may anticipate returns; for that would deprive the coming generation of the part belonging to them.

Let us all view our State as one large home in which we take pride as members of one great family. Here is, as I said before, a wide field for profitable study and action on the part of our younger generation. But today it is our country—tomorrow it will be theirs. Let us teach them what they might expect. It would be a practical gain and a highly patriotic labor besides, for this joy of possession and protection incalculates true patriotism by cultivating attachment to the very soil which so generously holds forth the fruits of its bounty.

REPORT OF THE DIVISION OF GEOLOGY

W. N. LOGAN, State Geologist.
THEODORE KINGSBURY, Supervisor of Natural Gas.
VERNE PATTY, Curator of Museum.
ESTHER LIPP, Clerk and Stenographer.

The staff of the Division of Geology is composed of some members whose duties are of a technical or advisory nature, of others who are engaged in office and clerical work, and of others who are engaged in field and inspection work. Three members of the office force are the only members drawing salaries regularly from division funds. Occasionally one or two members of the field force are paid for one or two months of the field season. The gas inspectors collect fees for the wells inspected by them. A part of the funds so collected are used to defray office expenses and the remaining funds are returned to the inspectors.

Members of the staff acting in an advisory or technical capacity include: W. N. Logan, Economic Geology; E. R. Cumings, Stratigraphy and Paleontology; C. A. Malott, Physiographic Geology; S. S. Visher, Geography; W. M. Tacket, Hydrology; J. E. Switzer, Geography; Arch Addington, Subterranean Drainage; R. E. Esarey, Economic Geology; Howard Legge, Preparator.

Members of the staff engaged in field work during 1926 include:

The members of the gas inspection force are: Theodore Kingsbury, Supervisor; Wm. Kelly, Geneva; John Ersinger, Sullivan; J. P. Horton, Montpelier; Hershel Ringo, Muncie; Geo. H. Smith, Owensville; C. E. Noble, Princeton; O. H. Hughes, Sharpsville; Howard Legge, Bloomington; and Marion Brown, Loogootee.

FIELD INVESTIGATIONS

The summer season is used for the investigation of some of the phases of the geology of Indiana. The past season was used for the most part in the investigation of geological conditions in the Indiana oolitic stone belt. The members of the field party who were engaged
in this work included: W. N. Logan, R. E. Esarey, A. E. Moore, J. S. Kaserman, R. E. Stouder, and J. E. Organ. The investigations undertaken include the mapping of the geological formation from which the Indiana oolitic building stone is obtained, the location of the producing area and the location of railroads, quarries, and mills. Studies were made in the field regarding the quality of the stone, its thickness, state of erosion and decomposition; conditions of overburden with reference to thickness, character, and methods of removal of overburden; the relation of the building stone to underlying and overlying materials; and vertical and horizontal changes in the building stone.

Samples of stone were collected for study in the laboratory. These samples will be examined and analyzed to determine the chemical and physical properties of the stone, such properties as porosity, absorption, specific gravity, texture, strength, resistance to frost, resistance to heat, composition and other properties.

The field studies embrace the study of the field relation of the Harrodsburg limestone, the transition layers, the Salem limestone, and the overlying Mitchell limestone.

The study of the divisions of the Borden formation in Indiana by Mr. P. E. Stockdale was continued for a portion of the field season. Vertical sections of the formation were studied and mapped. The area investigated extends from the Ohio River to the typical Borden area. Samples of the formation and of fossils were collected for study in the laboratory.

Field studies of the upper Silurian rocks of northeastern Indiana was continued by Mr. R. R. Shrock working under the direction of Dr. E. R. Cummings. The study of the stratigraphy included, also, a study of the causes underlying the formation of the dome or quaquaversal structures which are so common in parts of the Wabash and Mississinewa drainage basins.

Dr. C. A. Malott continued his field study of the subterranean drainage of the Lost River area in Orange County. Professor Arch Addington who is engaged in a study of the caves of Indiana explored, surveyed, and mapped caves in Owen County, principally, though some work was done in other counties notably in Crawford County.

SPECIAL GEOLOGICAL INVESTIGATIONS

At the request of citizens or groups of citizens or organizations, special investigations involving field and laboratory work were undertaken by the Division during the year. Among a large number of minor investigations the following of greater importance received attention: The Investigation of an area of Minshull coal land in Fountain County and the preparation of a report containing the general geologic and economic conditions of the area. The study and preparation of a report on a supposed oil-bearing area in the same county. Studies made of oil-bearing areas in Gibson and Pike counties. Similar studies in Adams, Allen, and Randolph counties. The study of a coal field in Sullivan County, an investigation of deeper oil-bearing strata in the same county. Located outcrops of white limestone for a commercial company. Located new areas of raw materials for stone fibre company. Ran
levels on oil wells in eastern Daviess County to determine structural conditions. Made investigation of water conditions in oil wells in Allen County.

Located shales and clays suitable for ceramics near the Laconia gas field in Harrison County. Studied areas containing building stones in Washington County; and located white Indiana clays to replace southern kaolins for ceramic uses. Gave information regarding number and kinds of coals in surveyed area in Dubois County. Made a field survey of an area near Logansport and located beds of marl, peat, sand, gravel, and limestone for agricultural and structural uses. Examined sandstone in Martin County supposed to contain an oil-bearing substance. Made a survey of an area of supposed coal and oil-bearing region near Francisco. Mapped and investigated Indian mounds in Greene, Owen, Sullivan, and Lawrence counties. Examined excavated materials on State Highway No. 37 and on No. 51 for State Highway Department, classified material, and testified in court regarding same. Examined supposed oil-bearing area in Jackson County and furnished report. Examined oolitic stone in a quarry near Stinesville, studied origin of glass seams and gave report as to probable vertical and horizontal extension of seams.

