GEOLOGICAL REPORT

ON

HARRISON AND CRAWFORD COUNTIES,

INDIANA, 1878.

BY JOHN COLLETT, A. M.

PROF. E. T. COX,

State Geologist:

SIR:—I have the honor herewith to hand you my report on the geology of Harrison and Crawford counties.

I take pleasure in renewing my assurances of high regard and tendering my cordial thanks for information, assistance and kindest courtesy. Trusting in an unwavering continuance of the same, I remain,

Yours very truly,

JOHN COLLETT.

INDIANAPOLIS, 31st December, 1878.

HARRISON COUNTY.

Harrison is one of the extreme southern counties of the State of Indiana. It contains four hundred and seventy-eight square miles, and is bounded north by Washington, east by Floyd county and Ohio river, south by Ohio river, and west by Ohio river and Crawford county. In each case the Ohio river is, as well, the southern boundary of the State, and separates it from the State of Kentucky.

Harrison county was organized in 1808. Corydon, the seat of justice, is one hundred and twenty miles south of Indianapolis. It is pleasantly situated in a picturesque valley at the junction of Big and Little Indian creeks.

A synclinal axis in the underlying rocks, a little north of Ohio river, helps in giving general direction to that stream. The smaller creeks and streams, of comparatively recent age, when they depart from lines of erosion during or prior to the Glacial epoch, follow a westerly or southwesterly direction—the general dip of the rocks.

The principal streams, besides Ohio river, which, in a great arc of a circle, forms the southeast, south and southwest boundaries, are Blue river, forming the general dividing line between Harrison and Crawford counties; Big Indian, Little Indian, Buck and Mosquito creeks. These are usually reliable streams, and form much reliable mill power. These streams pass through narrow valleys or canon-like gorges, at a depth of three hundred to four hundred feet below the highest hilltops, and from one hundred and twenty-five to one hundred and fifty feet below the level of the "barrens" or valley plateaus.

Of equal or greater importance is the subterranean drainage. Perhaps no part of the world exhibits this feature so significantly. The rocky substratum of the county is, as a

rule, limestone. The surface is a porous mass of flints, geodes, siliceous fossils and fragments of quartz, the insoluble remains of this limestone dissolved and eroded by atmospheric agencies. The rain-fall is absorbed by this mass as if by a sponge, and quickly conducted to sink-holes and ever-enlarging crevices to underground canals or ducts. The result is a subterranean system of rivers, creeks and brooks, which flow along in midnight darkness, peopled with a peculiar fauna—fishes, crayfishes, worms and beetles, in which the organs of vision, unused for generations and ages, are obsolete. A world of night for the use of sightless life.

This peculiar system, and its depth below the surface, renders the supply of water from wells uncertain, and residences, churches and school-houses are usually supplied with cisterns for securing rainwater for culinary and drinking purposes. At many points the prevailing good health may be attributed to the use of pure rainwater. Another remarkable effect of this drainage is observed in many electrical phenomena, seemingly contrary to the well-known laws of electricity. Lightning rarely or never strikes on the hills or table-lands, but generally or always in deep valleys, and often in basin-shaped sink-holes, from two hundred to four hundred feet below the high hills immediately adjoining or contiguous. Dry, porous earth, filled with air, is a poor conductor. Such is the condition of areas underrun by rivers and streams. The electricity seeks the shortest line to a good conductor by passing through the humid air to one of the underground water-courses.

The water-fall in the northwest part of the county, after a hidden course of eight or ten miles, makes its appearance as a river at Harrison springs, six miles northwest of Corydon. Similar phenomena of remarkable interest were observed at the foot of Walnut valley in the "Blue

spouter," in the "Stygean" river, near the mouth of Big Blue river, at Big Blue spring, near Amsterdam, and at Boone's mill cave spring, west of Laconia.

RECENT GEOLOGY.

