they also show an increase of almost 60 percent in sales of veneer, and the amount of stone shipped as quarry blocks for fabrication elsewhere more than tripled.

Reported sales of all categories of construction materials, except sewer tile, manufactured from clay showed a decline during 1977.

Mining of gypsum, for the manufacture of wallboard, insulation, and other building uses, increased 8.43 percent, and total value increased 12.49 percent.

Pike and Warrick Counties continued as the major mineral-producing counties in the state, accounting for 37.94 percent (not including oil and gas) of the total value of all mineral commodities. Sullivan and Vermillion Counties were next, accounting for 14.09 percent. The following counties led in production of minerals (exclusive of 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	\$116,732,174.00	----	Coal
Pike	88,106,642.00	----	Coal
<u>\$25-50 million</u>			
Sullivan	43,799,650.00	-----	Coal, crushed limestone, Sand and gravel
Vermillion	32,268,575.00	C	Clay and shale, clay products, coal, sand and gravel
<u>\$5-25 million</u>			
Clay	18,681,037.00	\$24,217,212.00	Clay and shale, clay products, coal
Spencer	14,318,993.00	-----	Coal
Greene	13,576,285.00	C	Clay and shale, clay products, coal, sand and gravel
Knox	12,079,846.00	-----	Coal, sand and gravel
Hamilton	7,060,544.00	-----	Crushed limestone, peat sand and gravel
Allen	6,819,955.00	-----	Crushed limestone, peat sand and gravel
Putnam	6,769,472.00	C	Cement, clay and shale, crushed limestone, dimension limestone, sand and gravel

Lawrence	6,626,303.00	28,672,995.00	Cement, clay and shale, crushed limestone, dimension limestone, dimension sandstone
Dubois	6,504,536.00	-----	Clay and shale, coal
Crawford	C	-----	Crushed limestone
Daviess	6,174,844.00	-----	Coal
Perry	5,933,514.00	-----	Coal, crushed limestone
Martin	5,730,855.00	-----	Coal, gypsum
Marion	5,659,727.00	-----	Crushed limestone, sand and gravel
Clark	5,413,308.00	C	Cement, clay and shale, crushed limestone

	1976		1977	
	<u>Quantity</u>	<u>Value</u>	<u>Quantity</u>	<u>Value</u>
Coal	25,354,912 tons	\$304,258,944.00	27,470,394 tons	\$357,115,122.00
Crushed limestone	28,227,358 tons	57,657,307.00	26,670,152 tons	61,368,015.00
Sand and gravel	22,170,809 tons	38,495,392.00	20,578,960 tons	39,850,837.00
Petroleum	4,629,737 bbls	50,421,000.00	5,314,470 bbls	66,218,296.00
Dimension limestone	2,310,261 cu.ft.	4,179,402.00	3,084,370 cu.ft.	6,470,257.00
Clay and shale	1,261,728 tons	1,867,442.00	1,267,528 tons	1,862,232.00
Peat	252,439 cu.yd.	801,906.00	222,034 cu.yd.	1,276,833.00
Natural gas	187,485,000 cu.ft.	97,492.00	183,000,000 cu.ft.	126,270.00
Undistributed - includes dimension sandstone, gypsum, marl, and whetstones		<u>5,077,684.00</u>		<u>5,664,019.00</u>
TOTAL		\$462,856,569.00		\$539,951,881.00
Value added for additional processing of dimension limestone, and manufacture of clay products, cement, and by-product gypsum (1977)		\$120,306,385.00		\$115,827,264.00



## GEOCHEMISTRY SECTION

Samples of rocks and minerals that are collected by all of the Sections of the Geological Survey are analyzed to determine their chemical composition. Various spectrometric, x-ray, atomic absorption, and wet chemical methods are used in routine analyses 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.

Because of a contract with the Department of Energy to analyze the contents of the New Albany Shale, new and sophisticated analytical equipment was added to the Section. These instruments included a CHN Analyzer, an instrument to measure the carbon, hydrogen, or nitrogen in a sample such as coal or organic shale, and an inductively coupled plasma-optical spectrometer, which vaporizes samples, analyzes the vapor, and causes a list of component chemical constituents to be typed out.