PUBLICATIONS

The most comprehensive publication of the Division for the year is the report entitled: "The Geology of the Deep Wells of Indiana." This publication is listed as Number 55. It was made possible through field work during which formations were studied and the logs of wells collected and through the cooperation of well drillers and other citizens of Indiana who are interested in the development of the mineral resources of the state. Many of the drillers and operators furnished accurate logs and in some instances full sets of drillings. Studies of these drillings were made in the laboratory and thus our knowledge of the geological formations of Indiana was extended downward to a depth of approximately four thousand feet below the surface. Facts were set forth in the report which will be of assistance to anyone desiring a knowledge of the deeper and older formations of Indiana. The discussion includes information concerning each county of the state and comprises 540 pages.

A report on the petroleum industry in Indiana in 1925 was prepared and published in the transactions of the American Engineering and Mining Institute for March, 1926.

In cooperation with United States Bureau of Mines a report on the coals of Indiana was prepared for publication. This report contains a discussion of the properties of Indiana coals, their mode of occurrence, the number and thickness of the beds, the associated rocks, transportation, conditions of mining, the chemical analysis and other facts. The report will be published by the Bureau of Mines and copies will be distributed in Indiana by both the Bureau and the Division.

A report on the progress made by the Division in the study of sedimentation in Indiana was prepared for the National Research Council.
The report of the Division on its activities in archaeological investigations was published in the American Anthropologist. The annual report of the Division was prepared and published in the Year Book for 1925. Information furnished by the Division was published in booklet distributed at the Sesquicentennial Exposition. A discussion of the Pennsylvania and Mississippian formations of Indiana was prepared and presented at the Kansas City meeting of the American Association for the Advancement of Science. A copy of this paper was furnished the secretary of the section, at his request, for publication. A report on the geology of Harrison County was published in the newspapers of that county. Articles on the geological conditions of the counties of Pike, Gibson, and Sullivan were published in the newspapers of those counties. An article on the limestones and marls of northern Indiana which may be used for agricultural purposes was published in newspapers of that section of the State.

LABORATORY INVESTIGATIONS

The samples of rock and minerals which are collected during the field season and the rocks and minerals which are sent to the Division for reports as to their use or their value are studied by laboratory methods. For example samples of coal are examined by microscopic methods in thin sections to determine the percentage of constituents such as vitrain, durain, spores, spore cases, etc. In the analysis of the coals the fixed carbon, volatile matter, moisture, ash, and heat units are determined. Samples of limestone are tested for resistance to heat, to frost, to wear, for weight, for specific gravity, for porosity, for absorption and for composition. Clays and shales intended for use in ceramics are ground, tempered, molded into desired shapes, and fired in kilns. The raw and the burned clay ware is covered with glaze materials of various kinds to determine their suitability for glazed ware. Laboratory investigations of the kinds enumerated above were carried on during the winter season on samples collected during the field work.

In addition to these investigations a large amount of laboratory work was done for individuals or companies. Among others the following: Made laboratory examination of a molding sand from Lake County; investigated properties of white clay for ceramic company; classified rock and mineral collection from Clifty Caves; examined bog iron ore from Brown County; assayed gold ore from Brown County; investigated samples of coal for Better Business Bureau of Indianapolis; investigated samples of coal for citizens of Terre Haute, Peru, Clinton, and Indianapolis; determined corrosive effects of minerals used for packing purposes; prepared geological map of Indiana for insertion in report on geology of deep wells; prepared article on mineral resources of Indiana for publication in Indianapolis Star; prepared maps to accompany report on Indiana building stone.

ARCHAEOLOGICAL WORK

Since the inception of the Conservation Department archaeological conditions in Indiana have been studied by the Division as freedom
from other duties permitted. Annual reports of the progress of the work have been made to the Indiana Academy of Science and to the National Research Council. Maps showing the location of mounds, burials, camp sites and flint quarries have been prepared for a number of counties and the larger and more important ones have been located for the entire State. During the past summer at the request of Mr. Fred B. Dyer of Worthington five small mounds in that vicinity were explored and three others were sectioned. Some of these mounds, though they were all natural sand dunes, had been used for burial purposes by the Indians. Some human bones and artifacts were obtained from them. Trips were made to the mounds near the Narrows and to the Albee mound which was opened under the direction of Mr. McLean. The material collected from this mound is now in the possession of the museum and has been studied by Mr. E. Y. Guernsey.

ROCK AND MINERAL DETERMINATIONS

During the year a large number of samples of rocks and minerals reached the office and the laboratory from well drillers, land owners, individuals, and companies interested in the development of the natural mineral resources of Indiana. The information requested was for chemical analysis, qualitative tests, microscopic examinations, and other qualitative and quantitative tests. Information was supplied concerning the following list of rocks and minerals:

<table>
<thead>
<tr>
<th>Well drillings</th>
<th>206</th>
<th>Sphalerite</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestones</td>
<td>71</td>
<td>Geodes</td>
<td>5</td>
</tr>
<tr>
<td>Shales</td>
<td>56</td>
<td>Milky Quartz</td>
<td>5</td>
</tr>
<tr>
<td>Granite</td>
<td>35</td>
<td>Bryozoa</td>
<td>4</td>
</tr>
<tr>
<td>Quartz</td>
<td>34</td>
<td>Cornelian Crystals</td>
<td>4</td>
</tr>
<tr>
<td>Clays</td>
<td>36</td>
<td>Copper Ore</td>
<td>4</td>
</tr>
<tr>
<td>Pyrite</td>
<td>27</td>
<td>Oil Shale</td>
<td>4</td>
</tr>
<tr>
<td>Fossils</td>
<td>23</td>
<td>Peat</td>
<td>4</td>
</tr>
<tr>
<td>Coal</td>
<td>21</td>
<td>Basalt</td>
<td>3</td>
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<tr>
<td>Fossils</td>
<td>32</td>
<td>Gneiss</td>
<td>3</td>
</tr>
<tr>
<td>Mica</td>
<td>19</td>
<td>Malachite</td>
<td>3</td>
</tr>
<tr>
<td>Chert</td>
<td>18</td>
<td>Molding Sand</td>
<td>3</td>
</tr>
<tr>
<td>Shale</td>
<td>15</td>
<td>Slate</td>
<td>3</td>
</tr>
<tr>
<td>Smokey Topaz</td>
<td>14</td>
<td>Dolomite</td>
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</tr>
<tr>
<td>Coal</td>
<td>13</td>
<td>Marcasite</td>
<td>2</td>
</tr>
<tr>
<td>Oil Sands</td>
<td>15</td>
<td>Marl</td>
<td>2</td>
</tr>
<tr>
<td>Sandstones</td>
<td>12</td>
<td>Muscovite</td>
<td>2</td>
</tr>
<tr>
<td>Rge Ore</td>
<td>19</td>
<td>Pumice</td>
<td>2</td>
</tr>
<tr>
<td>Quartzite</td>
<td>19</td>
<td>Sand</td>
<td>2</td>
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<td>Concretions</td>
<td>8</td>
<td>Agate</td>
<td>1</td>
</tr>
<tr>
<td>Gravel</td>
<td>8</td>
<td>Chlorite</td>
<td>1</td>
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<tr>
<td>Bauxite</td>
<td>7</td>
<td>Conglomerate</td>
<td>1</td>
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<tr>
<td>Oils</td>
<td>7</td>
<td>Meteorite</td>
<td>1</td>
</tr>
<tr>
<td>Corns</td>
<td>6</td>
<td>Talc</td>
<td>1</td>
</tr>
<tr>
<td>Galena</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gypsum</td>
<td>6</td>
<td>Total</td>
<td>811</td>
</tr>
</tbody>
</table>