Recent geology comprises that succession of changes in the earth's surface which have occurred since the formation of the rock-beds in the bottom of the ocean, and their elevation above the surface of that sea. The term *recent*, then, is relative in its meaning. Although the term, by its phenomena, requires a very long period of time, variously estimated from thousands to millions of years, it is but a point or paragraph in the long, long years necessary for the preparation and elevation of the underlying rocks.

Alluvium.—The alluvial "bottoms" or valleys along the banks of the rivers and streams are due to causes now in action. Detritus, derived from wear and tear of rocks and their disintegration by atmospheric agencies, is seized by each brooklet and rainy day wash, hurried along by brook and river and by flood-tide deposited along or upon its banks. By a slow current, and at eddies, a close, impervious clay is deposited; but a stronger current carries in its bosom sand and vegetable matter, which, intermixed with clay, forms that loamy soil characteristic of our streams, and famous for the production of fine crops of cereals, vegetables, fruits, etc. The "bottoms" of this county are of the best, and continually enriched by the annual overflow, are, after a continuous cultivation for nearly one hundred years, without manure, well remunerative to the careful husbandman.

Lacustral Epoch.—This epoch succeeds in age the one above described. During the great ice age—next mentioned—the drainage of the great valley of this continent was from north to south. Northern areas were at an eleva-

tion of several hundred feet above their present level, relative to the ocean surface, and at the same time at a much greater elevation than now above areas to the south, causing a rapid flow in that direction. At about the close of the Glacial epoch, a slow oscillation of the crust of the earth occurred. The region of the great lakes, parts of Indiana, Illinois and Missouri, etc., were slowly and continuously depressed, at a rate so much greater than the southern parts of the country, that it worked a practical obstruction in the outlet of the water-shed.

A great fresh water sea resulted, at one time covering the greater part of the interior of the continent, connected with outlying lakes by channels and valleys eroded during the preceding period, driven by the wind, but otherwise currentless rivers or bodies of water. Along the shores somewhat coarse sands were tossed by the waves, while along the shallow bottom fine, impalpable sand and clay were deposited. As will be seen by referring to preceding reports, the animals found in this Loess or lacustral deposit indicate that a warm, subtropical climate prevailed. The Loess always overlies glacial deposits or boulder clay, proving that it was subsequent to that epoch. The resulting soil is apparently a yellowish clay, but is almost wholly siliceous, and when dry or worn by cultivation, is a dull ash-gray. Remainders of the flora of that age and climate survive to this day, and afford an almost sure indication of the Loess soil, as Persimmon (diospyros), Sweet Gum (styraciflua), etc., etc., while the red-gilled lizard and cotton-mouth snake, still tell of perennial warmth. Good examples of the Loess beds are seen on the road from Corydon to Leavenworth, west of Keller's hill, and from Palmyra to Bradford, in the northeastern part of the county. The original deposit was thin, varying from a few inches to about five

feet in thickness. Over a great part of the county it has been removed by rainfall, or so distributed as to be scarcely recognizable.

Glacial Epoch.—The Glacial epoch is the next important phenomena in the earth's existence. Its date is variously estimated by physicists. From astronomical data, but of uncertain value, its beginning is fixed at from 500,000 to 700,000 years ago. By other calculations, which seem somewhat more reliable, this epoch is referred to a period commencing 225,000 years since, and ending not less than 175,000 years ago. In all their estimates there may be a considerable margin for error.

The main facts in the glacial theory are unquestionable. An arctic climate prevailed throughout North America. A great sheet or river of ice, propelled by surface inclination, but more by the expansion of a long line of freezing or congealed water, invaded, and in a great degree covered, the basin of the northern lakes, and extended south to about the thirty-ninth degree of latitude. There are few or no evidences of glacial action south of this line, although there are abundant proofs that bergs and broken masses of ice floated after the vernal equinox and during the short arctic summers, bearing with them boulders, gravel, clays and other remains imported from their northern home. Stranded or lodged along this line, the glacier melted and sent great sluice-like rivers, increased by the excessive precipitation incident to a cold climate, in a southerly direction. At first they would seek to follow pre-glacial river channels, but as these were constantly modified, changed or obstructed by the propulsion of boulder clay and sand before the glacier's breast, these sluices were erratic and variable in their courses, wandering, at different periods, over nearly the entire surface of our State, and finally, as the ice slowly retired under the influence of a warmer