The computer revolution also reached some of our other standard analytical equipment such as the x-ray machine. Geochemists assembled two kits of electronic equipment that will be used to enhance the capabilities of the x-ray and CHN Analyzer. These provide limited automation and precise control of time and other conditions of analysis.

In addition to assimilating this new equipment and getting it to work, members of the Section turned out a particularly large volume of analyses. These included 2,896 determinations from 421 samples of rock material, and 726 determinations from 279 coal samples. Two hundred and thirteen determinations also were made on zinc sulfide material that was collected from Indiana rocks by Nelson Shaffer.

## GEOPHYSICS SECTION

During the 1977-78 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.

Members of the Section worked on an extensive program of seismic refraction surveys during the year. These included a series of 22 shots near the town of Advance in Boone County for the Division of Water; 56 shots in Adams, Blackford, Tippicanoe, and Wabash Counties to assist in a study of the Teays Valley; 79 shots in Posey County in an effort to detect faults in the Wabash River Valley; and 84 shots in Putnam County to provide information about coal resources of that region.

In cooperation with the Illinois Geological Survey, the Geophysics Section has launched a project to digitize information from quadrangle maps covering the northern two-thirds of Indiana, with the Illinois Survey having responsibility for the southern third under a contract with the Department of Energy. When the project is completed, maps of any area may be plotted by machine to show the locations of wells or other points for which a representation to scale is needed.

Geophysicists of the Section worked to develop instruments and techniques for the measurement of thermal properties of limestones. Little information is available about the thermal expansion or conductivity of stone, and these factors are particularly important now that architects and builders are concerned about thermally efficient buildings.

Work continued on preparation of computer programs that deal with special applications in geophysics. During the year one such program, a Fortran program for reduction of gravimeter observations to Bouguer anomaly, was published. Two other programs were written, tested, and prepared for publication.

#### 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 responses to 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 311 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 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.

Review of Petroleum Exploration Map Series -- The individual county petroleum map transparencies were updated at year's end. Forty-seven maps were revised and 44 were checked with no revisions necessary. One map, that for Gibson County, was completely re-drafted and published as a new map in the Series.

#### Records Improvement

Salem Limestone Sample Descriptions -- Sample descriptions of the Salem Limestone and associated formations from 123 wells were added to the master file. The descriptions were prepared many years ago by Arthur Pinsak in preparation for publication of Bulletin 11, but have not previously been available for public use.

Grant County Well Records -- A special project of evaluating miscellaneous well records and preparing them for inclusion in the master well data file was begun in May, 1978. The project consisted of associating the proper well record with the appropriate well location and determining the ground elevation for that well location. Records were then prepared in a manner consistent with existing file data prior to insertion in the master file. Larry Enochs was employed to undertake the project.

#### 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 received from the printer January 19, 1978.

Bulletin 57, entitled "Pre-Knox (Cambrian) Stratigraphy in Indiana," by Leroy Becker, Andrew Hreha, and T. A. Dawson was received from the printer June 21, 1978.

Structural Control Maps -- Maps for Dubois and Daviess Counties showing structural position of the base of the Beech Creek Limestone were published during the year. Maps for all counties in which the Beech Creek Limestone is present are planned and are in preparation. The maps are published as part of the Petroleum Exploration Map Series.

Study of Borden and Sanders Groups -- Stanley Keller is 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. A map of southwestern Indiana showing well locations which have penetrated Salem Limestone or deeper rocks was prepared for the study and was made available for publication and distribution. The results of the study will be published as a special report or bulletin. Leroy Becker, co-author of the report, contributed much in the earlier portion of the study has agreed to be available for consultation until its completion.

Natural Gas in Indiana -- Dan Sullivan is 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.

### 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 7,800 wells have been converted to the new system. It is estimated that the project is 76 percent complete and has provided sample storage for an additional 26 years.