OFFICE WORK

Interest in natural resources of the state is shown by the increase in office work over the previous year; more letters and packages were received and a great many more reports were distributed as compared
to the year before. Calls for information on practically every natural
resource of Indiana have been answered from the office. The Division's
extensive library has been arranged so that ready reference is possible
and all well records have been filed so the log of any well can be easily
referred to. Through the filing of extra copies of well records, a new
system of loaning records has been installed to meet a long felt demand.

Following is a summarized report of the office work for the year:

<table>
<thead>
<tr>
<th>Letters received</th>
<th>2,964</th>
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</thead>
<tbody>
<tr>
<td>Packages received</td>
<td>1,334</td>
</tr>
<tr>
<td>Letters mailed</td>
<td>2,527</td>
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<tr>
<td>Packages mailed</td>
<td>540</td>
</tr>
<tr>
<td>Reports distributed</td>
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<tr>
<td>Annual Geologic</td>
<td>230</td>
</tr>
<tr>
<td>Deep Wells of Indiana</td>
<td>299</td>
</tr>
<tr>
<td>Kaolin in Indiana</td>
<td>211</td>
</tr>
<tr>
<td>Oil Fields of Southwestern Indiana</td>
<td>141</td>
</tr>
<tr>
<td>Petroleum and Natural Gas in Indiana</td>
<td>49</td>
</tr>
<tr>
<td>Handbook of Indiana Geology—Parts</td>
<td>44</td>
</tr>
<tr>
<td>Handbook of Indiana Geology</td>
<td>41</td>
</tr>
<tr>
<td>Oral Reports</td>
<td>926</td>
</tr>
</tbody>
</table>

**STATE MUSEUM**

The registered attendance of the museum for the year was 40,013.
The heaviest attendance was in August when visiting school children
and tourists made the total 6,355 visitors for the month. During only
one month—February—did the attendance fall below 2000.

A number of rare and valuable specimens were added to the museum
during the year, most notable of which were the Louis A. Kiefer
collection of Indian relics and the Prof. Irvin Stanley collection of birds
and animals from Kerguelen Island, South Indian Ocean.

Following is the list of donations and loans received:

- Collection of historic post-marked envelopes and documents, including an autograph
  letter from Governor Baker; a letter written by Vice-President Schuyler Colfax, the
  joint resolution sent to the National Congress by the Governor of Indiana during the
  Grant administration relative to the purchase of Santo Domingo, and a notice of a
  Taylor-Pillmore rally. Donated by Wm. T. Wilson, Logansport, in return for favors
  extended to him by the Director of the Department of Conservation.
- Common water snake, by Reginald Force, Indianapolis.
- Pair of buffalo horns, Bible, New Testament, side saddle, by Mrs. Mary Eaton Payne,
  Indianapolis, Indiana.
- Croix de Guerre awarded to Louis M. Mobley, by Jesse I. Mobley, Hope, Indiana.
- Pair of all steel arrows more than 126 years old, by Gertrude Reesem, Indianapolis.
- Collection of 40 coins, including foreign and domestic issues, by J. N. Shearer.
- Pieces of oode, by Elmer McDonald, Indianapolis.
- Collection of fossils, donor unknown.
- Fireman’s hat, worn by Capt. Albert C. Meurer, during Bowen-Merrill fire. Mr.
  Meurer afterwards died of injuries. Donated by his son, Albert F. Meurer, Indianapolis.
- Frank hens egg. Donated by Mrs. Augusta Hoffman, Indianapolis.
- Flax, grown and worked by the Leedy family near Decedsville, and donated by them.
- Hand split lath used in old building in Peru, uses use in firing cannon in Civil
  War, photo of remarkable pistol owned by Miami County Historical Society, by Hal C.
  Phelps, Peru.
- Three specimens of lake coral, 4 arrow heads, 1 piece flint, 1 star shaped fossil, by
  Wilber Wade, Warsaw.
- Civil War sword and sheath of Capt. Wm. Judkins, Civil War envelopes, collection of
  army buttons, and photographs of Capt. and Mrs. Judkins, by their daughter, Mrs. Otto
  J. Deeds, Indianapolis.

Fanning Mill by Dr. Earl Brooks, Noblesville.

Medal awarded during Liberty Loan Campaign, for work to the donor, Fred E. Hayden.

Indian scalping knife found on farm of Samuel Fitch in 1882, near Pittsboro, donated by Mrs. Maria Fitch, Pittsboro.

Confederate money—5c, $5.00 bill, $10.00 bill, $20.00 bill, donated by John Gilroy, Indianapolis.

