

REPORT UPON THE GEOLOGY OF ALLEN COUNTY.

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The county of Allen was organized in 1823, out of territory then included in Randolph and Delaware counties. It is bounded on the south by the counties of Adams and Wells, on the west by Huntington and Whitley, on the north by Noble and Dekalb, and on the east by the State of Ohio. It is 24 miles wide from north to south, and its length from east to west varies from 26 to 28 miles. It includes 16 whole townships and 4 fractional, being a total area of about 664 square miles. For convenience of reference the civil names of the congressional townships are given in the following table:

	<i>R. 11.</i>	<i>R. 12.</i>	<i>R. 13.</i>	<i>R. 14.</i>	<i>R. 15.</i>
Tp. 32.	Eel River.	Perry.	Cedar Creek.	Springfield.	Scipio.
Tp. 31.	Lake.	Washing'tn	St. Joseph.	Milan.	Maumee.
Tp. 30.	Aboit.	Wayne.	Adams.	Jefferson.	Jackson.
Tp. 29.	Lafayette.	Pleasant.	Marion.	Madison.	Monroe.

Allen County is crossed by the parallel of 41° north latitude, the meridian of 85° west longitude, and the annual isothermal of 52° F. Its annual rainfall is about 35 inches, and its average elevation not far from 800 feet above sea level.

The city of Fort Wayne (population 30,000), the county seat, and the third city in the State, is situated three miles west of the center of the county at the junction of its three principal rivers, the St. Joseph, St. Mary's and Maumee. Its site is at the beginning of the portage from the Maumee to the Wabash rivers, and its occupation as a French trading post probably dates back to 1680.

The county is crossed east and west by the Wabash, St. Louis & Pacific, the Pittsburgh, Ft. Wayne & Chicago, and the New York, Chicago & St. Louis railroads; north and south by the Grand Rapids & Indiana, and Cincinnati, Richmond & Ft. Wayne, the Ft. Wayne, Cincinnati & Louisville, and the Ft. Wayne branch of the Lake Shore & Michigan Southern. The population of the county is nearly 60,000.

Physically, Allen County is a part of that shallow trough which continues the basin of Lake Erie southwestward across Ohio and Indiana nearly to the borders of Illinois, and which I shall call the Wabash-Erie region. The county lies exactly midway of this trough, where a curved, transverse ridge forms a divide which turns a portion of the water north-eastward through the Maumee to Lake Erie and the remainder south-westward through the Wabash to the Ohio. This region exhibits a continuity and unity of structure which indicate that the whole has been shaped by the action of one agent. Many features of its topography and drainage are anomalous, unique and explainable only by reference to a single cause.

Along the present axis of the trough extends one uninterrupted river channel, occupied, however, by different streams; from Lake Erie to Ft. Wayne by the Maumee, thence for about twenty miles by a marsh known as the Little River Prairie, thence by the Little Wabash River to its junction with the great Wabash below Huntington, and thence by the latter river. Down the sides of the trough ten streams of considerable size flow toward the central axis, arranged opposite each other in pairs, the Auglaize and the Tiffin, the St. Marys and the St. Josephs, the Upper Wabash* and the Aboit, the Salamonie and the Eel, the Mississinewa and the Tippecanoe. Those upon the southern side occur at regular intervals and flow in symmetrical curves parallel with the southwest shore of Lake Erie. The drainage system as a whole is almost sagittate in form, resembling the shape of an arrow with a five-barbed head. The general course of the ten tributaries is toward the western end of the trough, and, according to hydrographical precedents, all ought to be tributaries of the Wabash River; yet four are on the eastern side of the divide and turn back upon themselves in a remarkable manner. The St. Mary's River, after flowing northward sixty miles, and the St. Joseph, after flowing southwestward eighty miles, unite to form the Maumee, which then turns abruptly to the northeast; so that in a course of ten miles the waters of the St. Joseph suffer a change in direction of more than 160 degrees. The key to this unusual behavior was discovered in 1870 by Mr. G. K. Gilbert, then of the geological survey of Ohio. He found closely following the eastern banks of these rivers a ridge which he conceived to be "the superficial representation of a terminal glacial moraine."[†] About the same time Professor N. H. Winchell was studying these and other ridges in northwestern Ohio, which he described in detail in a paper read at the meeting of the American Association for the Advancement of Science at Dubuque in 1872.[‡] He pronounced all the ridges described to be terminal moraines of a local glacier which passed

*The Wabash above Huntington.

†Geological Survey of Ohio, Geology, Vol. I., p. 540.

