ECONOMIC GEOLOGY OF THE STATE.∗

Indiana has been bounteously endowed by nature. In other regions rich in ore, coal and stone, the soil is usually thin and unproductive, or, vice versa, fertile lands are not rich in mineral treasure; but here in Indiana, a bountiful and inexhaustible supply of mineral wealth is overlaid by the richest of soils; and with cheap and abundant food, cheap homes, cheap wood and coal for fuel, and good clays, sands, and the finest of building material, she offers to the farmers, laborers, mechanics and manufacturers a share of her abundant blessings, resources richer and more useful to humanity than gold or silver or precious stones.

BUILDING STONE.

The rocks of the State contribute largely to her wealth, for they contain some of the finest building stone in the country, and the supply, comparatively undeveloped yet, is practically inexhaustible. The excellent qualities, durability and beauty of these Indiana stones are just beginning to be recognized for building purposes throughout the country, and the quarrying interests promise to become an important feature in the products of the State, in the near future. This stone is being extensively used in some of the most expensive and imposing buildings throughout the country, and the demand is increasing as it becomes better known. During the year 1880, the capital invested in the operation of quarries was $613,500, and the output of material was 8,413,827 cubic feet, worth $633,775, or about $20,000 more than the total capital employed. To effect this result required the labor of 1,788 men and 545 horses, and the use of 13 steam channellers in quarrying; 107 derricks and cranes in hoisting; 14 saw mills and 42 gangs of saws (3 per mill), in dressing; while 5,727,225 cubic yards of space were excavated, in doing which $2,300 worth of powder and dynamite was used.

As to the geographical division of the quarrying interest, Southeastern Indiana supplies a large quantity of stone for foundations and rubble masonry, from the bluffs along the Ohio River, and extending through Wayne, Union, Fayette, Franklin, Dearborn, Ohio and Switzerland, west to Clark county; besides being found to some extent in the counties adjoining these to the west, which are included in the Lower Silurian geological range.

∗Republished from my Report of 1882, by frequent request.
The close-grained, compact, magnesian limestones are largely quarried in the counties bordering the above on the west, forming a belt extending northward from the Ohio to the Wabash River in Carroll, Cass, Miami, Wabash and Huntington, and to some extent in the counties north and west of these. This stone, which belongs to the Upper Silurian age, lies in even beds, having a thickness of from a few inches to two or more feet, and is especially adapted to work in foundations, piers, abutments, and massive range work where great strength is required. The thinner strata of this stone furnish, at a low cost, excellent slabs, flags and curbstones, etc., since it comes from the quarries with bed and top ready dressed by nature. The economy in its use is apparent.

A very popular stone among engineers and bridge builders is the North Vernon blue limestone, a good sample of which, as a bridge building material, may be seen in the new bridge of the C. & I. Air Line across Broad Ripple, north of Indianapolis. This stone is quarried extensively in Jennings and Jefferson counties.

Quantities of blue and buff Oolitic stone of superior quality for building purposes are quarried in Monroe county. These strata are from six to twenty feet thick, from whence one firm alone, Messrs. Dunn & Dunn, has been shipping their entire output to Chicago and Joliet, Ill. It is there sawed into thin slabs, matched and polished, and finds a large and growing demand for mantels, table-tops, pilasters, wainscots, and interior ornaments and decorations where handsome neutral tints are required.

From Warren county, on the north, to the Ohio River, in a widening range, the valuable limestones of the Keokuk group, the sandstones of the Chester, and Oolitic limestones of the intermediate St. Louis group, are quarried; while the basal conglomerate sandrock, found in a wide belt from Warren county to the Ohio, contains an unlimited supply of strong, fire, water, and frost proof stone, very suitable for piers, foundations, etc.

But by far the most beautiful and valuable stone for architectural purposes is the Oolitic limestone of Lawrence, Monroe, Owen, Crawford, Harrison and Washington counties. The supply is simply inexhaustible, as it lies in massive strata of from twenty to seventy feet thick, over an area of more than fifty square miles.