Piece of log cabin at Hodgenville, Ky., in which Abraham Lincoln was born, and piece from Anistol Cooper shop at Old Salem, Ill., in which he studied by the light of a shavings fire. Donated by Rev. D. P. Nelson, Newnan, Illinois.

Collection of badges and merit card, by D. J. McCormick, Indianapolis.

Collection of shells, fossils, and Indian relics, photo of members of Indiana State Horticultural Society, who attended the 1891 meeting, letter from U. S. Congressman, Ralph W. Moss, written at Paris, France, photos of Panama-Pacific Exposition, and books on natural history, by T. M. Kingbury, Indianapolis.

History nuts, very large, by Eugene Coffenett, Dexter.


Curious growth of tree, natural grown handle on large bush, by Mamie Handle Factory, Muncie.

Fossil formation found near Freetown, by Nellie Lutz, Indianapolis.

Election ballot for President Jas. G. Blaine, by Vance Haskins, Indianapolis.

Pair of Chinese child's shoes from Chinatown, San Francisco, California, by Louis Held.

McCormick table used by the commission that selected Indianapolis as the site for the Hoosier Capitol, by Edwin B. McCormick.

Rifle dated 1849, hand made full stock, set trigger, cap and ball type, by H. H. Evans, New Castle.

Budge of Chicago Herald-Examiner Midwest Old Fiddlers' Contest, March 1-2, 1926, by Capt. W. D. Wilson, Indianapolis.

Two mounted stormy alligators, from Kerquen island, South Indian Ocean, baby ostrich from Patagonia, and white heron from Hamilton County, with case, presented by Prof. Irvin L. Stanley, Westfield.

Miniature bag of hemp from Philippine Islands, by Major D. I. McCormick, Indianapolis.

Old type music box, leased by Mrs. Mary Scott, who later took it away.

Fossil, by Claude Wells, Indianapolis.

Matches of type used in 1866, by Curator Smith, of Henry County Museum, New Castle.

Six Chinese coins, 1 Japanese coin, watch fob with Latin McRand Medal, and several badges, by Major D. I. McCormick, Indianapolis.

Gov. Ed Jackson inauguration badge and case made of shells, from Chateau Thibery, by Capt. W. D. Wilson, Indianapolis.

Two Indian axes, 1 tomahawk, 2 pistols, 3 round stones, 2 hammer heads, 4 skin dresses, 1 drill, 2 arrow heads, and 1 piece of soapstone, by Wm. J. Wright, Indianapolis.

Hard granite from Mount Rainier, by John Knox, Indianapolis.

Officer's belt worn in Civil War, donated by Capt. W. D. Wilson, Indianapolis.

Collection of geological specimens, foreign coins, photos, books, etc., by Henry Maine, Indianapolis.

Three toothed sickle, donated by Broad Ripple Park and mounted by J. C. Welborn, Indianapolis.

Prussian revolver (Remington used in Franco-Prussian War by Fabian Cohen), donated by Minnie Cohen, Indianapolis.


Indiana State Banner. Donated by Walter H. Daly, Warden Indiana State Prison, Michigan City. Banner and staff made by convicts.

Fossil (Crinoid) found near Newcastle. Donated by L. M. Hoeiand, Indianapolis.
Lottery of Real Estate Certificate, $160 six per cent certificate, January, 1865, $5.00
State of Louisiana Certificate, October, 1862. Presented by Robert Glorck, Curator
Louisiana State Museum, New Orleans, Louisiana.
Deed to 40 acres in 1853. Presented by W. H. Herriman, Indianapolis.
Fractional currency $e, receivable for postage 1862, 10c series of 1874, 15c series
of 1863, 25c series of 1882, receivable for postage, 5c series of 1875. Donated by Geo.
Robert Knoff, Columbus, Indiana.
Igneous rock of diabase type, composed largely of iron bearing minerals and large
amount of hornblende, from Benton County. Donated by Chas. L. Ruby, Carthage,
Indiana.
Overhand hove of Abraham Rumsey, of 12th Regiment. Entire hand instruments,
presented by Governor Oliver P. Morton. Old photograph of the band, from tin-
type taken at Scottsburg, Alabama, in 1864. Old music book containing music played
by the band. Presented by J. Willard Rumsey, Indianapolis.
Land grant signed by President James Madison to Abraham Walton, by the grand-
son, Hiram Hall, Deputy, Indiana.
Page of manuscript of General Lew Wallace's Memoirs, given by General to Mer-
dith Nicholson, in Wallace studio, at Crawfordsville. Presented by Meredith Nicholson,
Indianapolis.
Three cent piece 1873. Donated by Arley A. Kibb, St. Louis, Missouri.
Piece of coal from bag of Shenandoah. Secured by M. C. Burck, Cambridge, Ohio.
Presented by F. H. Wilkinson, Indianapolis.
Bill of sale of negroes—sold for $385, in 1849. Donated by R. O. Babley, Seymour,
Indiana.
Epsidolites and mosh of Cant., H. E. Vandevender, killed at Vicksburg, Mississippi.
Purse and socks knitted by insane woman at Cleveland, Ohio, Hospital for Insane.
Donated by Mrs. Wirth Johnson, Cleveland, Ohio.
Wood cat, history unknown. Donated by N. E. Foster, Brookville.
Copy Cincinnati Enquirer, March 19, 1859; copy Franklin Democrat, October 22,
1852; copy New York Herald, February 20, 1848. Donated by Wm. L. Chambers,
Brookville, Indiana.
Lana moh. Donated by Wm. Chalil, Indianapolis.
Skeleton of Great Dane dog owned by Carl G. Fisher. Mounted by Dr. O. C.
Newdew, Indianapolis.
Fossil, donated by Wm. G. Jones, Indianapolis.
Infant table. Contains 250,150 pieces of hardwood. Made and loaned by Peter
Messer, Etna Green, Indiana.
Sharp's rifle. Owned by E. M. Baldwin, of Mooresville, Indiana, member Co. J,
52nd Ind. Inf., during Civil War. Donated with cartridge belt and 45 cartridges, by
Frank Baldwin, Mooresville, Indiana.
Canes made of shells taken from Argonne Forest. Presented to Maj. James A.
Collection of shells from many parts of the world, fossils, sponge and sea hens.
Loaned by Lennie Blocketer, of the U. S. S. Destroyer Wainwright during World War,
now of Indianapolis.
Two specimens of wood engraved by Clifford Roe, Indianapolis. Donated by him.
The Lexington Collection of Hymus, printed in 1811. Donated by Nancy Orelle
Buch, Indianapolis.
Two large specimens of copper ore from Quincy mine, shaft No. 2, 8,700 feet below
surface. Donated by Mr. and Mrs. Geo. Wisman, Hanes, Michigan.