Reviewing Process for County Strat Tests -- During the year, records for 236 strat tests from various 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 south-western Indiana. Geologist John Mackey began mapping faults in various stratigraphic units December 1, 1977. The project is under the sponsorship of the Nuclear Regulatory Commission.

Hoosier National Forest -- The Petroleum Section evaluated the oil and gas potential of the Hoosier National Forest, involving all or parts of Crawford, Dubois, Lawrence, Martin, Orange, and Perry Counties. The evaluation included a review of the geology of subsurface strata and the productive history of oil or gas fields in or near National Forest property.

Map Editor -- Stanley Keller is Map Editor for the Indiana Geological Survey. During the year he reviewed 18 manuscripts.

DOE Eastern Gas Shale Project -- Geologists Nancy Hasenmueller and John Bassett continued a study of the stratigraphy of the Devonian New Albany Shale in Indiana under sponsorship of the Department of Energy. Robert Gunther assumed the duties of Marilyn Ryerson as draftsman for the project and Gerald Carpenter was named as investigator following the retirement of Leroy Becker.

Records Inventory -- The Petroleum Section conducted a records inventory and analysis of all records on file in the section during November 1977.

Display Case -- Preparation of a new exhibit for the display case in the Petroleum Section was completed in February 1978.

## PUBLICATIONS SECTION

During the past fiscal year the Publications Section sold 4,416 reports and 12,503 maps. The section sent 12 reports and one map on exchange to institutions in the United States and in foreign countries. It also distributed without charge 7,795 reports and 1,602 maps to members of its own organization and to individuals, libraries, and companies in the United States and abroad. The Publications Section served 4,078 office customers, handled 2,987 letters pertaining to geologic reports and maps, and sent out 1,212 announcements of new publications.

Nine reports, four new maps, and 63 revised maps were issued during the fiscal year. In addition, one report and seven maps were reprinted.

At the request of the Accounting Records and Services Department of Indiana University soon after the beginning of the fiscal year, the Publications Section began using a single Indiana Geological Survey invoice form for cash and credit sales. Discarding multiple Indiana University invoice forms that had to be processed by the Accounting Records and Services Department, adopting one invoice form for all sales, and billing and collecting by the Publications Section have resulted in prompter payment by customers and more efficient handling of financial records.

REPORTS AND MAPS PUBLISHED BY THE GEOLOGICAL SURVEY

Bulletins

Becker, L. E., Hreha, A. J., and Dawson, T. A., 1978, Pre-Knox (Cambrian) stratigraphy in Indiana: Bull. 57, 72 p., 1 pl., 25 figs., 3 tables.

Carr, D. D., Leininger, R. K., and Golde, M. V., 1978, Crushed stone resources of the Blue River Group (Mississippian) of Indiana: Indiana Geol. Survey Bull. 52.

Schneider, A. F., and Moore, M. C., 1978, Peat resources of Indiana: Bull. 42-0, 32 p., 15 figs., 1 table.

Stratton, J. F., and Horowitz, A. S., 1977, Polypora M'Coy from the Devonian of Southeastern Indiana: Bull. 56, 48 p., 4 pls., 3 figs.

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Mineral Economics Series

Carpenter, G. L., and Keller, S. J., 1977, Oil development and production in Indiana during 1976: Mineral Economics Ser. 23, 29 p., 4 figs., 5 tables.

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Kwon, B. D., Rudman, A. J., and Blakely, R. F., 1977, Fortran program for reduction of gravimeter observations to Bouguer anomaly: Occasional Paper 23, 32 p., 3 figs., 4 app.

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Gray, H. H., 1977, Geologic Story of McCormicks Creek State Park: State Park Guide no. 3.

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Patton, John B., Industrial Minerals for Building Construction in an energy-deficient age, *Mining Engineering*, v. 30, no. 6, p. 683-687.

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Shaver, Robert H., Silurian reef geometry, new dimensions to explore, *Jour. Sed. Petrology*, v. 47, p. 1409-1424, 29 figs.

#### REPORTS PUBLISHED IN OUTDOOR INDIANA

Carr, Donald D., Leininger, R. K., and Patton, John B., 1977, Indiana's burning hill--energy source for the future, *Outdoor Indiana*, v. 42, n. 7, p. 4-8.