climate, they became more fixed in their channels, either in geological synclinal axes or along the outcrop of soft rocks or those most liable to disintegrating effects of the elements. The tangible evidences of the glacial age are limited to small detached beds of blue clay, with pebbles of northern origin, and to the transported boulders and pebbles found along Ohio and Blue rivers; but of more importance than these are the waterless channels and cuts hewn out of the Chester sandstone in the west and south-western parts of the county, at an elevation of seventy to ninety feet above the beds of existing streams. Notable instances may be seen in an old channel around the east base of Greenbrier mountain, near Wyandotte cave, and in the notches cut in the Kentucky hills south of the Ohio, by Blue river, Potato, Indian and Buck creeks.

Pre-glacial Age.—This may perhaps be classified as a novel subject in geological science. But little opportunity has been presented of studying this period, and I have seen nothing written upon it. According to the theory of all geologists, the sub-carboniferous rocks of this county were elevated above the level of the sea soon after the beginning of the Permo-carboniferous period; while a majority, especially those who adhere to the commonly received swamp theory, with its impossible paradoxical alternate elevation and depression of the coal-measure basin, are sure that the whole of this county had emerged from its ocean birth-place (origin) at the beginning of the Coal-Measure epoch. In either case, a great hiatus occurs in nature's record and chronology. The ages and cycles of ages in which the Permian, Cretaceous and Tertiary seas came into existence, culminated with their wondrous life, and passed away, building up great depths of solid rock, offer, in this region, a record so scanty as to unveil but little of their story. The vegetal and animal life of these seas prove conclu-

sively that a tropical climate prevailed in adjoining regions. Many of these graniverous animals and birds were of regal size and strength, requiring abundant food. The small development of brain capacity shows clearly that their methods of existence were easy, and food attainable without strife or effort. We must conclude that somewhat similar aerial conditions existed here during this period.

From analogy, unqualified developments elsewhere, and abundant facts easily seen, this region, upon its emergence above the sea, was a great level plain, sloping gently to the west. Approaching Corydon from the eastern boundary of the county, a great valley is discerned—a nearly level plain —now traversed by many streams, with deep, canon-like beds, but of recent origin, traversing the county from north to south. It is eight to fifteen miles wide, and from two hundred to three hundred feet deep. The eastern bluff is the Knob sandstone of Floyd county, and the western the Chester hills in the western part of the county, along Blue river. A fine view, embracing a large part of this valley, can be had at a single glance from the top of Pilot knob, adjoining Corydon on the south. Words can hardly express the gratification experienced on ascending this point, as the veil faded away which had mystified so many other visitors and students, disclosing that long vision in the history of the past. A succession of such sharp, conical "knobs" or peaks are seen to the northwest, and continue to occur beyond the northern boundary of the county, followed by a similar succession to the south-southeast.

The great valley locally known as "the barrens" is a nearly level plain. In a wild state when visited by the Boones and other hunter pioneers, it was nearly a typical prairie, exhibiting a few knarled and scotched shrubs or "stools," and covered with a luxuriant growth of tall prairie grass, herbs and vines. These were burned after each

autumnal frost, preventing the growth of trees and permanent vegetation. The soil is a silicious clay. The subsoil a confused, irregular, disjointed mass of flints, quartz and geodes, from ten to forty feet in depth—in some places approaching or covering the surface as to prove an obstacle to pleasant agriculture, and at a few points in such extreme development as to require their removal and use in building fences, houses, etc. This rubbish is not in natural "place," and no such beds occur in this local geological formation, or any other. They are not imported by water or ice; their origin is local. Looking for their source, we see in the cliffy outlines of adjoining hills that the material of this *debris* is scattered in thin layers, one to fourteen inches in thickness, throughout the beds of St. Louis limestone, the place of which is occupied by this valley. Judging from the isolated sections visible then, these layers, gathered from two hundred feet of St. Louis rocks, would just about equal the amount of the remains here left.