These strata are homogeneous, equally strong in vertical, diagonal or horizontal sections. The stone comes from the quarry so soft as to be readily worked by saw, chisel or planing machine, while on exposure it hardens to a strength of from 10,000 to 12,000 pounds to the square inch—a strength amply sufficient to sustain the weight of the largest structure in the world. In use it presents a handsome, creamy brown appearance, gradually whitening with age. It is of almost unprecedented purity, containing an average of 96.8 per cent. of carbonate of lime, a purity rarely, if ever, surpassed, and scarcely equaled, in the world. Hence its advantage over the magnesian limestones, as it is not affected by decay in an
atmosphere charged with the gases of burning stone coal. In natural outcrop it presents bold perpendicular faces to the elements, showing every scratch and mark, unaffected after the exposure of thousands of years, as no other stone or rock does.

It is quarried by steam channelers, which carve it out in prisms six by ten, fifty or one hundred feet long, putting to shame the boasted prodigies of Egyptian story and effort. It is then rapidly sawed into blocks and dimension forms, and steam-planers carve, mold and smooth it like clay or wood, and more accurately than mallet and chisel. It is now fit to be carved and polished into the freest kind of sculptured and ornamental work.

Ready for the mason or sculptor, it is alive and resonant, answering with a clear metallic ring each touch or blow. This resonance is an excellent test of the perfect unity of its particles, and as a result it is highly elastic, bending under pressure and rebounding to place when relieved from it. This elasticity enables Indiana Oolitic limestone to adapt itself without cleavage or disintegration to our changeable climate, where material will be frequently subject to a change of from 20° to 60° of temperature in a few hours; as in large buildings, the outside will be subject to a temperature of 25° below zero in winter, or 120° above it in summer, while the inside will remain at 60° or 70°—differences of 50° to 80° in the extremities of the same stone—with their accompanying effects in expansion or contraction. The strains of heat and frost will tear down buildings and sides of mountains, with their great expansive forces, and even steel and iron will give way before them. Here, then, is presented to the builder and architect a new and wondrous element in an "elastic stone," a potent quality which, united with its other sterling excellencies of strength and beauty, makes Indiana Oolitic limestone the best in the world for exposed work in buildings in localities subject to great climatic changes. It has been and is now being used in many of the finest public structures in the country—the new $2,000,000 court house at Indianapolis, the new Indiana State House, the postoffice, and many churches in that city; the custom house at Louisville; the city hall and the water-tables of Lincoln park in Chicago, many fine structures in St. Louis, the Cotton Exchange in New Orleans, and many public and private buildings in New York and Philadelphia, and the exposed parts of the new State House of Illinois.

The sandstones of Indiana occur in a broad belt from the Illinois line, in Warren county, south and southeast through the counties of Fountain, Vermillion, Montgomery, Parke, Putnam, Clay, Owen, Greene, Martin, Pike, Dubois, Orange, Perry, Crawford and Harrison, to the Ohio River. This is the conglomerate sand-rock, forming the base of the Coal Measures, and the same as the sandstones so famous in Scotch and English architecture; and, although irregular in color and physical characteristics to some
extent, presents a great bed of building material, frost, fire and water proof, and of practical value for permanence and solidity. In these beds, in Warren, Orange, Lawrence, Crawford and Harrison counties, are found extensive and valuable bands of grit stones, of great utility for grindstones, as well as quarries of the "Hindoostan" whetstones, so favorably known in all the markets of the civilized world.

The sandstones of the Coal Measures proper, while not fully up to the above, are yet extensively used for foundations, piers, and hammered masonry. In the Sub-Carboniferous formation, the sandstones of the Chester and Knobstone groups are well developed, easily accessible, and merit the local favor and reputation they sustain.