NATURAL GAS SUPERVISION

Several oil and gas producing areas were developed during the year.
In southeastern Adams County, in Wabash and Jefferson townships, 32
producing wells were drilled during the year. The yield of these wells
ranged from a small amount to 80 and 100 barrels a day initial produc-
In Veale township, Daviess county, there was considerable drilling. Although this area was active the year before, several wells yielding more than 100 barrels a day initial production were drilled during the year covered by this report. In Harrison County, south of Corydon, a field of about 40 gas wells has been developed, several of these wells being drilled this year. Good oil wells have been drilled in Pike and Gibson Counties, and in the Somerville area, in southeastern Gibson County, two new gas wells have been drilled and the owners believe there are good indications for other producing wells in this vicinity. In Sullivan County, two deep wells drilled in a field that previously produced oil at shallow depths, made strong flows of gas. In Rush, Decatur and Hamilton Counties, in areas that have produced gas for 30 or more years, several gas wells were drilled and the supply in these communities has been maintained. In other localities, as Knox, Jay, Huntington, Wells, Blackford, and other counties producing wells were drilled. In many other counties test wells were drilled which produced little or no oil or gas.

Reports of leaking gas and wells in need of repair have increased. The wells and lines in many localities are old and as the supply of gas is decreasing, interest in keeping them in good repair has in some cases decreased accordingly. A special effort is being made to locate such wells and lines and have them repaired. In this connection several drillers and gas companies are giving hearty cooperation. During the year the state gas supervisor and deputies plugged 206 abandoned oil and gas wells.

The Indiana Oil and Gas News which is issued from this office monthly during the active drilling season and gives information on operations and prospective drilling, has been sent regularly to a list of more than 200. Several individuals are cooperating in collecting information for this report by sending in items regularly on the activities in their vicinity.

A PRELIMINARY REPORT UPON THE SURVEY OF INDIANA CAVES WITH SPECIAL REFERENCE TO MAREngo CAVE

By
Arch R. Addington, Geologist, Subterranean Drainage, Division of Geology, Indiana Conservation Department.

Foreword

During the latter part of the summer of 1926 it was my good fortune to devote a part of the time to the study and survey of a few of Indiana's caves. This study was made possible by a small grant of money from the State Department of Conservation, Division of Geology and also by the courtesy and assistance of the cave owners. Caverns of Owen, Lawrence, and Green counties were visited and particular attention was given to Marengo Cave, Crawford County, and to Porter's Cave, in Owen County.

Information leading to the location of the caves, general knowledge
of their interiors and many interesting incidents associated with their local histories were obtained from the farmers, principally those who live near the caves visited. These men willingly gave of their time and assisted me in many ways. To them I owe a special debt of gratitude.

I am greatly indebted to Dr. W. N. Logan, State Geologist, through
whose influence financial assistance was obtained. Dr. Logan gave valuable suggestions for carrying on the work and also criticized this report.

I also wish to extend my appreciation to Mr. Stewart and to his sons. These men are in control of Marengo Cave and they extended to me every courtesy and convenience at their command. It is not an exaggeration to say they gave me the keys to the cave and bid me make myself at home. I was also made a frequent and welcome visitor to their house; these friendly visits and the personal incidents which they related to me are among my choicest memories.

**PURPOSE AND SCOPE OF THE WORK**

The purpose of a survey of the caves is to secure information concerning their interior characters and possibilities of economic development. The value of a cave as a "show cave" or as a place for winter storage depends to a great extent upon its interior character and its accessibility. It is possible that greater utilization of caves as places for winter storage of fruits will be undertaken as trial experiments of this nature have proven successful.

Ultimately it is the intention of the survey to compile a more comprehensive treatise upon Indiana Caves. Data of this sort would be invaluable from the informational standpoint and might well form the basis of future economic development and exploitation. There have been but few publications concerning the Indiana caves since the time of Blatchey, 30 years ago.1 This work although of an admirable quality is chiefly of an entomological character. Beede's classic article upon subterranean drainage is also well known.2

The scope of this work covers so large a field that within the limited time at my disposal only a small amount of work could be accomplished. Two methods of conducting the work were suggested. One, a rapid reconnaissance of the entire limestone belt during which little could be done except to locate the caverns and determine their accessibility with reference to main traveled roads. Another was to select some particular cave and treat it in considerable detail particularly with reference to mapping its interior. This plan of procedure although covering less ground has the advantage of definiteness and of completing a single project. For this reason I chose the latter method as the most satisfactory.

Marengo Cave was selected as the type for investigation because of the following:

1. It is one of Indiana's beautiful caves as manifested by the numbers and variety of its mineral decorations.
2. It is one of the important show caves of the state. (I use the term, "show cave," in the sense that the cave is open to the public and is utilized as a basis of income to the owners.)
3. A detailed informational map of the cave, supplemented by carefully drawn cross sections and by photographic illustrations will serve as a source of information to prospective visitors.

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1 31st Indiana Report, 1896.
2 Indiana Academy Science Proceedings, 1916.
PLAN AND METHOD OF MAPPING

The materials used in mapping the cave were an ordinary plane table with compass attached, a peep sight alidade, a fifty-foot tape, candles and steel pegs. As I had no assistant in the work of mapping the cave it was necessary to drive a peg into the floor, attach one end of the tape to it then extend the tape its full distance, release the end previously attached carry it around the full distance beyond the second point of attachment and so on ad infinitum.