‡Proceedings of A. A. A. S. for 1872, p. 152.

up the St. Lawrence valley and was protruded into the *cul-de-sac* of the Maumee. In 1881 Professor T. C. Chamberlain published his classic report upon the Terminal Moraine of the Second Glacial Period,* from which it appears that the ice did not stop at Ft. Wayne, but pushed on nearly to the western border of Indiana.

The discovery of the key to the peculiar structure of the Wabash-Erie region is due to the sagacity of Mr. Gilbert. The sequel may show that this key has been applied with too little discrimination; but there is now no reason to doubt that the parallel, crescentiform ridges which determine the course of the principal streams of this region are of glacial origin and morainic character. Allen County is traversed by two such ridges, and further discussion of the subject will be confined to them.

The surface of the county is everywhere covered with a sheet of drift seldom less than 100 feet in thickness. The character and disposition of the drift govern its topography, control its drainage, and determine its agricultural character. A study of the geology of Allen County must be almost exclusively a study of the drift. For convenience of description the county may be divided into six natural divisions.

1. The Maumee Lake Region.
2. The St. Mary's and St. Joseph Moraine.
3. The St. Mary's Basin.
4. The St. Joseph Valley.
5. The Wabash-Aboit Moraine.
6. The Aboit and Eel River Region.

THE MAUMEE LAKE REGION.

Once covered by the waters of a glacial lake, forms a triangle with a base of 18 miles on the east line of the county, and its apex in section 3 Adams Township. It occupies the townships of Jackson and Maumee, the greater part of Scipio and Milan, one-half of Jefferson and portions of Springfield, St. Joseph and Adams, and has an area of about 120 square miles, or nearly one-fifth of the county. This lake emptied westward into the Wabash channel, and its eastern shores were probably formed by the ice-foot or wall of the retreating glacier. The Blanchard ridge† of Winchell marks the next halting place of the ice-foot, and was probably for a time the eastern boundary of the lake. During that period it was an intermorainic lake, and had an area of 800 or 1,000 square miles, and a maximum depth near Emerald, Ohio, of perhaps 60 feet.‡

*U. S. Geol. Surv., 3d Annual Report, p. 291.

† This ridge is a terminal moraine approximately parallel with the St. Mary's and St. Joseph moraine. It extends from Adrian, Mich., to the Maumee, below Defiance, Ohio, thence southeastward to the Putnam County line, thence eastward through Leipsic and Fostoria to Tiffin.

‡ T. P. Roberts' letter in the Toledo Blade, February 22, 1876.

The surface of this region is remarkably uniform,* being in some places an absolute level and occupied by extensive marshes, such as "great bear swamp," in Jackson Township. The streams are crooked and sluggish, and proper drainage, always difficult, is often impossible. It exhibits all the characters of the "Black Swamp" of Ohio, of which it forms a part. The surface soil is chiefly a compact boulder clay, overlaid in some places by laminated clays, with here and there a patch, streak or ridge of sand or gravel. The clay is commonly yellow to the depth to which aerated water has penetrated, below that blue. The boring of wells reveals the presence of layers or pockets of sand and gravel, which form the water-bearing strata.

Along the northwestern borders of this region "fountain wells" are very common. Near the line between Springfield and Milan and Maumee townships, there are as many as twenty within a distance of three miles. Flowing water is usually struck at depths between 35 and 45 feet, and a copious stream rises to the surface, or a few feet above. The following section of Rupert's well (section 1, Milan), is typical:

Yellow clay	7 feet.
Blue clay with gravel	20 "
"Putty clay"	5 "
Quicksand	1 "
Water bearing gravel, with coal	3 "

The "coal" often comes up in considerable quantities. It consists of black water-worn fragments, never larger than a cherry, which chemical analysis shows to contain—

Volatile matter	14.17
Coke	64.12
Ash	21.71
	100.00

These wells are all south of the Hicksville ridge and the water probably comes from the higher ground of the St. Joseph ridge.

Through this region, in a course almost parallel with its northern border and not more than four miles from it, the Maumee River flows in an exceedingly tortuous channel 25 to 40 feet deep, and with a fall of not more than one foot to the mile. At Bull Rapids (Maumee township) the channel is 360 feet wide and the banks 30 feet high. In section 22, Milan, the banks show 25 feet of gravelly clay, underlaid by 5 feet of very coarse gravel and boulders, most of the stones being well rounded, but as many as one in twenty being flat and beautifully striated on one or both sides.