During the year 1882, there were quarried in Indiana nearly 1,000,000 cubic yards of sandstone.

COAL.

The Indiana coal fields are embraced in an area of about 7,000 square miles, and are entered from all directions by railroads, thus insuring a steady and inexhaustible supply of the best fuel at a low price. There are in all twelve seams at varying depths, from the surface to three hundred feet below, averaging a depth of eighty feet. Five of these seams are almost constantly workable wherever met, varying from one-half to eleven feet, and averaging four feet in thickness. The small seams are worked for local use by "stripping."

These coals range in quality from "fair" to "superior." The "block coal," pre-eminent as a metallurgic agent, is found in an area of about 600 square miles. Remarkably free from sulphur and phosphorus, it is rich in carbon, and admirably adapted to the manufacture of "Bessemer" steel, and for refining, as well as for rolling mill and locomotive use. It burns free, without caking, to a minimum of white ash, and with a ruddy flame.

Mr. J. J. Turner, Superintendent of the Indianapolis & Vincennes Railroad, made for some weeks a careful test of the comparative merits of Indiana coal (from Greene county) and the celebrated Pittsburgh coal, with especial reference to locomotive purposes, with the following results:

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<tr>
<th></th>
<th>Pittsburgh</th>
<th>Indiana</th>
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<tr>
<td>Wheels hauled one mile per ton coal</td>
<td>.97</td>
<td>.99</td>
</tr>
<tr>
<td>Gallons of water evaporated per ton coal</td>
<td>.53</td>
<td>.52</td>
</tr>
<tr>
<td>Average temperature during test</td>
<td>39°</td>
<td>39.9°</td>
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<tr>
<td>Total consumption</td>
<td>.40</td>
<td>.35</td>
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The enormous amount of power stored up in coal is thus set forth by Prof. Rogers: "The dynamic value of one pound of good steam coal is equivalent to the work of one man for one day, and three tons are equal to twenty years' hard work of 300 days to the year. The usual estimate
of a four-foot seam is that it will yield one ton of good coal for every square yard, or about 5,000 tons per acre. Each square mile will then contain 3,200,000 tons, which, in the total capacity for the production of power, are equal to the labor of over 1,000,000 able-bodied men for twenty years."

Of course this contemplates that period in the future when inventive genius shall develop processes by which the full power of coal shall be economized, now so wasted in smoke and imperfect combustion.

During the year 1881 the coal mines of Indiana employed 5,000 men, to whom were paid wages amounting to over $1,500,000. In the mines was invested a capital of $2,500,000, while the product was 1,500,000 tons of coal, worth at the mines $2,500,000, a sum equal to the capital invested.

From a small beginning in a region where wood fuel was so abundant as to be a drawback, the excellent quality of our coal has promoted Indiana to the place of sixth in the coal-producing States of the Union, with a gain of 231 per cent. in the past decade, or over 23 per cent. per annum, while the future promises still larger outputs and triumphs.

How much influence the State Geological Department has had in producing the above results may be inferred from the fact that since 1869, when the first full report of the coals of Indiana was made by my predecessor, Prof. E. T. Cox, the business has increased about 250 per cent.

**GLASS SAND.**

Extensive beds of sand and friable sandstone occur in the counties of Madison, Parke, Clark and Harrison. It is of ocean-washed purity, frequently white as snow, and so pure as to cause the plate-glass of our State to rival, and in some respects to excel, the best European products. With fair encouragement Indiana can supply the nation with glass cheaper and better than foreign manufacturers, and can at the same time give employment to thousands of skilled and unskilled laborers, and bring additional capital within her borders.

**GRAVEL.**

This is so bountifully present over nearly all the State that it is as common as air *and* as unprized. Other countries make costly highways with broken stone; here nature presents the best of granite, imported during the great "Ice age," ready prepared for use. This is the best possible material, and in the future, with ordinary enterprise, our State will have the best roads in the world, with the consequent blessings of comfort, enjoyment and profit. During the year the sale of gravel in the State amounted to about 200,000 cubic yards, but probably ten times that amount was used without cost.
LIME AND CEMENT.