After establishing a true north south direction, directions within the cave were determined by keeping the table oriented in a true north south direction and then sighting by means of the alidade upon candle flames placed near the middle of the passage.

A total of 18 cross section profiles of the cave were made at various points. These profiles illustrate features of the interior which it is impossible to show in the ground plan of the cave. Only a few of the 18 cross sections are included in this report but these are sufficient to show in a general way the transverse dimensions of the passages.

Further characteristics of the cave will be discussed in the remainder of the report. I shall take the privilege of omitting in this report a considerable amount of descriptive detail and statements concerning detailed measurements, which in the near future I hope to incorporate in a more complete treatise.

MARENGO CAVE

LOCATION

Marengo Cave is located in northeastern Crawford County, Indiana. Its exact location is a little east of the center of the northwest ¼ of section 6, township 2 south, range 2 east. The cave is three-fourths mile northeast of the main part of the village of Marengo. It is approximately seventeen miles south of Paoli, Orange County, Indiana, fourteen miles north of Leavenworth, Crawford County, Indiana, and ten miles north and east of English, the county seat of Crawford County.

Good state roads reach within a short distance, ten to fourteen miles, of the cave. From these state roads pike roads lead to the village of Marengo and from the latter place a good road is available to the cave entrance. The pike roads are passable in wet weather but are very rough in places so that patience and perseverance are essential requisites of the auto driver. Traffic from the south and east portions of the state will find the best approach to the cave by way of Corydon and Leavenworth while that from the central, north, or western parts of the state will find the best route by way of Paoli and Valeen. A stone road leading to Marengo leaves the Dixie Highway three-fourths mile east of Hardinsburg village. This road is passable in all weather but is usually rough.

TOPOGRAPHY AND DRAINAGE NEAR MARENGO CAVE

The country in the neighborhood of Marengo is decidedly hilly, a characteristic which applies to practically all of Crawford County.
Hill and ridge tops rise 200 feet or more above the adjacent valley floors. Nearer the Ohio River this relief is increased to 400-500 feet. The region is a maze of hills and valleys that characterize a well dissected upland. Physiographically, the region is typical of the Crawford Upland division of Indiana.*

The valley sides and much of the uplands are characterized by a dense undergrowth. The valley bottoms are mainly used as agricultural land but where the ridge tops are flattened to some extent tillage is practiced. Dense undergrowth on the slopes prevent washing or gullying while portions of upland and valley bottoms because of their thicker soils and level or nearly level surfaces are better adapted to cultivation. Topography, therefore exerts a direct influence upon the utilization of the land.

Topographic influence upon the location of roads is well illustrated in this region. For the most part, roads either follow the valley bottoms or keep to the ridge tops; a condition that is particularly true for the main traveled roads. Thus, while Crawford County is one of the very hilly counties in the state it is possible to traverse its entire length or width without ascending or descending very many steep hills.

Drainage of the region is to the Ohio River. Big Blue River is the immediate major tributary to the Ohio. The tributary streams to Blue River have been the principal factors in sculpturing the valleys in the immediate vicinity of the village of Marengo. Brandy Run Creek flows through the main part of the town. Whiskey Run Creek is somewhat larger and flows nearest the cave. These two streams join near the canning factory in the eastern part of Marengo and the single stream thus formed is joined within a short distance by the tributary of Cider Fork. The stream resulting from these tributaries is known as Whiskey Run Creek. It enters Blue River about four miles west and a little north of Depauw.

The topographic condition favors rapid run-off of surface waters. After heavy rains the streams rise rapidly but do not remain at flood stage long. Before the construction of the bridge across Whiskey Run Creek at the old village of Marengo the creek would rise rapidly after heavy rains so that it could not be forded.

In the immediate vicinity of Marengo subterranean drainage is limited to the valley sides and valley bottoms where such valleys are above adjacent valley levels. A dry valley to the north of Marengo illustrates this phenomenon. The valley floor is 80 feet above the valley level of the creek at Marengo Cave. At four points large swallow holes have developed within the valley. Surface waters drain into these places and disappear underground. It is possible their outlet is represented by the large spring which issues nearest the cave. It is not likely that the water which issues from the small cave near the road leading into the village is a part of this subterranean drainage.

Practically no evidence of subterranean drainage, such as characterizes a limestone region, is to be found upon the uplands in this vicinity. This is due to the differences in the type of country rock which forms the upland and that which is present in the valley bottoms and for some distance up the valley sides.

The surface materials of the uplands are residual types of soils. These vary from sandy to clay like loams of a yellow to brownish color. The surface materials of the valley bottoms are usually well mixed, are of a somewhat darker color, and vary considerably as to texture. These represent materials washed in from surrounding slopes and are typical of alluvial sediments.

The country rock of the upper part of the hills and ridges are sandstones and shales belonging to the Chester Group of rocks. Beneath them forming a part of the valley sides and the valley floors is the Mitchell limestone. The limestone exposed in the valleys and in the quarry at Marengo is the upper part of this formation. It is in stone of this type that groundwater is most efficient in forming caverns when suitable topographic conditions are developed.

FAVORABLE CONDITIONS FOR THE FORMATION OF LIMESTONE CAVERNS

Many persons fail to appreciate the agencies and processes that are operative in the formation of limestone caverns. A plausible reason for this is that consideration of the origin of caves rarely enters into the trend of ordinary thinking. It may be advisable, therefore to insert at this place a simple and brief discussion of those conditions which favor the formation of limestone caves.

A limestone formation of considerable thickness and areal extent is essential to the development of large and extensive caverns. Where the limestone formation consists of many layers traversed by numerous joints and bedding planes, as the Mitchell limestone for example, numerous caves are formed. A dense texture of the rock layers favors the concentration of ground water along the joints and bedding planes and thereby increases the effectiveness of this agent in enlarging them, more so than if the layers were rather uniformly porous.

