



MT. RIFENBURG.
A sand dune north of Miller's, Lake County, Indiana.

INDIANA.

DEPARTMENT

—OF—

Geology and

Natural Resources.

TWENTY-SECOND ANNUAL REPORT.

W. S. BLATCHLEY,
STATE GEOLOGIST.

1897.

THE STATE OF INDIANA, }
EXECUTIVE DEPARTMENT, }
January 21, 1898. }

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE, }
INDIANAPOLIS, January 21, 1898. }

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

A. C. DAILY,
Auditor of State.

Returned by the Auditor of State, with above certificate, and transmitted to the Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

CHAS. E. WILSON,
Private Secretary.

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W. D. OWEN,
Secretary of State.

Received the within report and delivered to the printer this 21st day of January, 1898.

THOS. J. CARTER,
Clerk of Printing Bureau.

State of Indiana,
Department of Geology and Natural Resources.

INDIANAPOLIS, IND., January 21, 1898.

HON. JAMES A. MOUNT, *Governor of Indiana:*

DEAR SIR—I have the honor to submit to you herewith the Twenty-second Annual Report of the Department of Geology and Natural Resources. This report embraces, in part, the results of the work accomplished by the different divisions of the Department during the calendar year, 1897. A large proportion of the energies of the Department were employed during that year in gathering data for a detailed report on the coal area of the State, which is now in course of preparation, and which, it is hoped, will be completed within a year. The present report includes papers of economic importance relating to the petroleum, stone and clay resources of the State, the reports of the chiefs of the divisions pertaining to Mines, Natural Gas and Illuminating Oils, together with an extended paper on the Birds of Indiana, which is something that has long been needed for use in our public schools.

Very respectfully,

W. S. BLATCHLEY,
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INTRODUCTORY.

The Natural Resources of Indiana, while not including among their number any of the precious or even useful metals, are, nevertheless, as varied in character and as valuable as those possessed by any State in the Union. In each of the last two reports issued by this Department there has been given in an introductory paper a resume of all of the State's mineral resources, while of several of the more important ones, as the sandstones, oölitic stone, petroleum, etc., detailed reports with accompanying maps and results of tests have been published.

The value of each of the five leading mineral resources of the State as produced in 1896 was as follows:

Natural Gas	\$5,043,635
Coal	3,946,081
Petroleum	2,954,411
Building Stone.....	1,691,341
Clay Products	2,674,325
Total	<u>\$16,309,793</u>

When, to the value of those mentioned, there be added that of the cement rock, marl, whetstone and lime rocks, curbing and flagging, molding and glass sands, and other minor mineral resources, the total will easily foot up twenty or more millions of dollars. With the exception of petroleum, the value of each of the resources produced in 1897 was increased over that of the previous year, though as yet the exact figures of all are not available to show the amount of gain.

No State in the Union, unless it be Pennsylvania, possesses at present a better and cheaper supply of fuels than does Indiana. Among the other States she ranks second in the production of natural gas, fourth in the production of petroleum and seventh in the production of coal. These three fuels are all stored products which have been formed in ages past and are not now being produced beneath the surface of our State. The citizens of Indiana are drawing upon them with a lavish hand. They not only waste them in their furnaces, their grates and their stoves by burning them at all hours and in over-abundance,

but they also allow twenty millions or more cubic feet of gas to escape daily because they are too indolent to plug or cap the wells which have been bored for oil. Indiana supplies, at ridiculously low prices, two millions of the citizens of Chicago with the greater part of the coal, gas and petroleum which they use. Individually those consumers may pay high enough for their fuels, but the producer who secures the fuels from the bowels of our noble State—or rather the middle-man who buys from the producer, pays less than one-fifth their real value. He gets his coal for 80 cents to \$1.05 per ton; his oil at 41 cents per barrel; his gas at 2 cents per thousand cubic feet. His only additional expense is for transportation, which, in the case of the oil and gas, is but a nominal sum. Those citizens of Indiana who, by right of ownership of the surface, claim the fuels which lie beneath that surface, are content to take these meagre sums because they do not know the real value of that which they are selling. Since they have not produced these fuels by the sweat of their brows, as they have their corn, oats and wheat, they do not realize their value. Surrounded as they are by the plenty of the present, it is difficult for them to realize that the time will come, and that before many years, when the stored reservoirs of at least two of these fuels within the borders of our State, will have been drained, and only the dregs be left as a reminder of the plenty that has been.