We can but conclude that water, charged with carbonic acid, dissolved and totally removed in a state of solution the whole of this limestone, rejecting the insoluble siliceous material found remaining. This solution is natural, and does not require the erroneous theory of volcanic heat or upheaval. If the water which caused this removal was simply confined rainfall, and without motion, evaporation would have developed great beds of calcic tufa. Such beds do not exist. Theoretically, we may infer that a body of flowing water assisted. This is made certain by the fact that, on ascending Pilot knob and similar eminences near the level of the ancient table-land, the extreme summits still exhibit well-rounded gravel and more angular coarse sand. These can only result from water in motion, and flowing with considerable rapidity—say two to four miles an hour. The northern and northwestern sides of the

hills and knobs, as a rule, are precipitous, as if roughly beaten by a current, while in every case a pronounced talus stretches out to the south-southeastwardly. All these definitely assert the existence of a pre-glacial river of great volume, flowing with some current, probably slow, to the southeast. This valley, followed to the south, at present shows little or no fall in that direction; but, with due allowance for the more rapid subsidence of northern areas, it is at once apparent that in the long past there was a time when this, as well as other rivers of Indiana and the northwest, which once flowed to the south, could and would be obstructed, and be compelled to find new outlets of discharges.

Ignoring the bed of the recent Ohio river, this valley crosses that stream between Brandenburg and Westport, at an elevation of two hundred and fifty to three hundred feet above low water, passed by a wide channel, now silted up near Elizabethtown, Ky., into the beautiful Nolin valley, and that of Nolin creek to Green river, accounting for the unusual bottoms of the latter, thus finally reaching the present Ohio river near Newburg. Below this point of junction, as well as above New Albany, the Ohio valley is from one to five miles wide, with well-rounded, gently-sloping bluffs, as naturally occurs by exposure to the elements a very great length of time. Between these points, along the southern line of Harrison, Crawford and Perry counties, the bottoms, exclusive of the river itself, range from nothing to a quarter of a mile in width, while the bluffs, from two hundred to five hundred feet in hight, boldly approach the water's edge; as a rule precipitous or very steeply inclined, and formed of limestone, which, by action of the atmosphere, is quickly sloped or rounded. They very strongly indicate the recent origin of the present Ohio river. On

the other hand, the well-rounded and gently-sloping bluffs of the supposed Pre-glacial valley as strongly demonstrate the extreme antiquity of this phenomenon.

The more deeply eroded Glacial of Post-glacial valley of Silver creek, which gives easy access to the Indianapolis and Jeffersonville railroad to the deep Ohio valley opposite Louisville, and its tributaries, in all cases, cuts or crosses the more ancient predecessor of Pre-glacial age, and the extreme depth of erosion beneath the city of Louisville of one hundred and seventy-five feet below the present bed rock of the falls of the Ohio, show conclusively a great change in conditions, if not probable oscillation, in the level of the earth's crust.

This subject merits extended study, and is here thus curtly mentioned for the purpose of inviting such attention and investigation as will demonstrate the theory here set up, or otherwise account for the facts noted.

Grassy, Brushy, Hancock and Ripperden valleys may possibly date back to this age. They are valley-like depressions, ranging from three to ten square miles in extent, from two hundred to four hundred feet below the adjacent ridge lands; immense basins without visible outlet streams, with walls of living limestone, yet well sloped and gently rounded by the healing hand of nature. They were the caverns of an early age, hollowed by underground rivers until, as has sometimes been known, the roof has fallen in, and the calcareous *debris*, removed by ages of rainfall, discharged by still lower cavernous conduits.

The Flat woods, from north to south, along the eastern side of the great valley, is a marked feature in the recent geology of this district. The soil, when unmodified by modern action, is dark and mucky, like the northern prairies, underlaid with yellow and white clay, with partings of

sand and rounded, water-worn gravel. While possibly of lacustral origin, it may probably be referred to the flood plain of the river of the ancient valley.