Rarick, R. Dee, and Guennel, G. K., Indiana's post-glacier forests: they reveal extent of early ice sheets, (Dec. 1977-Jan. 1978)

Rarick, R. Dee and Ault, Curtis H., Mineral wool - historic Indiana industry, Outdoor Indiana, 1977, v. 42, no. 8, p. 29-33.

Shaffer, Nelson R., Indianaite-mineral with a past, Outdoor Indiana, 1978, v. 43, n. 3, p. 35-38.

Shaffer, Nelson R., Indiana meteorites--close encounters from outer space, Outdoor Indiana, 1978, v. 43, no. 5, p. 4-10.

#### SUBMITTED FOR PUBLICATION

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

Bleuer, Ned K., and Moore, Michael C., Environmental geology of Allen County, Indiana.

Bleuer, Ned K., and Moore, Michael C., Environmental geology of Allen County, Indiana: Special Rept., 56 p., 32 figs., 13 tables, appendix.

Eggert, Donald L., Map of southwestern Indiana showing locations and conditions of fine coal tailings ponds, production, and dates of associated mine operations, 1978.

Gray, Henry H., Bleuer, Ned K., Hill, John R., and Lineback, Jerry A., Geologic Map of the 1° x 2° Indianapolis Quadrangle, Indiana and Illinois, showing bedrock and unconsolidated deposits: Regional Geol. Map 1 (revised edition).

Gray, Henry H., Buffalo Wallow Group--upper Chesterian (Mississippian) of southern Indiana: Spec. Rept., 45 p., 3 figs.

Hartke, Edwin J., and others including Ned K. Bleuer, Geology for environmental planning in Marion County, Indiana: Special Rept., 52 p., 1 pl., 19 figs., 7 tables.

Hartke, Edwin J., Ault, Curtis H., Austin, G. S., Becker, L. E., Bleuer, N. K., Herring, William, and Moore, M. C., Geology for environmental planning in Marion County, Indiana.

Hill, John R., Outcrop and mined areas of coals in Putnam Co., Indiana: Prelim. Coal Map.

Hill, John R., Carr, Donald D., Hartke, Edwin J., and Rexroad, Carl B., Geology as a contribution to land-use planning in LaPorte County, Indiana, Special Rept., 43 p., 1 pl., 12 figs., 3 tables.

Malott, C. A., with introduction and commentary by Henry H. Gray, The flatwoods region of Owen and Monroe Counties, Indiana, Occas. Paper, about 45 p., 4 figs.

Rexroad, Carl B., Stratigraphy and conodont paleontology of the Cataract Formation and Salamonie Dolomite in the subsurface of north-eastern Indiana, Bulletin, 102 p., 5 figs.

Rexroad, Carl B., Geologic story of Spring Mill State Park, State Park Guide, 5 p., 6 figs.

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Shaffer, Nelson R., Possibility of Mississippi Valley type mineral deposits in Indiana.

Shaver, R. H., Ault, C. H., Ausich, W. I., Droste, J. B., Horowitz, A. S., James, W. C., Okla, S. M., Rexroad, C. B., Suchomel, D. M., and Welch, J. R., The search for a Silurian reef model: Great Lakes area.

Shaver, Robert H., and Droste, J. B., The Salina group (middle and upper Silurian) of Indiana: Special Rept., 64 p., 10 figs.

Waterman, A. S., Conodont biostratigraphy and paleontology of the Trenton and Lexington Limestones in southeastern Indiana, Special Rept., 56 p., 2 pl., 3 figs.

Wright, R. P., Chitinozoa from Middle Devonian strata of Indiana, Spec. Rept., 61 p., 4 pls., 3 figs.

#### SUBMITTED FOR OUTSIDE PUBLICATION

Bleuer, Ned K., and Gray, Henry H., Summary of the geology of Indiana, in Governor Bowen's State Water Plan, 10 p., 5 figs.

