POSTAGE REPORT
1921–1922

Division	Received		Mailed	
	1st Class	All Other	1st Class	2nd Class
General Administration	5,519	385	3,917	10,224
Geology	1,735	666	1,859	648
Entomology	4,673	1,216	5,416	1,295
Forestry	1,755	106	3,262	3,139
Fish and Game	8,407	420	13,361	2,314
Engineering	902	187	2,035	127
Total	22,991	2,980	29,850	17,749

REPORT OF THE DIVISION OF GEOLOGY

W. N. LOGAN, State Geologist

ORGANIZATION

The working organization of the Division of Geology as it is now constituted consists of a technical force, an office force, a field force, and gas-inspection force. The members of the office force are the only staff members drawing salaries regularly from the division funds. A few members of the field force draw salaries from the division funds for a few months each year. The gas inspectors are paid from inspection fees collected by them. A part of the funds collected by them is used to help defray office expenses.

TECHNICAL FORCE

The members of the Department of Geology of Indiana University serve as members of the technical force as follows:

W. N. LOGAN, Ph. D., Economic Geology.
E. R. CUMINGS, Ph. D., Stratigraphy and Paleontology.
C. A. MALOTT, Ph. D., Physiographic Geology.
S. S. VISHER, Ph. D., Geography.
W. M. TUCKER, Ph. D., Hydrology.
J. R. REEVES, A. B., A. M., Assistant, Oil Shale Technologist.
H. W. LEGGE, Preparator.

OFFICE FORCE

THEODORE KINGSBURY, Supervisor of Natural Gas.
EDWARD H. SHAW, Curator of Museum.
MRS. ADDA RINKER, Clerk and Stenographer.

FIELD CORPS FOR 1922

W. N. Logan
E. R. Cumings
C. A. Malott
W. M. Tucker
J. R. Reeves
R. E. Esarey
M. A. Harrell
W. P. Rawles
W. A. Thomas
G. G. Bartle
R. L. Kidd
F. E. Madenwald
R. S. Hunt
Geo. Cressey

Fines and costs amounting to $36,116.50 were assessed against $731.90 in 1916.

Operated four fish hatcheries from which were distributed among others more than one million black bass and 400,000 pike perch to the waters of the state which is more than twice any previous year.

Eleven reels of motion pictures portraying the work of the division have been made available to the public organizations.

Nineteen new fish and game associations were formed in the state, making a total of 143 such clubs or associations.

Published a manual for the game warden service.

Engaged in a campaign of purification of our polluted streams and waters.

ENGINEERING

Completed topographic surveys of Muscatatuck park and unfinished work on McCormick's Creek and Clifty Falls.

Designed and constructed timber trestle in Turkey Run, one mile of road through new tract, water supply and sewage disposal system. Designed three roads and two timber trestles for Clifty Falls.

Inaugurated a drainage survey with the purpose of locating all areas in the state which have been mentioned in drainage reclamation enterprises, to ascertain areas in need of drainage, cost data and similar information.

There was inaugurated a system of stream gauging stations for the entire state. Plans are to establish ten stations immediately and ten the following year.

Established 165 shallow wells in the Kankakee valley for the purpose of taking measurements on the underground water table level which should give information on the effect of drainage of such lands.

Prepared a pollution index of the streams of Indiana.

Conducted investigations in the disposal of industrial wastes now being dumped into the streams.

Studied closely the effect of industrial wastes upon fish life of the streams.

Made forty-five separate investigations scattered over the state.

In a large number of cases filed affidavits against the violators and required of them plant changes which will handle the wastes.

CONCLUSION

The crying needs of the museum we hope will be taken care of by placing it in the contemplated Memorial Building in the Indianapolis Plaza. The importance of a museum can be under-estimated. Indiana is backward in its obligation to a great past. Collections are fast leaving the state which could be easily obtained had we the proper space to exhibit them.

Attention is also respectfully drawn to the insufficient housing of our department. The space is insufficient and cramped conditions are a detriment to the work that has to be carried out.

RICHARD LIEBER, Director.

NATURAL GAS INSPECTION FORCE

THEODORE KINGSBURY, Supervisor

DEPUTIES

C. N. Brown ..... Geneva
John Ersinger ..... Sullivan
J. P. Horton ..... Montpelier
J. E. McIntyre ..... Marion
Herschell Ringo ..... Muncie
Geo. H. Smith ..... Owensville
John Watson ..... Petersburg
Howard Legge ..... Bloomington
O. H. Hughes ..... Sharpsville
E. E. Wherry ..... Shoals

PUBLICATIONS

The following reports, books and articles were prepared and published during the year:

"Report of the Division of Geology," Indiana Year Book, 1922. This report contains an account of the field, office, laboratory and museum work and a financial report of the division. It also contains the technical papers entitled: "Gold in Indiana," "Potash in the New Providence Shale of Indiana," and "An Intraformational Breccia of the St. Louis Limestone of Indiana."

In answer to a demand on the part of the public for a map showing the distribution of the various coal beds of the state, such a map was prepared and published under the title, "Coal Fields of Indiana."

"The Handbook of Indiana Geology," comprising more than 1,100 printed pages, was completed during the year. This work contains a complete resume of the geological conditions in Indiana and a history of their investigations. The volume is divided into six parts, each part having been prepared by a member of the technical force.

Part I treats of the geographical features of Indiana, discussing location, area, climate, industries, population, and the geographic factors influencing industry, commerce and the distribution of population.

Part II discusses the physiographic conditions of the state and assigns causes for its most prominent relief features. It contains a discussion of the prominent physiographic provinces of Indiana and cites many examples of changes in topography taking place at the present time.

Part III deals with certain hydrographic conditions of Indiana, exhibits a map showing the streams and lakes, the surface drainage lines, gives tables of stream measurement, shows location of gaging stations used, discusses water supplies and sewage disposal, and contributes much to our knowledge of Indiana hydrology.

Part IV describes the strata which composes the geological formations of Indiana, names the various divisions and subdivisions of geological time represented by formations in the state, and correlates these with those of other states. It discusses the life present in those periods

and the environmental conditions under which the life existed. This part also gives a comprehensive view of the work which has been done on the geology of Indiana by former investigators.

Part V comprises a discussion of the economic mineral resources of Indiana; it devotes considerable space to the discussion of petroleum and natural gas, to the coal resources, to kaolin and clay, to ground and mineral waters, to building stones, to lime and cement materials, to abrasive materials, to sands used for foundry work and glass manufacture, to deposits of peat and marl, to pyrite, gold, precious stones and other minerals. Maps which show the distribution of these minerals and natural products accompany this part of the volume.