The beds of glass sand and kaolin marked on the map seem directly connected or caused by the agency which spread out this alluvial deposit, and similar beds on its continuation in Nolin valley in Kentucky.

GENERAL DESCRIPTION.

Details gathered from isolated localities, grouped together, give the following

CONNECTED SECTION.

QUATERNARY AGE.

Present Epoch.

	Ft.		Ft.	In.
River and creek alluvium	2	to	205	00

Lacustral Epoch.

	Ft.		Ft.	In.
Loess	0	to	5	00

GLACIAL PERIOD.

Glacial Epoch.

	Ft.		Ft.	In.
Soft white and blue clays	0	to	7	00
Fine pebbles and sand	0	to	2	00

PRE-GLACIAL EPOCH.

	Ft.		Ft.	In.
Alluvial flood plains	0	to	18	00
Local insoluble residuum of flints, geodes, etc.	0	to	35	00

CARBONIFEROUS AGE.

Coal-Measure Period.

	Ft.		Ft.	In.
Conglomerate sand rock	0	to	19	00
Place of coal A	0	to	0	02
Coarse, irregular bituminous shale	3	to	5	00

SUB-CARBONIFEROUS PERIOD.

Chester Group.

	Ft.		Ft.	In.
Kaskaskia limestone	5	to	20	00
Chester sandstone	35	to	70	00
Thin-bedded lithographic limestone	40	to	20	00
Carbonaceous shale (coal bone)	1	to	0	00

St. Louis Group.

	Ft.		Ft.	In.
Gray or blue (sometimes argillaceous) limestone, with massive buff layers	20	to	25	00
Argillaceous limestone, flint balls and partings.	15	to	25	00
Oolitic beds	0	to	15	00
Argillaceous limestone with balls and flint partings	50	to	40	00
Brown cherty limestone with clay beds	30	to	50	00
Heavy-bedded gray limestone	20	to	25	00
Gray limestone with clay partings (sharks' teeth bed)	25	to	30	00

Keokuk Group.

	Ft.		Ft.	In.
Gray or brown limestone	8	to	22	00
Buff argillite, with small geodes	16	to	14	00
Encrinital limestone and geodes	4	to	12	06
Blue and gray banded shales, somewhat calcareous	4	to	18	00
Buff argillaceous limestone, with Burlington fossils	6	to	4	00
Blue gray calcareous shales	20	to	5	06

Knobstone Group.

	Ft.		Ft.	In.
Ferruginous sandstone and shales, with beds of shaly argillite	150	to	125	00
Heavy sandstones and siliceous shales	200	to	135	00
Blue pyritous shales, with clay iron stones	175	to	150	00
Argillaceous impure limestone	2	to	6	00

DEVONIAN AGE.

Hamilton Group.

	Ft.	In.
Black slate in bores	110	00
Gray and black hydraulic limestone	30	00
Siliceous limestone	22	00

SILURIAN AGE.

Upper Silurian.

	Ft.	In.
Niagara and Clinton limestone in bore at Corydon	90	00

Lower Silurian—Cincinnati Group.

Limestone and shale in Corydon bore.....	267	00

PALEOZOIC GEOLOGY.

The order of succession and average thickness of the rocky formations of this county are given in the foregoing Connected Section. The rocks of each group vary so constantly in character, thickness of special layers and components, that it would be difficult, if not impossible, to surely determine them by stratigraphic study. Each age is, however, represented or indicated by a peculiar suite of fossils, according to the different conditions of the ocean bed in which the rocks were formed. By the fossils—known words interpreting the book of nature—the records are read and the horizon of the rocks determined; hence the importance of the extended list of fossils hereinafter given.

COAL-MEASURES.

Commencing with the highest and most recent rocky deposit in the western side of the county, we find there beds of bituminous or pyritous shales marking the place of coal A, the lowest coal seam in this State, capped by a few feet of Conglomerate Sandrock, named "Millstone Grit" by the English geologists. It is so near the rim of the basin that, as is always the case, it is here barren—without coal. This horizon is remarkable for the abundance of well-preserved stems and fruits characteristic of the Coal-measures. No other point visited in this State offers a more interersting study than Keller's hill, southwest of Corydon, and thence

westerly to Blue river. It is, perhaps, unnecessary to say that no workable seams of coal exist in this county, and search in that direction will prove fruitless.