Bleuer, Ned K., Gray, Henry H., and Bassett, John L., Materials for Indiana part of U.S. Geol. Survey Quaternary map of United States.

Gray, Henry H., Stratigraphy of Mississippian and Pennsylvanian (Carboniferous) rocks in Indiana, in U.S. Geol. Survey Prof. Paper, 76 p., 5 figs.

Indiana University Paleontology seminar (includes Shaver, Robert H.), Stratigraphy, structure, and zonation of a large Silurian reef at Delphi, Indiana, Am. Assoc. Petroleum Geologists Bull., 46 p., 8 figs.

Rexroad, Carl B., and Gray, L. M., Spring Mill State Park, Outdoor Indiana, 9 p., 8 figs.

Rexroad, Carl B., and Thompson, T. L., A spathognathodontid (conodont) lineage in the Mississippian system, Ames, Iowa State Univ. Press, 16 p., 1 fig.

MEMORANDUM REPORTS

Ault, Curtis H., (75) Reef exposures in Indiana: locations, lithology, commercial uses and selected references, January 1978.

Brittain, A. E., (C-95), Geometry, stratigraphy, and depositional environment of the Springfield Coal and the Dugger Formation (Pennsylvanian) north of Winslow, Pike County, Indiana, 1975.

Carr, Donald D., and Eggert, Donald L., Visit to the Amax Coal Company Wabash Mine near Keensburg, Illinois, May 10, 1978.

Hartke, Edwin J., A general geologic evaluation of the unconsolidated and bedrock materials within three miles of Kentland, Indiana: 4 p., 6 figs. (for Chris Larson, Kankakee-Iroquois Regional Planning Commission).

Hasenmueller, Walter A., (C-96), Packard: A FORTRAN program to reformat KWIC index records, 1978.

Hasenmueller, Walter A., (C-97), KWIC 410: versions of the GLIB KWIC library program used to prepare KWIC indexes of coal and industrial minerals section files, 1978.

Hasenmueller, Walter A., and Smith, Synthia, (C-94), The 1976 revision of Miscellaneous Map no. 15: General outline and suggested future work, 1977.

Hill, John R., A preliminary geologic evaluation of a proposed apartment housing site in Cannelton (Indiana Planning and Development Region 15), 3 p., 3 figs., August 22, 1977.

Hill, J. R., Information on depth to bedrock on the ridge tops of the Monroe County sanitary landfill expansion area, 3 p., 1 fig., (for county officials), September 2, 1977.

Hill, John R., A laboratory and visual analyses of seven glacial drift samples from borings made at the Bailly Power Plant site in Porter County, Indiana, 4 p., 1 fig., (for George Heim, Sargent and Lundy, Chicago), March 30, 1978.

Jenkins, Robert D., (C-93), The Geology of the Hillham Quadrangle, Martin, Orange, and Dubois Counties, Indiana, 1956.

Khawaja, Ikram, A review of literature on iron sulphide associated with coal. (C-92), 1966.

Shaver, Robert H., Preliminary paleontological assessment of the West Franklin, Indiana, area: 6 p., 2 exhibits (for David Clark, Dames & Moore, Cincinnati), May 16, 1978.

Stockton, John B., Byrnes, William R., and McFee, William W., (C-89), Physical and chemical criteria for assessing plant growth potential of mine land overburden, 1977.

Wier, C. E., and Powell, R. L., (C-90), Distribution of West Franklin Limestone in Southeastern Sullivan County, 1969.

Wier, C. E., (C-91), Geologic report on area of proposed new lake at Shakamak State Park, Clay, Greene, and Sullivan Counties, Indiana, 1965.

#### PAPERS PRESENTED AT PROFESSIONAL MEETINGS

Bassett, John, and Hasenmueller, Nancy, The New Albany Shale and correlative strata in Indiana, Proceedings of the Third Annual ERDA (DOE) Symposium on Enhanced Oil and Gas Recovery at Tulsa, Oklahoma.

Bassett, John, and Hasenmueller, Nancy, The New Albany Shale and correlative strata in Indiana, presented at the First Annual Eastern Gas Shales Symposium in Morgantown, West Virginia, October 1977.