REPORT OF PROGRESS ON COAL SURVEY.—The principal work of the Department of Geology during the year 1897 was done upon the coal survey which was started the previous year and which, it is hoped, will be finished in 1898. During the field season, from the middle of April until the first of November, 1897, the following counties were surveyed: Warren, Fountain, Vermillion, Parke, Vigo, Clay, Sullivan and Greene, and those parts of Benton, Montgomery, Putnam and Owen included in the coal fields—a total of about 3,200 square miles. The field party included Messrs. G. H. Ashley, in charge, C. E. Siebenthal, E. M. Kindle and J. T. Scovell, the latter two being in the field only part of the season. Each member of the party had definite areas to work up, and will be responsible for the details of those areas. This, with the work of last season in Knox, Daviess and Martin counties, completes the field work north of the East Fork of White River, or a total area surveyed of 4,500 square miles. Two weeks were also spent in Pike County, during which most of the mines were visited and much information obtained which will not be available in the Spring when the survey of the county will be completed.

In that portion of the area which has been finished every mine has been visited, and, as far as time would allow, every known outcrop,

in order to obtain records of all the prospect bores, well sections, etc., possible, and especially to make a systematic topographic survey from point to point along the outcrop of the principal coal beds. The information sought has been for two purposes; first:

General, to obtain the salient topographic features of each part of the area; to obtain typical columnar sections, especially with regard to the coal, with the variations from place to place; to obtain the characteristic features of each principal coal bed, as regards stratigraphic details and thickness, quality, quality of roof, of under-clay, workability, adaptability for different purposes, etc.; to obtain the distribution of each workable coal bed, both vertically and horizontally, etc., etc.

Secondly, from the data thus obtained, combined with the data obtainable at any point, to be able to tell at that point what coals underlie that region, their depth below drainage, thickness and details concerning quality, accompanying strata, characteristics by which each bed may be recognized, probable condition of roof and under-clay and other factors affecting workability.

There yet remain to be surveyed, Gibson, Pike (in part), Dubois, Warrick, Vanderburgh and Spencer counties, and parts of Posey, Orange, Crawford and Perry counties. It is planned to push the work on these counties the coming year with the hope of completing them fairly early in the season so as to allow the completion of the report as a whole by November 1st, 1898.

In the report the following subjects will be treated:

- I. General geology of Coal.
- II. General geology of Indiana coal field.
- III. Mining methods, etc.
- IV. Details of coal distribution in Indiana.
- V. Summary of coal and mining. (Tables and statistics.)

In addition, there are contemplated 7 colored geological maps on the scale of two miles to the inch; page or double page maps on the scale of one mile to the inch of all the more important coal areas; drawings illustrating typical columnar sections, detailed coal sections, cross sections, besides numerous figures illustrating geological features of the coal, and mining methods, together with some half-tone plates, showing mines, processes, etc. In preparing the report it is planned to group similar matter as far as possible, making comparisons easy and revealing relations and facts that otherwise would not be observed.

In the matter of progress, it may be stated that four of the colored maps are nearing completion; 12 double-page and 16 single-page

maps are completed or in progress; nearly 30 cross sections have been prepared; also between 75 and 100 columnar sections, near 300 coal sections, and about 50 figures, from page size down, of mining and geological subjects. Part I. of the report is ready for the press. Parts II. and III. are well under way, and 300 pages of Part IV. are finished.

When this report on Indiana coal is completed, any one wishing to know the area, average thickness or quality of the coal belonging to any one of the seven workable veins of the State can have access to a work which will furnish him the information desired.