These necessaries of life are so abundant in the State as to escape attention. The whole northern, central drift regions and eastern and middle parts are underlaid with good limestone, suitable for calcining. The very best quality of lime is produced from these rocks, and in quantities not only sufficient for home consumption, but for an extensive trade in exportation also. To-day it is only used for mechanical purposes, but its full value will be appreciated when, in the near future, it becomes more generally used in agriculture for fertilizing purposes. The lime of the Upper Wabash, Central and Southern Indiana is unrivaled; the Delphi and Huntington and Utica limes are of a very superior quality.

Cement that meets all the requirements of the market is prepared from the native beds of Clark county, and is of fine quality; while large beds still undeveloped exist in Harrison county, waiting to reward him who will turn his attention to and bestow his labor upon them. From the lacustral clays and chalks of St. Joseph county is made, at South Bend, a fine “Portland cement,” which is not rivaled even by the best European brands. During the year 1882 there was produced in the State 836,628 bushels of lime and 82,938 barrels of cement.

CLAYS AND KAOLIN.

Brick clay is as common as water throughout the State. Owing to the presence of iron, the clays of Delphi, Carroll county, offer a product of extra beauty, smooth and ruddy, and with colors so fixed that buildings which have stood for twenty or twenty-five years present the same cheerful, bright appearance as those erected last year. Our builders would do well to consider the color and quality of this material, permanently painted by nature.

Underlying all our coal seams are great beds of excellent fire clay. Good fire bricks are made in Clay and Vermillion counties, and the raw material is abundant in the southwestern regions. When the coming man builds, not for to-day, but for all time, he will require permanent fire-proof edifices, and will then avoid disastrous conflagrations by cheaply furnishing from this clay, window and door frames, roofs, cornices, etc., and ornamental brackets of terra cotta ware. The supply is sufficient to furnish the world, and, when common sense prevails, the clays of Indiana will be richer than the mines of Colorado and the golden sands of California. During 1882, 2,769 tons of fire clay were produced.

The kaolin mines of Owen and Lawrence counties have lately opened a new and prosperous field of labor. The product of these mines is used by the “Encaustic Tile Works” at Indianapolis, where are being produced tiles of rare beauty and excellence, rich in design, perfect in form, equally vitrified, and unrivaled by the best factories of England and France, over
whose products they take precedence in the great public buildings in eastern cities. Large beds of kaolin, still undeveloped, invite exploration and examination in Owen and Harrison counties. The discovery of these kaolin beds has already resulted in the importation of large amounts of capital, and numbers of foreign skilled workmen.

NATURAL GAS.

In Harrison and other counties considerable areas present, from the deep bores, a flow of gas distilled by the internal heat of the earth from the bituminous beds of the Devonian age. This flow has been utilized for concentrating brine, and is of great economic value for driving engines, burning lime, crockery, etc., as well as for illuminating and culinary purposes. It invites and deserves attention.

SOIL.

The soil of Indiana is composed of materials from all the geological horizons. It contains the elements of all, spread as a broad alluvial plain along the ancient glacial bed. Being deep, it holds like a sponge the excess of winter and spring moisture to alleviate with dews, or water by springs, the surrounding country, avoiding excessive drought. Posey county has shown to the State Board of Agriculture her great crop of corn, while Vermillion county comes to the front with 64.78 bushels of wheat and 110 bushels of oats to the acre. Other regions are equally rich, showing results in grains and grasses which rival these. Such crops are not accidents, but are the legitimate and natural results of a superior soil and its mineral constituents. When we consider that a soil composed of the decomposition of local rocks only is lean and soon needs manure, we can appreciate the effects of the deposition of the glacial drift over Indiana in the almost fabulous fertility of its soil, as instanced by the above examples.