Blakely, Robert F., The seismicity of Indiana, presented at the 1978 Midwestern GSA meeting, May 1, 1978.

#### PUBLIC LECTURES

Ault, Curtis H., The reef generations of northern Indiana and their economic implications, Indiana Geologists, November 9, 1977.

Ault, Curtis H., Display on geologic careers, Youth group of the Church of Jesus Christ of Latter-Day Saints, March 4, 1978.

Bassett, John, Gas in the New Albany Shale, Illinois Oil and Gas Association annual meeting in Mt. Vernon, Illinois, January 26, 1978.

Biggs, Maurice E., Slurry Ponds, Conference of Buffalo Riders, McCormick's Creek State Park, June 10, 1978.

Blakely, Robert F., Lectured to Jerry Davis' class in Indiana University Geography on the subject of Meteorology, November 14, 1977.

Blakely, Robert F., Earthquake Probability, Indiana Geologists, January 11, 1978.

Blakely, Robert F., The Statistics of Seismicity Studies, NSF Math Students, June 6, 1978.

Blakely, Robert F., What is Geophysics, NSF Science Institute, June 19, 1978.

Bleuer, N. K., Pre-Illinoian tills of western Indiana: Conference on Old Tills, Ill. State Geol. Survey, Urbana, October 5, 1977.

Carpenter, Gerald, Indiana Petroleum - A Review and Update, I.U. Geology Colloquium, April 3, 1978.

Carr, Donald D., Indiana's Coal Resources, Indiana Senate Select Joint Committee on Energy, October 27, 1977.

Carr, Donald D., SME Activities, IVTC SME Student Chapter meeting in Terre Haute, April 12, 1978.

Carr, Donald D., The measurement of the physical properties of rocks at the annual meeting of the Indiana Limestone Institute of America, April 24, 1978.

Eggert, Donald L., The Geology of the Blue River area, southern Indiana, Professor Robert Hattery's class at Indiana University, July 13, 1977.

Eggert, Donald L., Coal Reserves of Indiana, Wabash Valley Association meeting at Vincennes, August 10, 1977.

Fraser, Gordon, Sedimentology and Alaskan Stratigraphy, Eastern Kentucky University, April 21, 1978.

Gray, Henry H., What does a geologist do? The view from a State Geological Survey, Indiana University Geology Colloquium, October 10, 1977.

Gray, Henry H., Orientation of lineaments and joints in glaciated and nonglaciated terrains of southwestern Indiana, North-Central Section, Geol. Soc. America, Ann Arbor, Mich., May 1, 1978.

Gray, Henry H., Geology of the Sugar Creek canyons: Canoeing and walking field course, auspices of Indiana Univ. Continuing Education, May 23, 1978.

Hill, John R., Use of new Mobile auger rig: Survey personnel, September, 1977.

Hill, John R., Septic systems in Indiana, Indiana University environmental geology class, April 3, 1978.

Hill, John R., Geology and geography of Brown County, Indianapolis school group at Graw Bone Camp in Brown County, June 1, 1978.

Keller, Stanley, The Salem limestone of south-western Indiana, Indiana-Kentucky Geological Society meeting in Evansville, April 18, 1978.

Patton, John B., The invisible crisis: Implications for Indiana of federal energy policy, Indiana Academy of Science, October 27-28, 1977.

Patton, John B., The third coal age, Public Services Committee of I.U. Librarians, February 15, 1978.

Patton, John B., The invisible crisis: implications for Indiana of federal energy legislation, Indiana State University-Evansville, February 23, 1978.

Patton, John B., The invisible crisis: implications for Indiana of federal energy legislation, St. Joseph College, March 15, 1978.

Patton, John B., The invisible crisis: implications for Indiana of federal energy policy, to university groups throughout Indiana, April 17-19, 1978.

Patton, John B., Such quantities of sand, at Tarum Shrine Club, Richmond, IN, April 20, 1978.

Rarick, R. Dee, Life of the geologic past, Lakeview School, Monroe County, April 6, 1978.