CHESTER GROUP.

The upper member of this group is a dark blue or gray limestone, somewhat variable in color and character. Its surface conformed to the uneven bed of the ocean, in which it was deposited, and indicates by wave-like inequalities the deep sea currents which inaugurated the age of coal, bringing with it from some rocky shore the overlying coarse sands and pebbles of the Conglomerate.

The fossils are generally Sub-carboniferous, as pentremites, corals, bryozoans, crinoids, etc., although a few Coal-measure fossils give promise of the coming life.

Next in succession below this are the beds of siliceous shales and shaly sandstones passing into ledges of massive sandstone and grit stones. At such localities the stone is of excellent quality. Blocks of any usable size may be easily split or squarely broken. The grit stones have proved equal to the best, under the severest test. The few fossils are, as a rule, strictly of the Coal-measures. Thin-bedded, argillaceous limestones succeed at many points, having the appearance of lithographic stone, and were it not for small inequalities and "glass seams" it would prove of great value. No bed sufficiently perfect was seen to promise great value, but it is possible, if not probable, that a good bed may be discovered. A pretty constant feature near the base of this stone is a thin parting of black slaty "coal bone." As no fossils have been observed within several feet above and below this parting, it has been adopted as an easily observed line between the Chester and St. Louis groups, although more favored observers may hereafter discover that it is not absolutely correct from a palæontological standpoint. The

Chester rocks build up the hills and wall the valleys in the western and southwestern parts of the county, and are the surface rock of this region, with the exception of the small area of Coal-measure rocks before mentioned.

ST. LOUIS GROUP.

The rocks of this group are principally limestones, more or less argillaceous, with beds of clay between the strata, containing flint-balls, geodes, etc. These materials indicate the deposits of a quiet sea, traversed by gentle currents with water of such purity as to allow the life of animals which can not survive an addition of impurity or earthy matter. The argillaceous beds show that the conditions were not favorable to their life, and but few fossils are found in them.

At intervals throughout this group, trough-like depressions or synclinal axes are found perpendicular to or at a marked angle with the rim of the basin, in which shells and calcareous remains of the many animals which flourished in this age were carried by the gentle currents which flowed from north to south along the shore line or rim of the basin. These remains, coarsely broken, ground together by the ever-restless waves of the sea, became cemented together by pressure and chemical action, and form the common limestone for burning and for rough masonry. When the comminution was more perfect, the remains were reduced to fine powder, and a considerable amount of lime was dissolved and held in solution; the product is the fine-grained quarry limestone so well and favorably known over Owen, Monroe, Lawrence and Washington counties, and at Breckenridge in Harrison county. But at extended periods the ocean currents were of such power that large amounts of lime so held in solution were borne along to the south until, in still stations or by chemical action, the lime was deposited, almost chemically pure, in the shape of myriads of

minute concretionary balls, so minute as to resemble the delicate roe of a fish. These little spheres, closely compacted and cemented with calcareous matter, form the famous "white oolitic" stone, so grandly represented in this county. Its qualities and characteristics will be further considered under the head of "economic geology." The horizon of the oolitic seams at different localities, ranging from ten to seventy feet above the base of the group, and sometimes deposited in thin strata, is repeated two or more times.