The upper surface of the limestone formation must be above the principal drainage line of the region. Where the valleys are entrenched deeply below the limestone surface there is greater probability of finding in the adjacent hill sides larger and more extensive caverns than under similar conditions where the valleys are less deeply entrenched below the uplands. A rugged country in which there has been considerable dissection of the limestone layers is the type of country that one would expect to abound in caves. Crawford County and portions of Harrison County, Indiana, have a very rugged topography due to the work of the surface streams adjusting themselves to the level of the Ohio River. As the Ohio eroded its valley lower and lower, tributary streams deepened their valleys so that we now find such streams as Little Blue River, Big Blue River, and Indian Creek entrenched well below the surface of the limestone.

A topographic condition of this sort favors an active circulation of ground water downward and outward from the ridges and hills to the level of the principal valley of the region. The circulation of the water along the joints and bedding planes of the rock enlarges them and in time a cave is the result.
Groundwater is efficient in enlarging fractures in the limestone because of its slightly acid character. Rain absorbs some carbon dioxide from the air and when the water enters the ground it obtains more of this substance from the soil air. It is further acidulated by coming in contact with products of organic decay and by the absorption of humic acids from the soil and vegetation. When water of this character comes in contact with the limestone, solution of the rock occurs, the dissolved material being carried away by the circulation of the ground water. In the course of time a passage will become large enough to hold a stream of considerable size. Surface waters which disappear in sink holes on the uplands or in the upland valleys, drain rapidly to these subterranean passages so that the underground stream varies a great deal in volume and velocity. The variation in volume and velocity enables the stream to transport from time to time fragmental materials that may have been washed into the cave or that may have fallen from the cavern roof. As a result a certain amount of erosive or wearing action upon the limestone layers is performed during the transport of the fragmental material. It seems, therefore, that the processes of solution and erosion are operative in the formation and enlargement of limestone caves and that the caves are not entirely the result of solution. These processes are slow in operation and large caverns represent an enormous amount of time for their formation.

**Origin of Marengo Cave**

The conditions just discussed with reference to the formation of caves are beautifully illustrated at Marengo. Here, deep valleys have been formed in the upland and the main valley bottoms are well below the level of the limestone surface. In response to this condition numerous springs are present near the main valley levels. The supply for these springs is the water which sinks into the soil and rock of the upland.

A short distance west of the cave entrance a large spring appears at the base of a low bluff. The elevation of the spring is about 580 feet as determined by barometer measurement. Within a short distance the waters of the spring enter Whiskey Run Creek. It seems quite possible that the waters appearing at the spring are representative of those which formerly flowed through the cave as the present spring outlet is at a lower elevation than any point within the cave. The elevation of the cave entrance is approximately 625 feet. In going into the cave the distance one descends is not equal to the difference between these two elevations. Consequently the lowest elevation in the cave is above the level that could be occupied by the sub-surface stream. Abandonment of the cave route by the sub-surface stream would come as a result of the deepening of Whiskey Run valley in the neighborhood of the cave. According to this mode of thinking Marengo cave came into existence as the region was being maturely dissected, the circulation of ground water being downward and outward in adjustment with the deepening of the adjacent valley now occupied by Whiskey Run.

During the long period of time that the water must have flowed through the present cave route it exerted a solvent and erosive action
upon the rock layers gradually enlarging and widening the cavity to the dimensions that we see at the present day. From time to time, during the process of enlargement, portions of the cave walls and roof became sufficiently unsupported so that they collapsed into the interior. Much of this rock material has no doubt been entirely removed by the work of the underground stream while in a few places one can still observe that the task was only partly completed.

The slow seepage of ground water into the cave has resulted in the development of mineral formations which in a few places almost block the passage. The formation of the mineral deposits is subsequent therefore to the formation of the passage in which they occur.

**DISCOVERY OF THE CAVE**

Marengo cave has been known only since 1883. The cave was first entered on Thursday, September 6, 1883, by two children of the name of Hiestand. The children were at play in the grove and were attracted to the opening at the bottom of a sink hole. Accounts as to why they ventured into the opening differ. For some reason the story is told that they followed a rabbit into the opening and this led to the discovery of the cave. Mr. Stewart and those connected with the cave emphatically deny the rabbit story and say the discovery is due solely to childish curiosity. It is significant that shortly preceding the discovery, the virgin timber had been removed from the hillside upon which the entrance was found. Mr. Stewart thinks this favored increased guilting and that the increase in runoff was the main factor in opening up the hole in the sink.  

The children did not venture far into the cave, certainly not beyond the zone of light, but they realized there was a great interior opening. The discovery was not mentioned until the Sunday following at which time the first party of explorers, people of the vicinity, entered. Mr. Block, upon whose land the discovery was made noticed that people returning from the cave were carrying numerous mineral formations that they had broken from the walls or ceiling. Realizing that the feature must be an unusual one he wisely prohibited the breaking and carrying away of the mineral deposits. This early protection is largely responsible for the nearly unmutilated character of the cave interior.

Another incident, purely accidental, saved the most beautiful part of the cave from mutilation by the first party of explorers. The part of the cave to the right of the old entrance (as one enters) is known as Pillared Palace, Queen's Palace, and Crystal Palace, places that are literally filled with wonderful mineral formations. The first party of explorers did not notice this part of the cave upon entering and traversed the entire length of the cave, following much the same route now taken by tourists. When this part of the cave was first discovered directions for the preservation of the mineral forms had already been given, so this section remains today in all of its primitive glory. Only the natural process of a hard winter freeze has slightly marred the interior decorations.

Since its discovery Marengo cave has been in the hands of the

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1 Personal communication from Mr. Stewart, Manager of Marengo Cave.
Stewart family. These people have made it a show cave and its walls and halls have echoed and re-echoed with the tread of thousands of visitors from all parts of the United States.