*Wabash & Erie Canal at State line	750 feet A. T.
N. Y. C. & St L. R. R.	761 " "
New Haven, Allen County, Ind.	762 " "

The Maumee has no flood plain, terraces, benches, or bluffs. Its numerous northern tributaries rise within two or three miles of the St. Joseph River, and flow directly down the slope of the trough. It has almost no tributaries from the south, nearly all the streams within 20 miles of it flowing parallel with it. Platter Creek rises in Milan Township, within two miles of the Maumee, and flows northeast about 25 miles to the Auglaize. The numerous branches of Flat Rock Creek, which drain the southeast corner of the county, unite to form a sluggish and serpentine stream, which flows parallel with the Maumee at a distance of ten miles, and also empties into the Auglaize.

The Maumee Lake region is bounded upon the southwest and northwest by the Van Wert ridge of Winchell. It branches from the Blanchard ridge at Findlay, O., passes through Benton, Webster, Pendleton, Delphos and Van Wert, across the southwest corner of Paulding county, and enters Indiana in Section 2, Monroe township, Allen county. Thence it pursues a somewhat irregular course presently to be described, to New Haven. The portion north of the Maumee called the Hicksville ridge, begins in Section 3, Adams township, extends in an almost straight line to the northeast corner of Allen county, and continues thence through Hicksville, Williams, Center, Bryan, West Unity and Fayette, Ohio, to and beyond Adrian, Michigan, where it probably again joins the Blanchard ridge. The arrow head-shaped space enclosed by these ridges, its point being at New Haven, the extremities of its barbs at Adrian and Findlay, and the bottom of its notch at Defiance is the area once covered by the waters of the Maumee Lake.

The Van Wert and Hicksville ridge is regarded by Prof. Winchell as a terminal moraine, but by Mr. Gilbert and Prof. Newberry* as a lake beach or shore line. After a careful examination of it in Allen county, the evidence in favor of the latter view seems to be decisive. In Van Wert county, Ohio, the ridge breaks up into several members, and enters Allen county in at least four parts, all in Monroe township. The most southerly branch crosses the State line on the middle line of Section 14, and can be traced into the northeast quarter of Section 16. It is a sand and gravel ridge four or five feet high and three rods wide, trending E. S. E. by W. N. W. A second similar and parallel ridge crosses the State line one-fourth of a mile north of south line of Section 11, and ends a few rods to the west.

A third ridge crosses one-fourth of a mile north of the second and can be traced to the northwest corner of Section 10. The main branch enters Allen county a few rods north of south line of Section 2. It is a ridge of fine gravel and coarse sand averaging twenty rods in width and ten feet in height, but is quite variable. It extends northwest to the center

*Geological survey of Ohio, Geology vol. II, p. 57.

of the northwest quarter of Section 3, thence west one mile, thence northwest to center of southeast quarter Section 32, Jackson township, where it ends abruptly. Thence to the center of Section 36, Jefferson township, where the ridge again appears, is a gap of more than two miles, to pass through which the upper branches of Flat Rock Creek converge from the west, south and southwest. In Sections 36 and 25, Jefferson, the ridge trends a little west of north, and is very strong, its dimensions being fully twice the average given above. In Section 23 it is much less prominent, and in the northeast quarter curves sharply to the west. At Besançon, northwest quarter of Section 22, it becomes a quarter of a mile wide and divides into two branches. The north branch fades out near the center of Section 16, and the south branch runs west to the southwest corner. Thus far the ridge is quite symmetrical, sloping equally on both sides; but on entering the southeast corner of Section 17 it becomes a bench or terrace slightly elevated above the general level on the south, but sloping northward forty rods to a level twenty to thirty five feet below. It maintains this character to the southwest corner of Section 7, where it becomes a ridge of fine sand twenty feet above the level on the south and thirty to forty feet above the plain on the north. It traverses the south half of Section 12, Adams township, passing a little south of New Haven, and near the center of Section 11, becomes broader and bends back southward a half mile into Section 14, where it terminates. The west end and southward extension is composed of rather coarse gravel. Six Mile Creek has cut off the northwest angle and it has been excavated for road building. The section at the gravel pit shows strata of coarse sand and gravel in somewhat confused anticlinal stratification, having a total thickness of twenty-three feet, and underlaid by clay. The summit of the ridge is thirty-five feet above the creek. At a point on the very crest of the ridge one mile east of its western end, E. W. Greene had just bored a well seventy feet deep from which the water was flowing in a half inch stream, although the level seemed to be higher than that of any land visible around it. The boring was through sand twenty feet and gravelly clay fifty feet to water bearing quicksand.