MINE INSPECTOR'S REPORT.—The report of the State Mine Inspector, Mr. Robert Fisher, will be found, in the present volume. It shows that the output of coal in Indiana in 1897 was 4,228,085 tons, or 159,961 tons more than in 1896. When it is remembered that an extended strike among the miners began July 4th and continued until September 14th, the output for the year is a very creditable one.

In those mines of the State operating ten or more men, 7,636 miners are employed. In the smaller mines nearly 900 additional men are at work, making a total of 8,500 miners in the State. The report shows also a large decrease in 1897, in the number of accidents in the mines, there being but 16 fatal, 24 serious and 74 minor accidents, as against 28 fatal, 66 serious and 94 minor in 1896. Such a decrease is excellent proof of the efficiency of the work done by the Mine Inspector, and his deputy, Mr. James Epperson, in seeing to it that many of the former elements of danger about the mines have been removed or modified.

While the State Inspector and his assistant visit many of the mines employing less than ten men, and make recommendations, the law gives them no power to enforce better conditions of ventilation and measures of protection. A bill was introduced into the last Legislature giving them such power, but it failed of passage. Such a statute is one of the most needed additions to the mining laws of the State, since the life of a miner working in a small mine is just as valuable as that of a man working in any of the larger ones.

The report of Mr. Fisher will be found to contain much statistical and other information differing in nature from that compiled for former reports, and to it the reader is referred for additional details concerning the mining industry of the State.

PETROLEUM.—For the first time since the discovery of petroleum in Indiana, the annual production has fallen below that of the preceding year, the total production for 1897 being 4,353,138* barrels, as against 4,680,732 in 1896—or a decrease of 327,594 barrels. The

* This does not include the amount used for fuel and other purposes in the field.

prevailing low price of Indiana petroleum, which averaged for the year but 43 cents per barrel, or 20 cents less than in 1896, prevented the sinking of many new bores in the main petroleum field, and the old wells in that field decreased on an average about 40 per cent. in output.

New developments of importance were made near Alexandria, Madison County; Peru, Miami County, and Broad Ripple, Marion County. The Alexandria field very probably has an unbroken connection with the main field to the northeast, and tends to prove the belief advanced in both of my former reports that the entire gas field of the State will, in the near future, yield petroleum in greater or less quantities. The Peru and Broad Ripple productions are more probably from isolated areas of porous Trenton limestone. Such areas are very liable to be found on the slope of the main gas field anywhere within 15 to 25 miles of its margin. A paper, giving in detail the developments made in the new fields during the past year, and accompanied by maps of the Peru and Broad Ripple fields, will be found in the present volume.

The petroleum produced in Indiana is piped and shipped from the productive areas by three companies. The largest of these, the Indiana Pipe Line Company, with headquarters at Lima, Ohio, handles more than three-fourths of the production, and kindly furnished me with statistics showing the amount handled by them each month. The other two companies—The Indiana Pipe Line and Refining Company, controlled by the Cudahy Bros., of Chicago, and the Manhattan Oil Company, of Lima, Ohio, refused to furnish statistics showing the number of barrels handled. Since petroleum is one of the more important mineral resources of Indiana, and since accurate statistics relative to the State's production are of value in showing the mineral wealth of our State, and thereby attracting capital and population within her bounds, I would advise the passage of a law by the next General Assembly, compelling all companies or individuals shipping or piping crude petroleum from the receiving tanks at the wells, to furnish to the Department of Geology monthly statements showing the number of producing wells and the number of barrels so piped or shipped. Such monthly statements must, according to law, be furnished the Department by all operators of coal mines, and there is no reason why the oil companies should not be compelled to do likewise.

The total amount of oil produced in Indiana since 1889, when the first wells were sunk, has been 20,386,231 barrels,* valued at \$10,816,-

* Not including the amount used for fuel and other purposes in the field.

326. The real value of a barrel of crude petroleum is much greater than 43 cents, the average market price in 1897. When the market price rises more nearly to the true value there is little doubt but that the industry will take new life, and bores sufficient in number will be sunk to bring the production up to or above that of 1896. The oil has been stored for thousands of years in the porous reservoirs, from which it is now being obtained, and the operators are content to let it remain there as long as prices are kept at a figure which gives but little profit above the actual cost of production. Unlike the gas, there is little danger of its dissipation and loss during the wait for a rise in the price.