Part VI deals with a single economic feature of the state, the oil-bearing shales. It describes the distribution of the New Albany oil-bearing shales, describes their mode of occurrence, condition of outcrop, thickness, physical and chemical properties; it also discusses the location of quarries, extraction plants, methods of extraction, quantity and quality of the oil, recoverable by-products, and other features of the subject.

An article on the "Natural Gas Resources of Indiana" was published in the Oil and Gas Journal. An article on the coals of Indiana was published in the Black Diamond under the head, "Coals of the Allegheny Division of Indiana; Farming the Top and Mining the Bottom, Along the Line of the Chicago, Milwaukee and St. Paul Railway in Indiana." A special edition of 30,000 of this number was issued and distributed to commemorate the taking over of the Chicago, Terre Haute and Southeastern Railway by the Chicago, Milwaukee and St. Paul Railway and the opening of the territory traversed by that road as a market for Indiana coal.

A bulletin on the "Oil Shales of Indiana" was prepared and published in co-operation with the United States Bureau of Mines. An illustrated article on oil shales was published in a large number of newspapers of the state as were many other articles relating to the mineral resources of the state.

ARCHAEOLOGICAL INVESTIGATIONS

Investigations of the archaic deposits of Indiana were continued in conjunction with the activities of the regular field work. No funds being available for the work, it could not be carried forward except as an accompaniment of other lines of work. A number of new localities were visited during the year. The co-operative work with the State Historical Commission in conducting a county by county survey of an historical and archæological nature was continued. In preparation for the work of this survey, the Division of Geology prepared a large number of county base maps for the location of points of historic and archaic interest.

CO-OPERATIVE OIL SHALE INVESTIGATIONS

At the beginning of the year the Division of Geology entered into a co-operative agreement with the United States Bureau of Mines through the director, Dr. H. F. Bain, with a view to securing a more systematic

investigation of Indiana oil-bearing shales. It was agreed that for a period of time the methods of investigation outlined and used by the bureau should be followed in our laboratory. This laboratory work to be inspected from time to time by representatives of the bureau. At the suggestion of the bureau, Mr. J. R. Reeves, of the division, was sent to the United States Bureau laboratory at Boulder, Colorado, for the purpose of studying the methods being used there. As a result, our methods of investigation have now been standardized with those of the bureau. ThTe expenses of the investigations are divided as follows: The laboratory expenses are being paid by Indiana University, the expenses of inspection and publication by the Bureau of Mines, and the field expenses by the Division of Geology.

GEOLOGICAL FIELD INVESTIGATION

The members of the technical force of the division responded to many requests for geological investigations in the field during the year. These investigations included the examination of oil and supposed oil lands, oil-bearing shales, the investigation of sources of water supply, problems, clays and shales for ceramic use, areas of land containing building stones, material for the manufacture of Portland cement and lime, peat and marl areas. Assistance was given cities in the location of more adequate water supplies.

In the course of the regular field season systematic investigative work was carried forward in the survey of the Coal Measures of Indiana. The territory surveyed during the past season embraced the whole or parts of the following counties: Greene, Sullivan, Knox, Pike, Gibson, Posey and Vanderburgh. The work consisted of the location of the outcrop of the various coal beds, a study of the stratigraphy and structural conditions, the collection of samples of the coals, fire clays and shales for study in the laboratory and the determination of their qualities and uses.

Assistance was given to oil companies; to farmers seeking coal for threshing purposes; to clay workers and others. The field party engaged in this work included the following members: W. N. Logan, R. E. Esarey, M. A. Harrell, G. G. Bartle, W. P. Rawles, R. S. Hunt and F. E. Madenwald.

An investigation was made jointly by the state geologist and the state forester on the proposed use of stripped coal land of the Central Indiana Coal Company for forestry purposes. It was found that the land was unsuitable for this purpose, for when the coal was removed the land was left in sharp ridges varying in height from 35 or more feet, the land between the ridges being occupied by V-shaped depressions of about the same depths. The surface soil is deeply buried and the surface of the ridges is occupied largely by undecomposed rocks, leaving a condition, both from the standpoint of topography and condition of soil, unsuitable for the growing of trees. It was suggested that if trees were to be planted on such land the ridges should be, at least, partly level and the growing of trees be tried out in an experimental way. More complete information on this subject is given in a report made to the director of the department in November, 1921.

Dr. E. R. Cummings, assisted by Mr. W. P. Rawles, continued his studies of the Ordovician and Silurian formations, tracing the strata of these formations into Ohio and correlating them with the formations of that state.

Dr. C. A. Malott continued his studies of the Mississippian formations of Indiana. His work embraced the mapping of the areas of Chester rocks in the western part of the unglaciated area of Indiana, and in correlating these areas with those previously studied. The structural conditions of the area were mapped. He spent some time, also, in mapping the topography of the Lost River region.

Dr. W. M. Tucker, assisted by Mr. A. W. Thomas, studied water supply conditions in the lake region, surveyed, took soundings and drew contour maps of nineteen lakes in northern Indiana for the Division of Fish and Game.

Mr. J. R. Reeves, assisted by Mr. R. L. Kidd, continued his study of the New Albany oil-bearing shale area, mapping the area of outcrop, selecting sites for quarries, studying transportation facilities, and collecting samples to be tested in the laboratory for oil content.

STATE FAIR EXHIBIT

The exhibit made by the division in the Indiana University building at the State Fair consisted of a display of some of the mineral resources of Indiana, of maps and charts showing the distribution of economic products and of publications. Oil shale extraction apparatus was exhibited and shale oil was extracted from the raw shale in the presence of the visitors. The exhibit was installed by Mr. R. E. Esarey and Mr. H. W. Legge. Mr. Legge remained in charge during the entire period of the fair.

MINERAL INVESTIGATIONS

A large number of rocks and minerals were received at the office and laboratory during the year with requests for their examination, testing, and analysis with a view to determining their value or usefulness. Some of these required merely a qualitative test, others required a careful quantitative analysis which consumed much time. All qualitative tests were made without expense to the citizen and no charge was made for the quantitative analyses, except for the actual time charges of the chemist.

The following is a summary of the determinations made during the year:

Alum	3	Garnet	2
Asphalt	6	Gold Ores	6
Barite	2	Granite	25
Calcite	19	Hematite	2
Chert	11	Iron Carbonate	5
Clay	57	Iron Ores	20
Clay, Ceramic	10	Jasper	4
Clay, Fire	9	Kaolin	5
Coal	64	Limestone	55
Coppers Ores	18	Magnetite	1
Fossils	6	Marl, Calcareous	14
Galena	3	Mica	48

Ocher	1	Schists	3
Oil	56	Shale	64
Oil, Sands	238	Silver Ores	6
Oil, Shale	31	Soils	8
Ozecerite	1	Sphalerite	9
Peat	9	Water	42
Pyrite	90	Water-Oil Mixture	16
Quartz	49	Miscellaneous Minerals	14
Sand, Building	3		
Sand, Molding	2	Total	1,037

Not less than fifty examinations were made during any month.