Rarick, R. Dee, Life of the geologic past, Grandview School, Bloomington, May 5, 1978.

Rarick, R. Dee, Indiana caves and their features, Wabash Valley Gem and Mineral Society, West Lafayette, May 18, 1978.

Rarick, R. Dee, The origin, the features, and the wildlife of Indiana caves, Wilderness and Survival Training class, Warren Central High School, Indianapolis, June 26, 1978.

Rexroad, Carl B., Classification of conodonts, Indiana University geology graduate class, November 11, 1977.

Rexroad, Carl B., Classification of conodonts, Indiana University geology graduate class, November 14, 1977.

Rexroad, Carl B., Paleontology and stratigraphy of conodonts, Indiana University paleontology class, April 12, 1978.

Rexroad, Carl B., Paleontology and stratigraphy of conodonts, Indiana University paleontology class, April 17, 1978.

Rexroad, Carl B., Fossils, fundamentalism, and folly, Sunday Forum Trinity Episcopal Church, May 21, 1978.

Rexroad, Carl B., Fossils, fundamentalism, and folly, Sunday Forum, Trinity Episcopal Church, May 29, 1978.

Shaffer, Nelson, Indiana's industrial minerals and reviewed mineralization in Indiana, New Mexico Bureau of Mines and Institute of Mining and Technology, July 5, 1978.

Shaffer, Nelson, Geology and minerals of Indiana, Wabash Valley Gem and Mineral Club at West Lafayette, April 20, 1978.

Shaffer, Nelson, Poster Session on mineralization in Indiana, Institute of Lake Superior Geology at Milwaukee, Wisconsin, May 11, 1978.

Shaver, Robert H., Silurian reef geometry--new dimension to explore, Indiana Univ.-Purdue Univ., Fort Wayne Geology Colloquium, Sept. 16, 1977.

Shaver, Robert H., Silurian reef geometry--mostly from the fourth dimension, Indiana University Geology Colloquium, September 26, 1977.

Shaver, Robert H., Silurian reef geometry--projected to the fourth dimension, Geology colloquium, Univ. Waterloo, Ontario, Oct. 6, 1977.

Shaver, Robert H., Silurian reef geometry--projected to the fourth dimension, Geology colloquium, Brock Univ., Ontario, Oct. 7, 1977.

Shaver, Robert H., Silurian reef geometry--projected to the fourth dimension, Canadian Soc. Petroleum Geologists, Calgary, Oct. 17, 1977.

Shaver, Robert H., Silurian reef geometry--projected to the fourth dimension, Geology colloquium, Northwestern Univ., Evanston, Ill., October 21, 1977.

Shaver, Robert H., Silurian stratigraphy of the Great Lakes area, Indiana Univ. geology class, April 4, 1978.

#### PUBLIC FIELD TRIPS

Eggert, Donald L., participated as a geologic guide on a field exercise for Professor Hattery's class, July 20, 1977.

Gray, Henry H., with others, Canoeing and walking field course on Sugar Creek (for noncredit adult education course at Indiana University), May 23-24, 1978.

Rarick, R. Dee, visited Morgan County Gravel Co. gravel pit with children from Hilltop Garden, Bloomington, Rock collecting trip, July 1, 1977.

Rarick, R. Dee, field trip to Woolery Stone Co. quarry and mill for an Indiana University class, July 8, 1977.

Rarick, R. Dee, field trip to AMAX Coal Co.'s Chinook Mine for Indiana University class, July 29, 1977.

Rarick, R. Dee, field trip for Manchester College geology class. Visited Woolery Stone Co. quarry and mill, Buckner's Cave and collected geodes, October 13, 1977.

Rarick, R. Dee, field trip to AMAX Coal Co.'s Chinook Mine for a group of Monroe County Soil and Water Conservation supervisors, November 11, 1977.

Rarick, R. Dee, field trip for a group of 9th graders from Minneapolis, Minnesota, viewing Silurian and Devonian exposures in southern Indiana, May 14, 1978.