REPORT OF THE STATE SUPERVISOR OF NATURAL GAS.—No unbiased person can read carefully the report of Mr. J. C. Leach, State Supervisor of Natural Gas, printed in this volume, and not conclude that we are nearing the end of the supply of this valuable fuel in Indiana. This report but affirms what has been written in the previous reports of this Department, even as far back as 1890.

The natural gas field of the State originally embraced almost 3,000 square miles. To-day the productive area is less than half that size. The average rock pressure was in the beginning 325 pounds; to-day it is less than 200 pounds. Mr. Leach reports that in the heart of the field, an area of 250 square miles, located in Grant, Madison, Blackford and Delaware counties, the pressure decreased 30 pounds in 1897, and now averages but 215 pounds; while in these four counties, which are the most productive of the entire field, the average pressure is but 200 pounds. This decrease in rock pressure, added to that of an exhaustion of one-half of the original productive area and the constant encroachment of salt water towards the center of the field, all point to the final exhaustion of the supply.

In the face of these facts there are many men in the gas field who are either so foolish, so woefully ignorant, or so dishonest as to decry constantly the idea that the supply of natural gas is failing. They assert, in spite of the evidence of the best scientists in America to the contrary, that the gas is being generated as fast as it is used. They continue to attempt to boom, on every occasion, the gas field. They still offer "free gas and free lands" to all factories that will locate near their towns. They condemn the reports issued by this Department. They have even told the Supervisor that the truth ought not be told; that it was not necessary to proclaim to the world the fact that gas is failing.

Such men evidently forget that this Department was organized to advertise the resources of Indiana as they are, not as boomers would

have them. If the supply of a resource is failing, or if its quality is defective, it is as much the duty of this Department to make known such facts as it is to publish an account of those resources which are increasing in quantity or possess some newly discovered excellence of quality. The vast majority of the people of the State expect the truth in the reports of this Department, and the truth must be told as nearly as it can be ascertained by careful investigation.

The chief duty of the State Supervisor of Natural Gas is to prevent, wherever possible, the waste of the fuel. This duty Mr. Leach has performed to the best of his ability with the means at his command. As an assistant in this Department, he was directed to enforce the flambeau law, and by his efforts the burning of such lights has been practically abandoned. When the waste of gas began last May in the vicinity of Alexandria, I directed him to use the full limit of his powers to stop such waste, and he immediately began the enforcement of such laws as were on the statute books. He was condemned by many for not stopping the waste at once, and additional directions were given him by the Chief Executive of the State, but it was soon found that he was already doing all that he could under the existing laws, which are defective in that they do not give the Supervisor the power to cap any well whose owner insists on allowing the escape of gas. At first his efforts were condemned by many of the citizens of Alexandria, who saw a prospective oil boom in their midst. However, the rapid decrease of the rock pressure, consequent upon the wanton waste of the gas, soon brought those citizens to a proper realization of their best interests, and led them to add their efforts to those of the Supervisor in trying to stop the waste. As a result, several cases have been pushed, and are now before the Supreme Court of the State, which will soon decide whether a party in search of a few hundred barrels of oil can jeopardize the interests of thousands of citizens by allowing a waste which will soon deprive those citizens of a most valuable necessity.

The manufacturers of the gas field have, for the most part, done all that they could to stop the waste. Their association has advanced means and furnished help to assist in shutting off all unnecessary flow of gas. They realize that the future life of the field, as compared with the past, is of short duration, and they desire to prolong it as much as possible.

No one can say with certainty how long the supply of gas for manufacturing purposes will last in Indiana. It may be for one year; it may be for five. When it fails, the factories now in the field will not of necessity have to move therefrom. Petroleum can and will be

used as a fuel in many of the factories. Improved methods of separating the gas from coal are constantly coming to the front, and the time may come when artificial gas from this fuel will be made in quantity and piped to the factories in the gas field. Again, their situation within 70 miles of the center of a great coal basin will give them advantages which, though far inferior to those they now possess, will still enable them to compete with many of the factories of the East, where fuel has to be transported a much greater distance.