NATURAL GAS SUPERVISION

The conservation of natural gas and petroleum by preventing wasteful practices about wells, by stopping leaks in pipe lines, and by supervising the plugging of abandoned oil and gas wells, is in charge of Theodore Kingsbury. Assisting in this work are ten deputies, in charge of districts in which they live, who are paid no salary, but receive a part of the fee they collect for supervising the plugging of wells. A list of these deputies is given in the first part of this report.

During the year 246 wells were plugged under the supervision of the State Gas Supervisor and deputies, the former visiting only the wells in districts not covered by deputies. The fee of $10 collected by him for the plugging of each well and $2 of each of the fees collected by deputies, a total of $644, was turned over to the general fund of the Department of Conservation. Wells were plugged in thirty-one counties as follows:

County.	No. of Wells.	County.	No. of Wells.
Pike	39	Tipton	3
Delaware	35	Decatur	3
Jay	31	Madison	3
Grant	15	Shelby	3
Gibson	14	Martin	2
Wells	14	Miami	2
Huntington	11	Vermillion	2
Blackford	9	Vigo	2
Sullivan	8	Wabash	2
Randolph	7	Bartholomew	1
Rush	7	Daviess	1
Adams	6	Hancock	1
Hamilton	6	Henry	1
Howard	5	Lake	1
Marion	6	Warrick	1
Knox	4		
		Total	245

During the calendar year 1921, Indiana produced 1,163,000 barrels of petroleum (42 gallons each), as compared to 932,000 barrels in 1920. This production has not been equalled since 1914, when 1,335,456 barrels were produced. Of the 1921 yield, 891,000 barrels were produced in the southwestern field, and 272,000 in the older northeastern field. The largest production for any one month during the year was in May, when 107,000 barrels were produced, an average of 3,452 barrels a day. The

production thus far in 1922 is only slightly below that for corresponding periods in 1921, but is above that of several years previous. Increased activity in drilling, stimulated by the higher price of petroleum, accounts for the increased production during the last two years.

The most remarkable well drilled during the year is on the Tom O'Brien farm, Jay County, eight miles south of Portland, in the Ridgeville field, which made an initial production of 200 barrels a day. A number of wells in other parts of the state have been reported as having made an initial production of more than 100 barrels a day, but the average production of producing wells in Indiana is less than five barrels a day.

With the exception of the southwestern part of the state where several oil sands are found, all of the oil produced in Indiana thus far comes from the Trenton formation. However, during the year several attempts have been made to find oil below Trenton. In Bear Creek Township, Jay County, the deepest well in the state has been drilled. In June, when drilling was temporarily suspended, this well was 3,267 feet deep. South of Greensburg a deep test well is being drilled which is more than 3,000 feet deep. The chief of this division has been consulted by the owners of this well on a number of occasions, and has tested many samples of sand for them.

Following a study of structural conditions in southern Harrison County by the Division of Geology, recommendations were made for prospecting for gas, which resulted in the opening of what is known as the "Laconia Gas Field." The production of gas from this field is ample to supply the needs of at least three nearby towns—New Middletown, Elizabeth and Corydon. A special report on this field was made to the director in December, 1921.

Gas has been found in several other localities in the state during the year. At Brewersville three productive gas wells were drilled and plans are being made to pipe this gas to North Vernon. Several wells have been brought in near Newcastle and the gas will be piped to that town. Notwithstanding the development of new gas territory, the supply in many localities, as in Rush and Decatur Counties where gas has been produced for fifteen to twenty years, is becoming depleted, so that the total production for the state is gradually decreasing. This condition necessitates the closest observance to state laws to conserve the supply.

Beginning with December, 1921, and regularly each month following, a report on the activities of drillers for oil and gas has been issued and sent to deputies and others interested. This report gives all the information on the discovery of oil and gas and the progress of wells being drilled that can be obtained from reports and newspaper clippings received in this office. It has assisted in getting more hearty co-operation from deputies and others interested in the production of oil and gas in Indiana, and has resulted in a closer observance to state laws.

A persistent effort has been made throughout the year to collect well logs or records, but some difficulty has been experienced in getting in touch with new companies operating in the state and acquainting them

with the regulation requiring that logs be filed in the office of this division within thirty days after the completion of wells.

OFFICE WORK

The office work of the division is attended to by the assistant geologist and stenographer. It consists principally of attending to correspondence, mailing reports on request; tabulating circulars, reports and other sources of information received in the office, collecting and recording well logs; collecting data on the natural resources of the state for the office, individuals and press; and giving information to callers.

Considerable work has been done in arranging the books and bulletins of the division's library, so they may be referred to more readily and the information they contain made more available. A complete general index to the Handbook of Indiana Geology was compiled in the office. In response to requests for information on archæology in Indiana, a Bibliography of Indiana Archæology was prepared and copies made for distribution. Arrangements were made with the state library to file trade journals received in the office, so they could be of use to the public as well as being in a readily accessible form for use by this division.

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

	Office	Laboratory	Total
Letters received	1,740	500	2,240
Letters mailed	1,859	410	2,269
Reports distributed—			
Geological	294	...	294
Petroleum and Natural Gas	132	16	148
Kaolin	270	10	280
Coal Maps	110	...	110
Personal conferences	1,373	380	1,753

MUSEUM

The registered attendance of the museum for the fiscal year was 42,760, as compared to 43,968 the year before, a decrease of 1,208. The reunion of the National G. A. R. which was held in our city last September would account for this. A conservative estimate of callers not registering or refusing to do so would be 20 per cent, making an approximate of 51,312 during the fiscal year just ended. The legislature not being in session this year has depleted the number of visitors to the museum considerably.

The wants of the museum are numerous, but the greatest complaint from visitors is that the crowded and congested condition prevents them from seeing the display properly. Eighty-five per cent of the attendance was from our "Home State," who expressed extreme praise for the collection, while totally ignorant of the fact that our store room contains three times as many specimens as are now on display, for lack of space to show them. The "Paxton" collection is still unpacked. A number of articles are donated almost daily, and the collection is losing many other donations because they cannot be shown, as so many of the aisles are so close together that the cases cannot be opened, or guests pass between.

Provisions for lighting are totally inadequate. In many of the

lower cases exhibits cannot be seen, let alone decipher the cards. No new cases have been added for years and the old ones are obsolete and largely out of repair. Space is required for teachers and students for their accommodation in making the sketches and notes required in their studies, of which a large number visit us. The universal cry is "More space should be provided." To sum up, it needs *space*:

To enable the caller to get around.