The flint balls are at localities on Indian and Buck creeks, and generally in the southern part of the county in great abundance. This region furnishes a solution of the vexed question, "Where and how did the Indians make their arrow and spear points, knives, awls, spades, etc.?" The quantity is unlimited. A stranger will soon have his attention called to black, sphere-shaped balls, from one inch, or less, to twenty inches in diameter, on almost every hillside. He will soon wonder at their peculiar fracture, when exposed, perpendicular to the plane of deposition, although somewhat irregular. Tested with a hammer, it will soon be discovered that, although easily broken, the cleavage is not sufficiently straight and in the direction of the blow to give artistic results. The Indians, from facts here observed, knew the law—that it was necessary to open deep trenches to the unexposed beds to secure such specimens as might be chipped into useful shapes by the dexterous hand of the professional arrow-maker. On repeated tests it was found that flints, fresh from their natural beds in the earth, could be split, even by one not an expert, with much precision into such angular prisms as are always found among the remains of these ancient people. Trenches from four to ten feet deep, and

from one quarter to one half a mile in extent, indicate the long, patient toil of these people in search of this, to them, most valuable mineral.

The animal life of this age was varied and vigorous. Brachiopods were most abundant; crinoids and pentremites opened and closed their appendages like sensitive buds and branches of vegetation; corals wove their delicate tracery of lace-work, while smaller shells, though ranging down to microscopic size, and so fragile that the tenderest wave would crush the tiny home of its owner, are all ornamented as if for dress parade before their great Creator.

The vertebrate life of this epoch was not extensive. A few families of fishes, mostly sharks, survive from the Devonian age of war. They came armed with buckler, stiff spines and cutting fangs, ready for a life of battle. Their business was defense or destruction. Riven and broken or worn teeth tell the story of the deadly struggles of these descendants of a warrior race.

This group is sometimes known as the Cavernous Limestone. It is well known that water, falling through the air and flowing over the surface of the earth, absorbs gases which slowly dissolve the solid limestones. Seeking a lower level, it finds a crevice, and passes, drop by drop, to deeper strata, enlarging the outlet. This process, long continued, forms large, funnel-shaped basins called "sink holes," which are a constant feature wherever the rocks of this group approach the surface. These sink holes gather the surface water, sometimes holding it in ponds and lakelets until, in passing through and between the solid limestones, a small outlet is first found, which is constantly enlarged by the process above mentioned until, by the lapse of ages, brooks grow to creeks and creeks to rivers, tunneling their tortuous subterranean way for miles, absorbing nearly all the surface drainage. The flow, as a rule, is on

the line of dip. When lower lines of drainage are found, the upper ones are abandoned, and partly silted up or obstructed. Such unused channels are the famous caverns of the world, including Wyandotte, Pitman and Borden's caves.

In the course of time much or all the evidences of the ancient river are removed or covered over. Water percolating through "sinks" in the roof, charged with lime in solution, by evaporation deck the walls and roofs with a snowy film of white spar, garnishing every projecting point with icy pendants grandly beautiful and attractive.

About seventy feet above the base of the St. Louis limestone occurs a dark calcaro-bituminous hydraulic rock of great economical importance. It exhibits a thickness of thirty to forty feet in the extreme southern part of the county, thinning to two feet near Elizabeth and Bridgeport. It will be more fully considered in local details and economic geology.

KEOKUK GROUP.

The Keokuk rocks outcrop along Ohio river and tributaries in the eastern part of the county, as far south as a point opposite Rockhaven, Kentucky, and in the deep valley of Little Indian creek and its branches, near Lanesville. The thickness of the beds range from fifty to eighty feet. They consist of dark-gray limestones, weathering brown, with partings or divisions from a few inches to eight or ten feet of soapstone, or indurated clay, often containing a great number of geodes. The limestone, on disintegration, forms a ruddy, ochreous clay, so colored from a quantity of iron contained in the stone, and which is believed by Dawson and other eminent geologists to indicate either a near shore line or the inflow of a river containing earthy impurities. The geodes, so characteristic of the Keokuk epoch, are round balls of crystalline quartz, with mammillated exterior, but white within, and often

containing crystals of spar (calcite) of great beauty. Many, if not all, these geodes owe their origin to the remains of animal or vegetable matter, which, by decay, left cavities in their matrix, which were filled with water having silica in solution. On evaporation of the water the silica was crystallized, and as substances expand in the process of solidification, so the casts are often, not always, so enlarged as to form a grotesque exaggeration of the original mould. Sponges are the most common geodized fossils, and corals, crinoids and brachiopods are frequently met with. Life was abundant, as may be seen by the list of fossils further on in this report, many of which are well preserved. Fish remains are not unfrequent, and indicate, by their dental remains, great vigor and aptitude for eating and fighting. Pentremites, crinoids and star fishes seem to have reigned in this sea. Their remains indicate great size and beauty. A crinoid stem was observed over four feet long, with feathery branches attached its whole length, plastered upon the Keokuk rocks opposite and above Rockhaven.