Every one will admit that the highest use to which this gaseous fuel can be put is that of household consumption. With no kindling, no replenishing, no ashes, no soot, the duties of the housewife are decreased many fold. For this reason every effort should be made to husband the present supply by stopping at once all unnecessary use or wanton waste. Any attempt to evade the law relative to the waste of gas should be promptly reported to the proper officers. Instances were cited during the past season of persons who piped the gas into a pile of brick and burned it, hoping thereby to keep themselves within the pale of the law. All such persons are wholly lacking in public spirit, and devoid of every feeling which tends to advance the interests of humanity. All future attempts to locate large factories within the field by promising them free gas should be decried. Such factories can but shorten the present fuel supply of those in existence, and diminish the amount which will in the future be available for household purposes.

THE GEOLOGY OF LAKE AND PORTER COUNTIES.—In the law creating the Department of Geology it was specified that one of the duties of the State Geologist shall be the continuation "of the geological survey of the State by counties or districts, and the completion and revision of the same as may be practicable." My predecessors in charge of the Department followed this law literally, and in the annual reports previous to the Twentieth, dealt with all the counties except Adams, Blackford, Fulton, Hendricks, Kosciusko, Lake, Porter, Tipton and Wells. All of these counties are included in the drift-covered area of the State, and but few outcrops of rock are found within their bounds.

Since the civil boundaries of a county have little or nothing to do with the limits or boundaries of a natural resource or geological formation, the work of the Department for the past three years has, in the main, been devoted to the preparation of monographs on each of the leading natural resources of the State. The worthy citizens of Lake and Porter counties, occupying, as they do, that region of the State lying nearest the great city of Chicago, have felt that the De-

partment of Geology had not done them justice in the bestowal of its favors in the past. It was thought best, therefore, to continue, for a time, the work based on the county boundary system, and several months of the summer and autumn of 1897 were spent by the writer in gathering data for a paper entitled "The Geology of Lake and Porter Counties, Indiana," which appears as a part of the present volume.

The paper is, in the main, devoted to the physiography or surface features of the two counties, since not a single outcrop of rock is located within their bounds. Lying, as they do, adjacent to the southern shore of Lake Michigan, much of their northern portion is covered with sand. Unfortunately, the more important railways which pass through the counties traverse this sandy region, and the traveler bears away with him wrong ideas concerning their fertility and general prosperity.

No one who spends a considerable period in the study of the surface of these two counties can deny that a large percentage of their area ranks among the most fertile lands of the State. In the production of hay, Lake stands second and Porter third among the 92 counties of Indiana; while in the production of milk, Lake ranks third and Porter fifth. Much of the sand-covered area is admirably adapted to the raising of small fruits and vegetables; and the thousands of acres of marsh-land in the valley of the Kankakee is being rapidly drained, and in time that section will be known as the garden spot of northwestern Indiana.

While no ledges of stratified rock were available for study, interesting problems were presented relative to the glacial deposits, the formation of sand dunes and prairies, the former extent southward of Lake Michigan, etc., and a discussion of these and many other features is given in the paper which follows. It is also accompanied by a map showing the more salient physiographic features of the area under consideration.

THE CLAYS AND CLAY INDUSTRIES OF NORTHWESTERN INDIANA.— Since the publication of the paper on the "Clays of the Coal-Bearing Counties of Indiana," in the report of this Department for 1895, the interest in Indiana clays and their possibilities for manufacturing purposes has largely increased. Scarcely a day passes but that inquiry by letter or person is made at the office of the Department concerning the clay resources of the State. Large factories have been recently erected near Mecca and Montezuma, Parke County; Brazil, Clay County, and Martinsville, Morgan County, for

the purpose of utilizing the deposits described in detail in the report cited, and additional factories will be erected in 1898 west of Terre Haute and north of Brazil.