To enable the teachers to get the information they are in search of.

To aid the pupils to prepare their studies.

To show fully the beauty of each exhibit.

Nearly every state in the Union *has* provided a separate building for the proper showing of the *state's resources*, and the people's demand, as evidenced by our visitors, should not go unheeded.

DONATIONS, ADDITIONS, ETC.

Collection—Picked up on Rush County farm and donated by O. O. Barrett, Indianapolis:

Hawaiian Criminal Whip—Containing over 300 shark's teeth. Used over 100 years ago.

Hawaiian Basket—Hand Made.

Sea Grass Breech Clout—Worn by Hawaiian women.

Hawaiian Police Mace—Stone inside.

Stone Pestle for Grinding Grain for Food—Hawaiian.

Hawaiian Beads.

Bolas Ball.

Electric Armature—From the first Electric Vehicle made in the United States. Was brought to Indianapolis in 1888 by Chas. Reitz. A one-seated affair. Donated by his son, Herman.

Shells from Recondra Beach, Calif.—Donated by Melvin J. Addington, 3503 North Illinois, Indianapolis.

Archer's Cross Bow—Presented by Misses Emma and Frieda Metzner, Indianapolis. Brought from Europe by their father, Emil Metzner (deceased) many years ago.

Mammoth Tooth—Elepleas Prinrigenius. Donated by Clint Perry, 807 North Drexel Avenue, Indianapolis.

Pewter Wash Basin—Presented by Mrs. Charles N. Money, granddaughter of Thomas W. Moore, Parke County, Indiana. Said to have been used by the Dunkards during the early settlement of this country in their foot washing services.

Civil War Relics—Campbellsburg, Indiana—Odds and Ends, bayonets, shells, cannon balls, etc.—No other advice in regard to them.

Bean Ring and Nut from Honolulu—Made in prison there. Donor, H. B. Reish, 1111-12 I. O. O. F. Building, Indianapolis. Relics from B. G. Mann.

Belt Buckle and Fragments of High Explosives—From Chateau Thierry, France. Brought from and donated by Earl Deitrich, Indianapolis.

(*Bowie*) *Dirk Knife*—Donated by Mrs. Kate Shepherd, 419½ East Twenty-Second Street, Apt. 1, Indianapolis. Carried by Capt. Thomas Hibben during the Civil War.

Surgical Instruments—This case of amputating instruments was purchased in 1840, in Cincinnati, Ohio, by the late Dr. Albert G. Preston, of Greencastle, Indiana. They were used in his civil practice, prior to the Civil War. Dr. Preston enlisted in the Civil War in April, 1862, and was appointed Surgeon of the 55th Ind. Vol. Inf., by Gov. O. P. Morton. They were used at the battles of Richmond, Kentucky, Shiloh Church, Sieges of Vicksburg and Corinth, Mississippi, and other battles. This case is now 82

years old, and is surrendered to the Indiana State Museum by the Preston family, through a son of the late Dr. A. G. Preston, Dr. Joseph L. Preston, Cloverdale, Indiana, as a memoir of the past.

Birthday Cake—This twelve-layer jelly cake, covered with icing and decorated with candles, was baked by Mrs. Fannie McCabe for her son, Vincent, February 14, 1880, to be served with ice cream to his playmates, who had gathered together in honor of the occasion. Upon second thought, Mrs. McCabe baked another cake, which she served instead, and placed this birthday cake under the glass globe to see how long it would remain. Mr. and Mrs. McCabe were married March 30, 1855, in Indianapolis, and the plate, upon which the cake is resting, was one of their wedding plates. Presented to the Indiana State Museum by Vincent McCabe May 22, 1922.

Hawk—Caught three miles west of Fort Wayne, Ind., 1917.
Sea Parrot—From Alaska, 1909.
Sawbill Duck—From Alaska, 1909.
Hat—Greek Fez.

Wooden Shoe—Above listed specimens donated by J. E. Martin, 2107 Hanna, Fort Wayne, Indiana.

Fossil—Portion of the tooth of the mammoth. Donated by J. M. Larsh, 840 North Meridian, Indianapolis.

Pocket Piece—Log Cabin Campaign of 1840. Donated by D. W. Atkins, Marion, Ind.

Niagara Limestone—Chain Coral—From Cass County, Indiana.

Abalone Shell—Extremely large. Donated by Garrett W. Olds, 829 N. Pennsylvania Street, Indianapolis.

Lithographic View Andersonville Prison—Large size. Donated by Bennie Coombs, Columbus, Indiana.

Bird of Paradise Feathers—1 large Black Paradise, double, 1 large Black Paradise, single, 1 made-up Black Paradise, 2 small wired Paradise, 2 small wired Yellow Paradise, 5 large Yellow Paradise, 4 natural Goura Scalps, 6 large Yellow Miner Paradise, 4 bunches long white Aigrettes, 40 strands each. Donated by National Association of Audubon Societies, 1947 Broadway, New York City, N. Y.

Screw Driver, Wrench, etc., Combination.

Knife, Spoon and Fork, Combination—Carried by John L. Lewis, Co. D, 40th Indiana Volunteers. Donated by L. Estel Lewis, 2144 Sugar Grove Avenue, Indianapolis.

Star Fish—A large specimen from Tampa, Florida.

Silk Badges—Collection of Presidential Political Badges of both parties—Harrison, Cleveland, Marion Club, Thurman, etc.

Land Patent—Signed by Andrew Jackson. Donated by Lawrence LeForge, 411 Stephens Place, Indianapolis.

Shawl—Donated by Mrs. Fanny McCormick Miller, granddaughter of James and Patsy McCormick. Inherited from her grandmother, and one of the souvenirs of the McCormick family—the first settlers of Indianapolis.

Skinning Knife—From the Philippine Islands. Used in Spanish-American War. Brought home by Geo. S. Mendel. Donated by his son, LaVerne S. Mendel, Indianapolis.

Saddle—Presented by Mrs. G. W. Brown, who was daughter of Mrs. Mary Ann Hacker Coble, and to whom this saddle was given by her grandmother, Mrs. Mary Ann Van Blaricum, who with her husband, John Van Blaricum, and family came to Indianapolis in 1820 from Brookville, Indiana. Mr. and Mrs. Van Blaricum came from the same old Dutch family in Holland as Martin Van Buren, being a cousin of the President. They first located in Pennsylvania and then came to Brookville. Mrs. Van Blaricum rode horseback from Brookville when they came to this city, using this saddle.

Sword and Scabbard, Sash, Belt and Sword Knot—Worn by William Plummer Benton, Brig. Gen'l U. S. Volunteers American Civil War—Richmond, Indiana. Bequeathed by his son, Walter P. Benton, Indianapolis, Indiana, 1921.