BURLINGTON GROUP.

The lower member of this bed is a buff or greenish-gray argillite. Stratigraphically, it occupies the horizon of the Burlington group of Illinois and Iowa, and although fossils of the Burlington group are quite numerous, yet Keokuk fossils are still more abundant; therefore, until more decisive evidence as to the existence of synchronous conditions corresponding with those so remarkable in the geology of the States just named, we may still retain such beds in the Keokuk group.

KNOBSTONE GROUP.

The Knobstone shales and sandstones are the lowest rocks here visible. They are seen along the high bluffs of Ohio river, developing a total thickness from the top to the

Black Slate, in the adjoining county of Floyd, of 416 feet. Dipping rapidly to south and west, it passes from view below the surface of the river at Brown's Landing, at mouth of Mosquito creek. This group consists almost wholly of buff, blue or green pyritous shales. Wedge-shaped plates and thick bands of sandstone occur in the upper and middle members of the deposit, some of good workable extent and quality. It is equivalent to the Waverly sandstone of Ohio, and some of the quarries have furnished stone of such quality as to induce extensive use for piers, guard banks, etc.

The pyritous nature of the shale causes rapid decomposition on exposure. The result is a fine plastic clay, which at once yields to the action of water, almost of moisture; hence, whenever exposed, the surface of the country underlaid by rocks of this age presents a wonderful succession of sharp, conical knobs, from ten to four hundred feet in hight, of singular beauty and symmetry. As seen from a commanding eminence, when covered with grass, they look like the tents of an army of silent giants. One view from the high knob at New Albany is of interest and beauty. The "Belle riviere," bearing busy steamers on its bosom, proudly dashes over the Falls and passes to a dim line in the distance; the cities of Louisville, New Albany and Jeffersonville, thronged with stirring life, cluster around the Falls. The abandoned site of historic Clarksville and the remnant of Corn island, with its prehistoric relics, recall the chronicles of pioneer days and a lost race; while off in the distance the Kentucky hills rise up against the sky as if by mirage. Bayard Taylor, after experiencing all that is beautiful and grand in foreign travel, pronounced this one of the most interesting and attractive landscapes that had come before his eyes.

The name "Knobstone" was applied by Dr. David Dale Owen in his Geological Report on Indiana, more than forty

years ago, and, although other names have been proposed, it is retained as a matter of justice to the distinguished father of western geology, and because the name so expressively describes the peculiarities of the group.

DEVONIAN AND SILURIAN FORMATIONS.

The Devonian and Silurian rocks are not visible in the county. They have been reached by boring for salt at Corydon, the record of which was so carefully kept as to give a very accurate and recognizable measure of the strata at that distance within the basin, and indicating, with many other facts observed, that strata thicken as they dip and recede from the rim of the basin. This law is almost without exception throughout the Indiana section.

The following list of fossils is believed to be full; years have been spent in collecting by the many energetic geologists about the "Falls," to whom thanks are due for assistance and favors. Special acknowledgments are due to Mr. George K. Green, of New Albany, whose energy and success as a collector is so well known. Many of the most perfect specimens were obtained from his collection. The list has been submitted for revision and arrangement to the eminent palæontologist of the American Museum in Central Park, New York, Prof. R. P. Whitfield, to whose patient kindness my heartiest thanks are given.

It will be observed there are many species and even genera unpublished, a duty which Indiana owes to science, and that should be discharged by full palæontological reports profusely illustrated. It is especially the duty of the State, by such publication, to enable her own citizens and the rising generation to recognize the fossils peculiar to the State, without the heavy expense of buying costly works of other States now almost inaccessible.