After the completion of the work in Lake and Porter counties, all the available time of the writer for the remainder of the season of 1897 was spent in an examination of the clays and clay factories of eight of the northwestern counties of the State, and the results of that examination are incorporated in a paper entitled "The Clays and Clay Industries of Northwestern Indiana," which is published in the present volume.

While no material suitable for the best grades of vitrified ware or pottery was discovered in the area visited, much which could be utilized in the making of pressed front brick, hollow brick, terra cotta lumber, and many fire-proof products was found. The largest pressed-brick factory in the State is located at Porter, Porter County, while at Hobart, Lake County, another, of almost equal capacity, is in course of construction. One factory at Hobart has been making terra cotta lumber for ten years, and the owner claimed to have the only deposit of clay in the State suitable for such material. The investigations and chemical analyses made and given in the paper cited prove the presence of a similar clay in a number of other localities in Lake, Porter, Laporte and St. Joseph counties. Capital invested in the making of porous fire-proof products at any or all of the points mentioned will, without doubt, return handsome revenues, since such products are coming into rapid use in the larger structures of all the leading cities of the United States.

The Knobstone shales which come to the surface over a large area in Jackson, Morgan and adjoining counties north and south, have, as yet, been practically unutilized for manufacturing purposes. In July, 1897, a careful study was made of a number of deposits of these shales in Jackson County, and an exhaustive chemical analysis shows their especial adaptation to the making of vitrified brick and sewer pipe. A plant erected by the side of the B. & O. S. W. Railway six miles west of Seymour can hardly fail in furnishing southeastern Indiana with the best grade of such products for a score of years to come.

The practical experience of the past ten years has proven that no more durable material for the making of pavements can be used than vitrified brick, provided sufficient care be taken in the structure of the foundation upon which the brick are placed. Such a pavement comes nearer than any other to a typically perfect pavement; i. e., one which is reasonable in first cost; low in cost of maintenance and easy to repair; durable under heavy traffic, with reasonable freedom from noise

and dust; free from decay, water proof and non-absorptive; of low tractive resistance and furnishing a good foothold for horses.

The city of Chicago has recently let the contract for 66 miles of vitrified brick pavements, and a number of miles of brick roadway were constructed in 1897 in the country near Monmouth, Illinois. The making of paving brick is an industry yet in its infancy in Indiana, for the time will come, and that before many years, when not only the streets of every town of two thousand inhabitants within our State will be paved with brick, but also many of our country roadways in those regions devoid of gravel and other road material.

UTILIZATION OF CONVICT LABOR IN MAKING ROAD MATERIAL.—The question of good roads is at present one of the most vital with which the farming community of Indiana has to deal. Many of the better counties of the State long ago realized the importance of this question, and, where road material was conveniently located, constructed gravel or macadam roads radiating in all directions from their county towns. In other counties, possessing a plentiful supply of road material, the importance of the question has not yet been realized, and for six months of the year the farmers are practically isolated from market, or, if they manage to reach it once a week, can only haul thereto a fraction of a load. Such counties are readily recognized as far below the average in wealth, prosperity, and the public spirit of their citizens.

Prof. Latta, of Purdue University, has for some time been making a careful study of the good roads question in the State, and has received reports from hundreds of farmers, some of whom live on good roads once bad, and others on roads still bad. From these reports he has computed statistics showing that the difference between good and bad roads amounts to 78 cents an acre annually on the farms. Applying this amount to the entire State—36,350 square miles, or 23,264,000 acres—we have the sum of \$18,145,920. Of this amount, fully two-thirds is wasted every year in the State in the loss of time, and in the loss of opportunity in securing the best market for the produce of the farm.

Moreover, our vehicles for rapid country travel are more numerous and of an entirely different style from what they were twenty years ago. Almost every farmer now owns his own buggy and carriage. The bicycle by countless thousands has come to stay, and the horseless carriage and motorcycle will ere long make their appearance upon the scene. The owners of all these lighter forms of vehicles are demanding, and will continue to demand, better roads, and the legislator must soon learn that the question is one of the most important which he has to face.