Spinning Wheel—From the old log house in which Governor Jennings, first governor of Indiana, once lived. Donated by Mrs. Maude Hughes.

Grain Sickle—More than one hundred years old. Used before the cradle was made. Donated by Fletcher Cortner.

A SECTION THROUGH THE NEW ALBANY SHALE

JOHN R. REEVES

INTRODUCTION

During the summer of 1921 the Louisville Cement Company bored through the New Albany shale with a core drill. This boring was done in the northeast corner of Grant 108, Silver Creek Township, Clark County, Indiana. The formation was found to be 98 feet 5 inches thick, which is the total and normal thickness. In its laboratories, the cement company had approximate analysis made of each 1 foot 8 inch section of the core. The remainder of the core and a copy of the analyses were then sent to the oil shale experiment station of the Department of Geology, Indiana University, Bloomington, Indiana, where additional experimental work was done.

THE NEW ALBANY SHALE

This formation is the principal oil shale of Indiana and is found outcropping in the southeastern part of the state between North Vernon and New Albany. The outcrop district running north and south is about fifty miles long and from five to fifteen miles wide. The same shale is also found in the northwestern part of the state along the banks of the Wabash River and its tributaries in White and Carroll Counties in the vicinity of Monticello, Delphi and Rockfield. The southeastern or principal outcrop district covers parts of Jackson, Jennings, Jefferson, Scott, Clark and Floyd Counties.

EXPERIMENTAL PROCEDURE

The core was divided into thirty-one sections, each about 3 feet long. Each section was then retorted to determine the oil yield in the convenient and reliable retort for the assaying of oil shales developed by the bureau. Since the oil yield varies with rate of retorting, all sections were retorted at the same rate; that is, the same amount of time was consumed in completing the formation of the oil. By previous experimental work it has been determined the maximum oil yield from the New Albany shale is obtained when the retorting time is one hour or slightly longer. The time of retorting for the sections of the core was one hour and fifteen minutes.

The amount of oil obtained from each distillation was usually insufficient for the determination of specific gravity and for topping. It was necessary therefore to combine the oil from two or more consecutive

samples for these tests. The percentage of unsaturates of the tops and the motor fuel index numbers for the different samples of oil were also determined.*

RESULTS OF EXPERIMENTS

It may be seen, by referring to the table, there is considerable variations in the yield of oil from the different parts of the formation. The upper 35 feet and the lower 20 feet being the richest while the lowest yield was obtained from near the middle of the formation. The average yield for the formation at the location of this drilling is 8.3 gallons per ton. The average yield for the upper 50 feet is 11.6 gallons. Between 50 and 60 feet, the yield is very low, while from 60 to 98 feet it averages 7.0 gallons per ton.

The same variation of oil yield in this vertical section of the formation does not necessarily exist for other localities. The low yield of oil obtained from certain portions of the shale is due to the lack of the oil-forming, organic matter being present. That the same proportion of organic and inorganic materials forming the shale was deposited over an area of several hundred square miles during the entire period of deposition of the formation is hardly possible because each was derived from different sources and was carried and deposited by locally varying agents. It is possible, also, that there was a periodical abundance of these two materials.

The table of analyses shows much sulphur to be present. Other experimental work has shown this to be in the form of pyrite (iron sulphide), existing in the shale as microscopic crystals and as small nodules and lenses of varying sizes.

Attention may be brought to the fact that the volatile matter and the oil yield show a comparatively close relation. Of the thirty-one distillations made of sections of the core and volatile matter for the same portion, only seven show an inverse variation, while the lines representing oil yield and volatile matter follow each other closely.

The diversity between volatile matter and oil yield between 50 and 65 feet of the core is due to considerable amount of calcium carbonate being present in the shale, the volatile matter running high, due to the breaking down of the carbonate yielding carbon dioxide as volatile matter.

That the oil-forming matter of the New Albany shale is probably of the same composition all through the 100 feet of the formation is shown by the very small variation in specific gravity, amount of tops of the crude oil, and the unsaturation of the tops. As shown in the table, the specific gravity of the various samples of oil obtained from different parts of the core varies from .953 to .921, the average being .931. The per cent of tops varies from 44.8% to 40.0%, the average being 41.5%. The unsaturation of the tops varies from 38.0% to 41.0%, the average being 39.2%. The specific gravity, tops, and unsaturation of tops of a great many other samples of oil from this same formation are near these averages.

* For explanation and interpretation of analytical distillation results and motor fuel index numbers, see Gavin, M. J. Analytical Distillation of Typical American Shale Oils, Bureau of Mines, Reports of Investigations, Serial Number 2332, April, 1922.

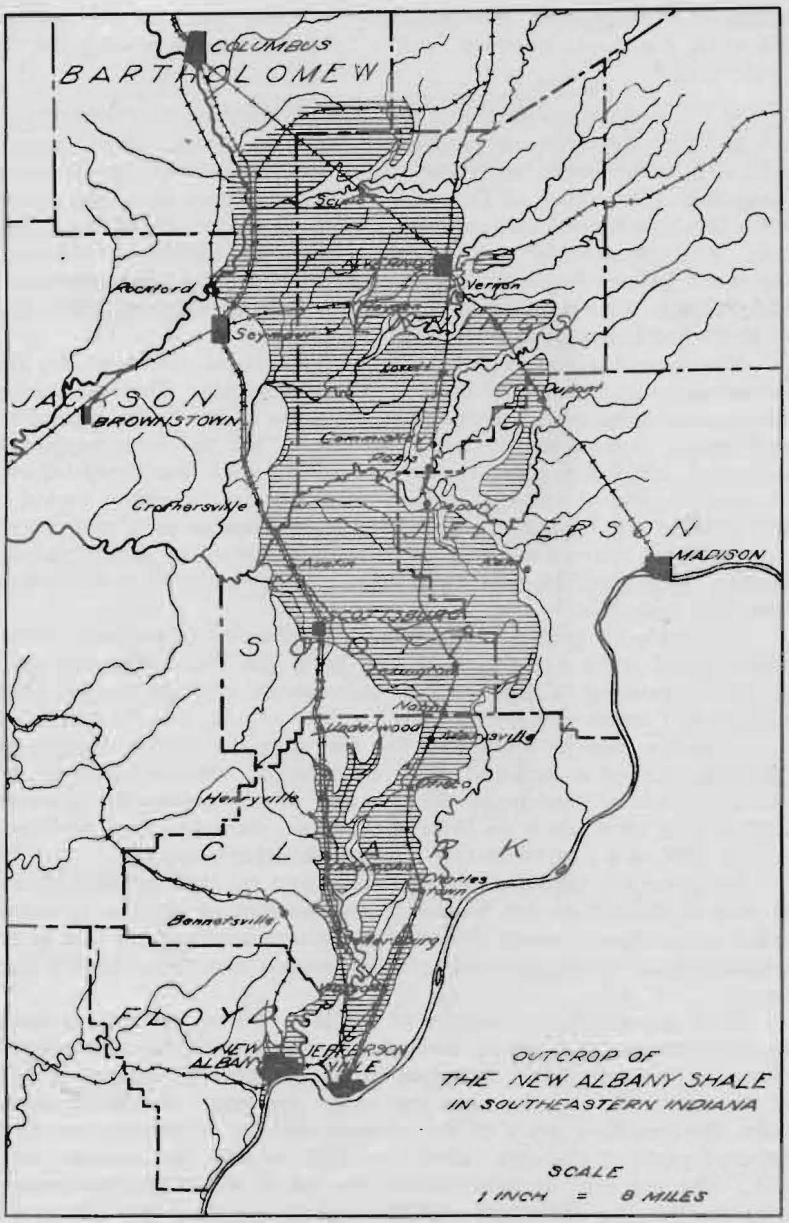
COLUMBUS
BARTHOLOMEW
Rockford
Seymour
Vernon
JACKSON
BROWNSTOWN
Crothersville
JEFFERSON
MADISON
Henryville
CLARK
Bonnersville
FLOYD
NEW ALBANY
JEFFERSONVILLE
OUTCROP OF
THE NEW ALBANY SHALE
IN SOUTHEASTERN INDIANA
SCALE
1 INCH = 8 MILES