**THE PRESENT ENTRANCE**

The entrance that is now used by tourists is artificial. It is near the cave house, see map, figure 1, and is protected by a heavy wooden door. When parties are not at the cave the door is kept locked. From the entrance a flight of 12 or 15 steps leads down into the cave. The sensation is similar to that one experiences in going into a cellar. At the bottom step artificiality ceases except for a short walk way cut out of the rock and clay. The rest of the trip, excepting a place or two where artificial steps have been built, is through a magnificent feature of nature's own carving.

The original entrance is now filled in so that ingress or egress by it is impossible. Its position is marked by a small spring 500 feet northwest of the present entrance. The creation of the artificial entrance was advisable for two reasons. In the first place the present entrance is more convenient and in the second place it does not introduce visitors to the most beautiful part of the cave at the beginning of the trip, it being the policy of the owners to reserve the best cave display until the last.

**DOMINATING INTERIOR CHARACTERISTICS**

Physiographically, Marengo cave is essentially a channel cave. Within a very short distance of the entrance it gradually dawns upon the observer that he is in an immense underground cavity and this impression grows as one walks along and listens to explanations and interpretations given by the guides. Although the cave is not the largest or longest within the borders of the state, its passages and halls are so spacious that the visitor scarcely realizes its true character.

To most people the dominating character of the cave is the beauty and variety of its mineral forms. Few of these deposits are pure white, more often they are stained a yellowish or clay color. Thousands of these deposits, of every form imaginable may be seen and admired during the cave trip that requires about two hours' time.

A third character of the interior is the cavern floor. Through most of the cave this is composed of hard dry clay, only in a few places is the clay veneered with a mineral deposit of flowstone and in relatively few places is it muddy. In this floor of clay an old stream channel has been eroded. The channel winds back and forth from side to side of the cave maintaining its uniform width of about twenty feet. It is bounded by banks 2½-3 feet high. (See cross sections 1 and 2, Fig.) For considerable distances the channel is used as a walk way by visitors. The stream which used to flow in the channel has now found a lower level and never rises sufficiently high to occupy it.

A fourth, and to many visitors a very agreeable characteristic, is the relatively small amount of climbing or stooping necessary to see all the cave. No stooping is necessary for people of ordinary dimen-
sions except a bending of the head while passing through a few short passages.

There is evidence of two levels. Within a short distance of the entrance one passes to the lower route of the cave and follows this to the Prison Bar. Here a short flight of steps leads to the passage known as Washington Avenue which corresponds to the upper level of the cave. The upper level is again reached in Elks' Hall and back of the Pipe Organ.

DISTRIBUTION OF THE MINERAL DEPOSITS

The central part of the cave is relatively free of mineral forms. There is less amount of water drip in this portion and it is also the part of the cave deepest underground. Mineral forms are more numerous at each end of the cave, the water drip is much more in evidence, and the cave is closer to the surface at these points.

ORIGIN OF THE MINERAL DEPOSITS

The water which drips into the cave has come through the overlying soil and rock cover. During this journey it has become slightly acid as has been previously explained. Ground water in this state has the property of dissolving the limestone although the rate of solution is very slow. Consequently, when the water comes into the cave it is oftentimes highly charged with the dissolved limestone. In the cave the water is in contact with the air and evaporation occurs with the result that some of the mineral matter is deposited. Where the deposits are formed on the ceiling and grow downward they form the stalactites. When the drop of water falls to the floor more mineral matter is deposited and a mass of material slowly grows upward. This is called the stalagmite. When deposits from ceiling and floor join the resulting feature is called a column. Columns may also be formed by continued growth of a stalagmite until it reaches the ceiling or by the continued downward growth of a stalactite until it touches the floor. When the mineral deposit is spread irregularly over clay or over the floor of the cavern it is termed flowstone.

In every one of the above cases the mineral forms represent limestone that has been taken into solution and then redeposited in a crystalline form.

TEMPERATURE

Temperatures in the cave do not vary to any appreciable extent. The average temperature within the cave is 54 degrees Fahrenheit. Near the entrance and at places where the cave comes close to the surface some variation of temperatures is found.

People who visit the cave on a hot summer day are impressed by its seeming cool and such is natural for a change from 90 or 95 degrees, the temperature of the outside air on a summer day, is quite in contrast to a temperature of 54 degrees on the cave interior. Consequently on a zero day in winter the cavern would seem warm to those who have occasion to enter it because the temperature of the interior remains at 54 degrees.
FACILITIES FOR VISITORS

Two hotels located near the railroad station at Marengo furnish accommodations for limited numbers of people. Treatment of visitors is courteous and accommodations are those in keeping with a village of 450-500 inhabitants. Prices are reasonable.

A free camp ground is maintained near the cave entrance for those who wish to travel the camp way. Water for cooking and drinking purposes is available. The water has been tested by the State Board of Health and is termed satisfactory for drinking purposes. In case of bad weather visitors are given free use of the tourist building which is provided with benches and tables. A store where ordinary camping supplies can be obtained is located about one-fourth mile west of the cave entrance.

Admittance to the cave is by ticket. Trips through the cave are scheduled to start at 7, 9, and 11 a.m., 1, 3, and 8 p.m. Individuals or small parties may be accommodated at any time regardless of the above schedule if circumstances warrant it.

The cave company maintains from 3-5 men as guides. The guides are thoroughly acquainted with the cave and its history and they are most considerate of the visitors. To the best of their ability they make the trip through the cave interesting and entertaining. The arrows, shown on the accompanying map, indicate the direction tourists are conducted through the cave.

Gasoline lanterns carried by guides and visitors is the method used to illuminate the cave. When full the lanterns will burn from 4-8 hours, giving an intense white light, that may be partly controlled by reflectors. This system of lighting is clean and very satisfactory for illuminating the cave. At the close of the cave trip the Crystal Palace and Music Hall are illuminated by red flares. This scene is a most entrancing one and as previously indicated is a fitting culmination to a cave trip.

The fact that the greater part of the cave is dry and that no crawling is required during the trip makes a change to cave clothes unnecessary. Where water drip has moistened the clay floor, walk ways have been constructed or the water is carefully drained to one side of the passage. To many people these are welcome conveniences while to others it would seem more cavelike if these marks or artificiality were not present.