Through all the panic and depression of the last four years, the farmers in the good road districts of Indiana, have gone on making money and improving their farms, and have not troubled themselves to any extent about politics or finance. On the other hand, those living in the bad road districts have, for more than a third of their time, endured an enforced idleness which has made them poorer, and caused them to cry out against the financial policy of the government, rather than against their own short-sightedness on the road question. Indiana is rich in clay suitable for vitrified brick, rich in gravel, rich in stone for macadam roads. There is no reason, therefore, why every public road of any importance in the State should not be improved so that it can be traveled with ease any day in the year.

In the penitentiary at Michigan City there are to-day almost a thousand able-bodied men who are being marched about to furnish them exercise, because the labor organizations of our State are opposed to their competition. The industry of the honest citizens of the State pays for maintaining these criminals in idleness. Let the General Assembly authorize the purchase of an extensive bed of shale in western Indiana; and the erection on it of a modern paving brick factory. Equip this factory with convict labor, and put several hundred additional convicts to breaking stone for foundation, and cutting it for curbing. This brick and stone can then be furnished at the plant at less than one-sixth present prices to those counties devoid of other road material.

The cost of a paving-brick plant, completed for work, which has a capacity of forty thousand output per day, is about forty thousand dollars. One with double the capacity costs about \$60,000. The greater amount of this expense is for buildings and kilns which could, by convict labor, be constructed of brick made on the spot, so that the cost to the State would be less than half this sum. After the plant is once in operation, with fuel and raw material both at hand, the only outlay is for labor. Where the daily output is eighty thousand brick, and the fuel is mined in connection with the shale, the number of hands necessary is about 125. These, at \$1.50 each per day, would make the cost of the brick about \$2.35 per thousand. With convict labor, the actual cost of the brick would be only the sum paid out for the maintenance of the prisoners. At 50 cents per capita, this would amount to about 80 cents per thousand. With a plant erected which will give employment to 375 men, 240,000 brick can be made daily. A year's output will be sufficient to pave almost one hundred miles of roadway.

The paving brick can be sold to the counties constructing the roads at \$1.00 per thousand, which would require an outlay of but \$760

per mile. The crushed stone prepared by convict labor can be furnished at 30 cents per cubic yard, and the curbing at a correspondingly low price. A road of vitrified brick, which will last a quarter of a century or longer with little expense for maintenance, can then be built and need cost but little if any over \$2,500 a mile, the most of which would be for grading and the laying of the brick. For, understand, the plan proposed does not consider that the convicts be employed except in the preparation of the material, the latter to be furnished at cost to the counties. All grading, teaming, bricklaying, etc., should be done by free labor, as it is at present. The day of the chain gang at work on the roadside, subjected to the gaze and jeers of the passer-by, is, rightfully, a thing of the past.

Five years ago California was in the same situation as Indiana is to-day. Her convicts were idle in deference to the wishes of her labor organizations. Her legislators passed a law authorizing the employment of the convicts in the breaking of stone for road material. To-day that State is supplying the prepared stone to the counties at 28 cents a cubic yard, on board the cars, which is less than one-third the ordinary market price; yet sufficient to pay for the maintenance of the convicts. The railroads of the State are carrying the material at the bare cost of hauling, for they realize that the improved country roads will bring to them in the future a great increase in farm products for shipment.

Many objections to the plan proposed will doubtless arise, for the questions to be solved are important ones, and for that reason no plan can or will be presented but what will have its weak points. The most serious of these objections is the cost of a new prison which would necessarily have to be constructed at the plant. This, however, would be much less than is generally supposed, since the shale can be burned into ordinary and pressed front brick of the finest quality. The brick could, therefore, be made and the prison constructed by the convicts themselves for a very reasonable cost. Moreover, fine building and pressed front brick could be made and furnished the other institutions of the State, at cost, whenever needed, thus reducing materially the amounts necessary to be appropriated from the public funds for new buildings and repairs. It seems, therefore, that given an ever-growing demand for better roads; an abundance of nature's products which can be made into the best of road material, and 850 convicts able and willing to work, that we have a combination which, under the proper management, would give us the improved roads, furnish employment for our convict labor,

and yet give no offense to that army of honest workmen whose interests and welfare are ever to be upheld.