TABLE OF ANALYSES OF NEW ALBANY SHALE FROM DRILL CORE

FEET OF CORE	Volatile	Ash	Water	Sulphur	Fixed Carbon	Gallons Oil	Specific gravity	Tops	Unsaturation Tops	Index Number
4′ 11″ to 6′ 8″	15.71	74.30	1.71	1.93	6.35	13.20	.....	.....	.....	.....
6′ 8″ to 8′ 4″	14.88	76.53	1.08	2.65	4.86	.....	.....	.....	.....	.....
8′ 4″ to 10′	14.61	77.24	0.95	5.83	1.37	11.00	.937	.....	.....	.....
10′ to 11′ 8″	14.09	78.21	1.28	4.49	1.93					
11′ 8″ to 15′	14.71	79.82	1.11	4.81	1.84	.....	.....	.....	.....	.....
15′ to 16′ 8″	13.06	79.95	1.08	4.92	0.565	.....	.....	.....	.....	.....
16′ 8″ to 18′ 4″	13.40	80.59	0.95	5.42	0.99	10.50	.937	40.40%	38.00%	25.04
18′ 4″ to 20′	15.19	76.93	0.88	3.20	.....					
20′ to 21′ 8″	13.78	79.72	0.87	4.91	3.80	12.5	.930	.....	.....	.....
21′ 8″ to 23′ 4″	14.47	78.86	0.88	4.46	0.72					
23′ 4″ to 25′	15.34	77.40	0.88	4.46	1.33	13.2	.931	40.60%	41.00%	23.95
25′ to 26′ 8″	14.01	78.90	0.79	5.14	1.92					
26′ 8″ to 28′ 4″	14.19	78.93	0.73	5.86	1.16	12.70	.953	.....	.....	.....
28′ 4″ to 30′	15.78	76.07	0.78	5.46	0.29					
30′ to 31′ 8″	17.76	75.32	0.85	5.82	1.91	13.42				
31′ 8″ to 33′ 4″	17.30	77.39	0.80	4.91	0.25					
33′ 4″ to 35′	17.14	79.37	1.05	3.73	....	11.4	.933	40.00%	40.00%	24.00
35′ to 36′ 8″	14.21	78.93	1.02	4.91	....					
36′ 8″ to 38′ 4″	11.55	84.87	0.97	3.32	0.91	11.40				
38′ 4″ to 40′	11.12	86.10	0.94	2.50	....	8.65	.....	.....	.....	.....
40′ to 41′ 8″	11.78	85.72	0.96	2.95	....					
41′ 8″ to 43′ 4″	13.73	82.79	1.02	2.45	....	7.20				
43′ 4″ to 45′	11.55	86.07	0.92	0.97	....	10.00	.922	44.80%	38.00%	27.77
45′ to 46′ 8″	12.75	83.70	1.05	3.07	....	7.45				
46′ 8″ to 48′ 4″	13.62	82.00	1.18	2.81	....	.....	.....	.....	.....	.....
48′ 4″ to 50′	11.97	84.87	1.41	2.10	0.37	8.40				
50′ to 51′ 8″	10.47	86.26	1.34	2.01	....					
51′ 8″ to 53′ 4″	10.80	87.33	1.15	1.95	....	7.2				.....
53′ 4″ to 55′	9.75	88.71	0.97	1.50	....	4.8	.921	.....	.....	
55′ to 56′ 8″	9.57	88.15	1.28	1.70	....	1.9				
56′ 8″ to 58′ 4″	10.08	87.06	1.29	1.90	....	2.9				
58′ 4″ to 60′	10.55	85.35	1.50	2.92	....					
60′ to 61′ 8″	9.98	88.52	0.99	1.22	....	3.85	.....	.....	.....	.....
61′ 8″ to 63′ 4″	11.10	87.01	1.07	1.80	....					
63′ 4″ to 65′	11.01	86.97	1.01	2.11	....	8.4				
65′ to 66′ 8″	9.79	88.07	0.98	1.67	....					
66′ 8″ to 68′ 4″	9.87	88.26	1.24	1.80	....	7.2				
68′ 4″ to 70′	10.22	87.80	1.05	1.48	....		.928	40.00%	38.00%	24.80
70′ to 71′ 8″	10.58	86.59	1.08	2.18	....	4.4				
71′ 8″ to 73′ 4″	10.42	88.21	1.26	2.00	0.11					
73′ 4″ to 75′	11.43	85.33	1.32	2.13	....	4.8				
75′ to 76′ 8″	9.38	87.88	1.15	2.09	....					
76′ 8″ to 78′ 4″	9.06	86.70	1.42	1.87	0.95	6.40				
78′ 4″ to 80′	9.83	86.95	1.05	2.80	....					
80′ to 81′ 4″	10.40	88.64	0.62	2.04	....	5.20				
81′ 4″ to 83′ 8″	10.62	87.02	1.12	1.83	....					
83′ 8″ to 85′	10.30	87.09	0.98	2.38	....	6.00	.923	43.20%	40.00%	25.92
85′ to 86′ 8″	8.75	87.98	1.01	1.93	0.33					
86′ 8″ to 88′ 4″	8.85	89.23	0.79	2.07	....					
88′ 4″ to 90′	9.89	87.27	1.21	2.23	....	6.40				
90′ to 91′ 8″	11.57	85.93	1.10	2.67	....					
91′ 8″ to 93′ 4″	11.56	83.95	1.10	2.12	1.27	7.6				
93′ 4″ to 95′	13.13	83.19	1.08	1.92	0.68					
95′ to 96′ 8″	18.00	79.60	1.00	1.94	....	9.2				
96′ 8″ to 98′ 4″	15.21	81.97	1.74	1.05	0.03		.924	41.60%	38.00%	25.79
98′ 4″ to 100′	14.62	82.42	1.39	1.57	....	9.2				
100′ to 101′ 8″	16.89	81.49	1.21	1.59	....					
101′ 8″ to 103′ 4″	15.58	78.95	1.29	1.97	2.21	9.2				