#### ACTIVITIES

Curtis Ault -- Survey Committee on Geologic Names; Steering Committee for classification of PR/AD/PA at Indiana University.

John Bassett -- Participated in an evaluation of the natural and scenic features of the Whitewater River along with other members of the Department of Natural Resources on June 29-30, 1978.

Robert F. Blakely -- Served as judge for the Regional Science Fair on April 15, 1978, representing AMS.

Gerald Carpenter -- Serves on the AAPG Committee on Statistics of Drilling.

Donald D. Carr -- Served as co-chairman in charge of organizing a symposium for the IX-ICC meeting in Illinois in 1979, on "Depositional Models for Low-Sulfur Coals."

Participated in a committee meeting of Directors at the SME St. Louis meeting.

Served as Chairman, Industrial Minerals Division, and Director, Society of Mining Engineers.

Pei-Yuan Chen -- Served as co-chairman in charge of organizing a symposium for the IX-ICC meeting in Illinois in 1979, on "Clays Associated with Coals in Carboniferous Rocks."

Donald L. Eggert -- Met with the One-day Field Trip Committee, IX-ICC to plan for a field trip in Parke County.

Walter A. Hasenmueller -- Served on the Exhibitor's Committee of the Community Service Council which planned an energy fair in Bloomington for the fall of 1977.

Stanley Keller -- Served as a member of the Potential Gas Committee. The committee members develop potential or undiscovered gas reserves for their specific areas.

John B. Patton -- Participated in a meeting of the Committee C-18 Natural Building Stones of America Society for Testing and Materials at Richmond, Va.

Acted as chairman of the I.U. Historic Preservation Committee and participated in the annual Indiana conference.



John B. Patton -- Served on the American Commission on Stratigraphic Nomenclature Committee which met in Calgary, to make recommendations regarding revisions of the American Stratigraphic Code.

Met with and presented information concerning reclamation of land mined for purposes other than coal to the Natural Resources Study Committee of the Indiana House of Representatives.

Made a presentation before the Indiana Senate Select Joint Committee on Energy

Participated in the fall meeting of the Indiana Academy of Science at Indianapolis and was selected "Speaker of the Year." He gave the talk "The Invisible Crisis: Implications for Indiana of Federal Energy Policy."

Participated in the annual meeting of the Geological Society of America and the American Commission on Stratigraphic Nomenclature in Seattle.

Participated in the meeting in Santa Fe of the Interstate Oil Compact Commission as a member of the Research Committee and Energy Resources Committee.

Participated in the annual meeting of the Indiana Mineral Aggregates Association in Evansville.

Attended a cluster meeting in Madison, Wisconsin with representatives of the U.S. Geological Survey and Geological Surveys of several midwestern states.

Participated in a meeting at Bedford with U.S. Forest Service personnel and representatives from the Division of Oil and Gas, oil industry, and conservation groups concerning leasing for oil exploration in National Forest.

Attended Spring Meeting of Indiana Academy of Science at Connersville, IN.

R. Dee Rarick -- Served on the 1978 Department of Natural Resources' Indiana State Fair Committee.

Served as a judge for the Decatur County and Martin County 4-H geology and weather exhibits.

Nelson Shaffer -- Served as Vice President of Indiana Geologists for 1978-79.

Dan Sullivan -- Served as a member of the API's 13-man Natural Committee on crude reserves.

Member of API subcommittee that gathers reserve data for Illinois, Indiana, Kentucky and Michigan.

GEOLOGICAL SURVEY EXHIBITS

Blind Fish - Nature Center, Spring Mill State Park.

Regional Geologic Maps - Boonville Museum.

Strip Coal Mine Reclamation - Boonville Museum.

Geological Survey Activities - Wesselman Park Nature Center, Evansville.

LANDSAT Imagery - Geology Building, first floor.

Indiana Mineral Resources, (Historical) - Geology Building, second floor.

Geological Survey Newspaper Series - Geology Building, sixth floor.

Geological Survey Environmental Publications - Geology Building, S-201.

Petroleum - Geology Building, S-201.

Apollo Moon Landing - Geology Building, S-201.