REPORT ON THE NIAGARA LIMESTONE QUARRIES.—The Niagara limestones of southeastern Indiana have, for a number of years, been extensively quarried, especially in Decatur, Franklin and Fayette counties. As yet, however, no detailed report upon the properties and uses of the stone, or the leading features of the deposits has been published. During the past season, Dr. August Foerste was engaged in collecting information for such a report, which he has prepared for the present volume.

The most valuable variety of the Niagara stone quarried is typically exposed in the vicinity of Laurel, Franklin County, and so to all stone of that variety the name "Laurel limestone" has been applied by Dr. Foerste.

This stone can be quarried more easily and at less expense than any other stone of a similar nature in the State; the natural seams and even bedding doing away largely with the necessity for drilling and blasting. The stone occurs in natural slabs of a uniform thickness—two to twenty inches—and with the upper and lower surfaces very even, so that for many purposes tool dressing after quarrying is not necessary. It is of a handsome color, very hard and durable, and is used extensively for flagging and curbing, and to a less extent for window sills, window caps, range stone, ashlar, door-steps, foundations, street crossings, gutter stone, pier footings, bridge abutments, etc. For many of these uses it is better suited, and can be furnished more cheaply, than either the Bedford oölitic limestone or the Berea (Ohio) sandstone, the two materials with which it comes in closest competition. The railway facilities of the region about Laurel and other localities, where the best deposits are found, are, as yet, very poor, the stone from most of the quarries being hauled on wagons to the cars. With several good switches to the leading deposits, this stone could be put on the market for a lower price, and yet with a greater profit, than is now secured; and its superior quality would soon lead to its extensive adoption for those purposes for which it is so well fitted.

CATALOGUE OF THE FOSSILS OF INDIANA.—The subject of paleontology has, during the past three years, received but little attention in the reports of this Department. That subject had been quite fully treated by my predecessors, and the economic resources of the State, which have been constantly growing in importance, demanded the time and energies of the force at my command. That the paleontology of the State be wholly neglected was not intentional, however, and Mr. E. M. Kindle has, therefore, prepared for the present volume

a list of all the fossils known to occur in the State. This list shows also the geological formation in which each species is found, and is accompanied by a bibliography of Indiana paleontology, making a paper which will doubtless be of much value to all collectors and students of the remnants of that rich fauna and flora which once existed in or near the waters in which the rocks of our State were laid down.

THE BIRDS OF INDIANA.—Students of Natural History throughout the State have long felt the need of a descriptive work on the birds of Indiana, which would enable them to readily recognize any species which might come into their hands. Such a work, I am pleased to say, has been prepared for the present volume by Mr. A. W. Butler, formerly of Brookville, Indiana, now Secretary of the Board of State Charities. Mr. Butler has devoted many years to the study of Indiana birds, and no man in the State knows more of their habits and distribution than he. For twenty-two years he has been gathering the data for such a report, and for that reason it can be relied upon as accurate and comprehensive.

In the paper will be found a description of each of the 321 species of birds which have been identified within the bounds of Indiana in the past; together with a description of the nest and eggs, and a statement of the geographical range of each species. An artificial key to the species is also given which will enable any one, after a little practice, to bring about their ready identification.

An account of the food habits and song of each species is also added, together with a statement of its abundance or scarcity, the season of the year in which it occurs within the State, and the time of its arrival therein and departure therefrom. A bibliography of the literature pertaining to Indiana birds and a list of those species which, by reason of their reported occurrence in adjacent States, may also occur within Indiana, is also given.

The work has been prepared with as few technical terms as possible in order that it may be readily used by boys and girls of the farm who come daily in direct contact with the birds, and by the pupils of our schools, who should have a more general knowledge of the names, songs and beneficial habits of our feathered friends throughout the State.