THE PEAT DEPOSITS OF INDIANA

W. N. LOGAN, State Geologist

One of the important mineral resources of Indiana is comprised of its peat deposits, of which there is little general knowledge. The development of this resource as a fuel has been retarded largely because

of the abundance of other types of fuel, and partly because of other less prominent limiting factors.

At the time of the coming of the early pioneers to the territory of Indiana, about 85 per cent of its area was covered with forests containing an immense growth of timber. The remnants of these gigantic forests still continue to contribute to the state's fuel requirements, and though greatly depleted they still supply a considerable part of our fuel needs.

At a later period in the history of Indiana our rich coal deposits were discovered and subsequently developed through the influence of the iron and other associated industries. This developed resource has added greatly to our fuel supply.

Later on came the discovery of natural gas and petroleum within the state in abundance and these natural products served to still further meet the demands for fuel. All of these were supplied to the consumer, until within recent years, at a very low cost. Through it all there has been little necessity for exploiting peat as a fuel. Such has been our fuel situation up to the present time and such, with one exception, the situation may continue for a considerable period. The one exception, at least, is that there will be no more fuel at low cost to the consumer as has been true in the past. The fuel resources of Indiana are being depleted rapidly. The forests have all but disappeared, the natural gas and petroleum supplies are waning, the most accessible and economically minable coal beds are being exploited. The time may not be far distant when we will be driven by rapidly increasing prices to seek other sources of fuel supply; for as our fuel supplies wane our fuel demands increase. The present high price of coal has forced the use of peat in some localities.

In 1900 Indiana produced about six and one-half million tons of coal and in 1920 our production was nearly five times as much, being thirty million tons. Within the same period our per capita production had increased from less than three tons to about ten tons.

These increasing demands being made upon our fuel supplies should serve to draw our attention to those possible latent supplies which grim necessity may force us to exploit in the not far distant future.

But, however, important the peat of Indiana may prove to be as a fuel, it is probably not in this capacity that it will be found to be of greatest value to the state. Its potential value may be greatest in its usefulness to agriculture. Large areas of our soils have been depleted of essential plant foods. These essential elements must be restored in order that the productivity of our lands may not fall below the point of profitable farming. Our peat deposits lie easily accessible to large areas of good farming lands. They are often closely associated with beds of calcareous marl, which are useful in destroying soil acidity and in producing conditions favorable to cultivation and the fixation of nitrogen.

Distribution.—The peat deposits of Indiana are located principally in the three northern tiers of counties, lying between the Wabash River and the northern boundary of the state. These deposits lie largely within the area covered by the Wisconsin drift, though there are some isolated areas

beyond the Wisconsin in the Illinoisan drift and minor deposits in the driftless area.

In quantity of peat, the ten leading counties in order of their rank are:

1. St. Joseph
2. Kosciusko
3. Starke
4. Steuben
5. Marshall
6. Elkhart
7. Lake
8. Noble
9. Jasper
10. Lagrange

Origin.—The peat deposits of Indiana have accumulated in the basins of lakes and former lakes, in marshes, to a very limited extent in the abandoned channels of streams and in depressions formed by the shifting of sand dunes and in depressions formed by the damming of stream channels by shifting sands.

In northern Indiana where the glacial drift reaches its maximum thickness there exist on the surface of the drift numerous depressions which have given rise to lake basins and marshes in and around which the vegetation forming the peat had its growth. This process of vegetable accumulation which had its inception with the retreat of the glacial ice is still in progress. However, there are grounds for the belief that the rate of accumulation is slower now than formerly. There are at least two factors which may have influenced the change. In the first place it seems probable that at sometime after the retreat of the ice climatic conditions were more favorable to the growth and accumulation of vegetation than during the present climatic period. The second factor lies in the changes produced by man. These changes are found in the cutting of the forests, the draining of lakes and swamps, lowering the water table, and the cultivation and pasturing of low-lying areas.

Favorable Conditions for the Accumulation of Peat.—The essential conditions for the growth and accumulation of peat forming vegetation are largely topographic and climatic.

Topographic Conditions.—The essential topography is that which presents an area pitted with depressions bounded by higher lands, depressions in which the run-off of the region may be stored. The glacial drift region of the northern states presents such a topographic area. The finger, kettle hole, and other forms of depressions left by the retreat of the ice formed the basins for the numerous lakes of Indiana and the neighboring states. It is in and around these basins that the proper moisture conditions were found for the growth and preservation of the different forms of vegetation which contributed to our peat deposits.

Climatic Conditions.—Some of the essential climatic conditions are: A relatively high humidity, a medium annual temperature, a moderate length of summer season, the absence of strong prevailing winds, and a moderately low summer temperature. The humidity of the region must be such as to maintain a fairly constant supply of water, so that there will not be a very great variation in lake or ground water level. There must be present at all times in the depressions of accumulation a sufficient supply of moisture to produce favorable growth and to protect the

accumulating vegetation from too rapid decay. No deposits of peat of consequence have been formed in arid or semi-arid regions. Not only must there be an abundance of moisture, but its supply must not be intermittent.

Extremely high temperature are not conducive to the formation of peat deposits, even in the presence of abundant moisture as in the tropics and semi-tropics. This condition is due, probably, to the fact that high temperatures are favorable to vegetable decay, being conducive to rapid oxidation and to bio-chemical changes, which are held in check by lower temperatures.

Long summer seasons are favorable to plant growth, but on the other hand they are accompanied by higher temperatures, which are favorable to plant decay. Short summers are not favorable to extensive plant growth. It is the happy mean between these two extremes which seems to be the most favorable for the formation of peat.

Where strong winds prevail in lake regions the vegetation which grows on the surface and in the shallow water is broken up by the waves and tossed upon the shores to decay. Thus vigorous wave action prevents the formation of peat beds.

Thus we owe our peat deposits to the fact that the northern part of Indiana is favorably situated with reference to topography and to climate.

Varieties of Peat.—Considering the predominant type of vegetation, there are two varieties of peat in Indiana. The first is a moss variety composed largely of the fibers of the moss, Spagnum cymbifolium, but containing smaller quantities of other mosses and other plants. This variety has a higher fuel value than the grass-sedge variety, which is made up largely of grasses, sedges and other coarser plants. These two varieties grade into each other so that a great many sub-types could be named. Several other classes or types could be named, such as bog peat, swamp peat, tuff peat, muck and others. Johnson's classification includes the common types in Indiana. These varieties are: 1. Turfy peat, composed of slightly decomposed mosses and other peat-producing plants, having a yellow or yellowish brown color, very soft, spongy and elastic; specific gravity, 0.11 to 0.26, weighing from 7 to 16 pounds per cubic foot. 2. Fibrous peat, unripe peat which is brown or black in color, less elastic than turfy peat, the fibers either of moss, grass roots, leaves or wood, distinguishable by the eye, but brittle and easily broken; specific gravity, 0.24 to 0.27, weight from 15 to 42 pounds per cubic foot. 3. Earthy peat, nearly or altogether destitute of fibrous structure, drying to earthlike masses which break with more or less difficulty, giving lusterless surfaces of fracture; specific gravity, 0.41 to 0.90, the full cubic foot weighing from 25 to 56 pounds. 4. Pitchy peat, dense; when dry, hard; often resisting the blows of a hammer, breaking with a smooth, sometimes lusterless, fracture into sharp-angled pieces; specific gravity, 0.62 to 1.03, weighing from 38 to 65 pounds per cubic foot.

Properties.—The color of Indiana peat varies from light brown to pitch black, though dark brown is the prevailing color at the surface of

the deposit and black in the lower portion of the deposit. The color of many of the muck deposits is bluish-black when wet and dark gray or brown when dry.

Specific Gravity.—The specific gravity of Indiana peat ranges from 0.11 to 1.02 and its weight per cubic foot from 7 to 65 pounds.

Composition.—The average of the analyses of five samples of Indiana peat which were analyzed by Dr. R. E. Lyons, of Indiana University, exhibits the following chemical composition:

Water at 105 C.	11.99%
Volatile matter, air dried	88.49
Fixed carbon	22.00
Coke	31.51
Ash	9.51
Nitrogen	2.99
Sulphur, oven dried	.74
Phosphoric acid in ash	1.36
Potash in ash	1.22

Fuel Value.—The fuel value in British Thermal Units of 55 samples of Indiana peat was determined by Lyons and Cooper. The lowest recorded B. T. U. value was 4,542 and the highest in the 55 samples was 10,466. The average was 8,469 B. T. U.

Uses.—Indiana peat may be used for a variety of purposes. Among others may be mentioned fuel, in the manufacture of gas, as a fertilizer and fertilizer filler, in the manufacture of peat mull, as an absorbent, for packing purposes, in the manufacture of paper and paper boards, as a stable litter, and in the preparation of stock food.

As a fuel, the better grades of Indiana peat may be used. The calorific power of air-dried peat is a little more than half that of anthracite coal. The kiln-dried peat has about the same calorific value as dry lignite or about seventy per cent of that of anthracite coal. The heating value of one pound of the best coal of Indiana is equal to the heating value of 1.26 pounds of oven-dried Indiana peat.

Peat charcoal and peat coke, both of which are useful in metallurgical processes, may be manufactured from Indiana peat.

Gas has been manufactured from peat. The composition of the gas obtained from the use of peat is very similar to the composition of the gas obtained from the use of coal except that there is an absence of phosphorus and sulphur in peat gas.

Peat fiber, or peat litter, is prepared from peat by the removal of the finer particles and the earthy matter. The peat fiber may be used as an absorbent and deodorizer in stables and slaughter houses, containing liquids of fertilizing value which it is desirable to conserve. It is also used as an absorbent for the uncrystallized residues from beet and cane sugar refining.

Peat fiber may also be used in the manufacture of paper and fiber boards. In the manufacture of stock food, peat is dried, partly carbonized, screened and reduced to a powder which contains about ten per cent of moisture. The powdered peat may be used to absorb liquid foods or may be mixed with dry ingredients.

As a fertilizer, peat may be applied directly or it may be used as fertilizer filler. This is one of the most important uses to which the peat of Indiana can be applied. The peat of Indiana contains about three per cent of nitrogen and smaller amounts of potash and phosphoric acid, all essential plant foods.

Peat may be used as a base for complete commercial fertilizers containing phosphorus and potash compounds. It may be used, also, as a culture medium for the growth and distribution of nitrogen-fixing bacteria in the soil. The soluble nitrogen content of peat may be greatly increased by treating the peat with a dilute solution of ammonium sulphate and then inoculating it with nitrifying bacteria. By repeated treatments it may be made to yield as much as 4 per cent of nitrates.

The fertilizing effects may be increased by adding tricalcium phosphate to the bacterized peat, which when applied to the soil may react in such a way as to free its natural potash content.

The accessibility of peat and marl deposits to excellent farm lands in Indiana and the low expense of applying these products to the land should render these resources of very great value to the agricultural interests of the state; and I am hopeful of a more extended use of them in the near future.

The writer desires to acknowledge his indebtedness to written and published papers of Davis, Taylor, Johnson, Soper, and Osbon, especially to "The Peat Deposits of Northern Indiana," by A. E. Taylor, Ind. Geol. and Nat. Res. 31st Ann. Rept. 1906, and to the discussion of peat in Indiana by E. K. Soper and C. C. Osbon in Bulletin 728, United States Geological Survey, the proofs of which articles were furnished the writer through the kindness of Mr. Clarence C. Osbon.

REPORT OF THE DIVISION OF ENTOMOLOGY

FRANK N. WALLACE, State Entomologist, Chief of Division.
HARRY F. DIETZ, Assistant Entomologist.
EVERETT SMITH, Inspector of Nurseries.
FRANK B. WADE, Deputy Nursery Inspector.
CHARLES O. YOST, Chief Inspector of Apiaries.
THOMAS C. JOHNSON, Deputy Bee Inspector.
JAMES E. STARKEY, Deputy Bee Inspector.
WILLIS A. FONNER, Deputy Bee Inspector.
DAVID FELLOWS, Deputy Bee Inspector.
BENJAMIN H. WILKINS, Deputy Bee Inspector.
HELEN WARREN SEEGER, Clerk and Stenographer.

The Division of Entomology inspects all nurseries in the state and issues certificates of inspection to those whose stock is free from injurious insect pests and plant diseases. In some instances where stock is slightly infected and it is possible, by fumigation or other treatment, to kill the insect pests or eliminate the diseases a treatment is prescribed and the owner is required to sign an affidavit that same has been carried out. Certificates were refused to a few nurseries in the state this year.