North of the Maumee the Van Wert ridge is continued by the Hicksville ridge, which extends eastward from Ft. Wayne along the north line of Adams township to the center of the northwest quarter of section 3, where it makes a sharp bend of 110° toward the northeast. At northwest corner of section 35, St. Joseph Township, it becomes triple, the middle branch being in a direct line with the previous and subsequent course. The inner branch, next the lake, curves away to the distance of quarter of a mile, and rejoins the middle one a little east of the southwest corner of section 24. The outer branch is a bench parallel with the middle one and 40 rods from it. The triple character is maintained for about two miles, and without detriment to the mass of either branch. Thus far

the ridge is a rounded, symmetrical pile of sand and gravel of an average height of 25 feet above the lake bottom on the southeast, and with a slope of about half that fall to the northwest. Beyond the center of section 24 the ridge is broad, irregular and more difficult to define, the descent toward the northwest being slight or wanting. There is everywhere, however, a strong contrast between the flat bottom land on one side and the higher, rolling country on the other. It passes with slight deviation to Maysville, where it again assumes a regular and symmetrical character, and continues thence to the northeast corner of the county.

The true nature of the Van Wert ridge will be better understood after a consideration of other similar ridges which lie between it and the Maumee River. The most prominent of these is known as "Irish Ridge." It begins with a broad mass of gravel occupying the center of section 9, Jefferson Township. It was originally half a mile long, a quarter of a mile broad, and 10 or 12 feet thick, of fine gravel in perfect anticlinal stratification. From the gravel bed a ridge 15 feet high and five or six rods wide extends a little south of east across sections 10, 11 and 14, and into 13. Its eastern half is broader and not so well defined, and runs out into a mere streak of yellow sand. Its length is three miles and its direction parallel with the Van Wert ridge, from which it is distant a mile and a half.

Another called "Briar Ridge," is reported as extending northwest and southeast across section 15, Jackson Township, but I have not examined it. Small sand ridges parallel with the Hicksville ridge were noticed in sections 6 and 7, Milan Township, and probably others occur in the Lake Region. The following altitudes on the Van Wert Ridge have been obtained from various sources, chiefly railroad levels :

Gorham Township, Fulton County, Ohio	798 feet.
West Unity, Williams County, Ohio	803 "
Pulaski, Williams County, Ohio	773 "
Bryan, Williams County, Ohio	771 "
North of New Haven, Allen County, Ind	775 "
West end of Irish Ridge, Allen County, Ind	779 "
South of New Haven, Allen County, Ind	802 "
Van Wert, Ohio	786 "
Delphos, Ohio	784 "
Average height about	800 "

The character of the Van Wert Ridge may be summed up as follows :

1. It is composed of sand and gravel in more or less regular anticlinal stratification.
2. It is superficial, a deposit not over 20 feet deep (or high) superimposed upon the fundamental clay of the country.
3. It is narrow, sinuous, and frequently broken up into several members, each member being symmetrical and often equal in mass to the main ridge.

4. It offers little obstruction to the course of streams, being broken by frequent gaps for their passage.

5. Its crest shows a remarkable uniformity of level.

These characters mark it unmistakably as being not a glacial moraine, but a lake beach. Irish ridge is evidently an off-shore bar, and may have been the cause of the somewhat weak and confused character of the main ridge immediately south of it. The contrast between the simplicity and directness of the Hicksville ridge and the irregular complexity of the Van Wert ridge is readily accounted for. On the north the waters of the Maumee lake beat against the straight and bold escarpment of the inner margin of the St. Joseph ridges, while on the south the inner slope of the St. Mary's ridge, east of the centre of Jefferson Township is so gentle as to be imperceptible. The water crept up this slope in wide shallows and a change of level of a few feet would move the shore line as many miles. West of the center of Jefferson Township the inner margin of the St. Mary's ridge is high and bold, the main Van Wert ridge is coincident with it, and this fact explains all its anomalies.

Connected with the Maumee lake are two ancient drainage channels, the Six-Mile Creek channel and the Wabash-Erie channel. The former is a channel through which the St. Mary's River once emptied into the lake. It can be easily traced from the great bend of the St. Mary's River at the north line of section 7, Marion Township, to the Maumee at New Haven. It follows the valley of Merriam's Creek for half a mile, then the course of the Trier ditch northward through sections 5, Marion, and 32 and 29, Adams, thence along Six-Mile Creek through sections 20, 21, 15, and 11, to New Haven. The summit is in section 32, and is 20 feet above low water at New Haven, and not more than 10 feet above low water in the St. Mary's, so that frequently the St. Mary's water overflows the summit. The width of the channel is uniformly a quarter of a mile until it reaches section 15, where it begins to widen, and on the line between sections 10 and 15 it is a mile and a half wide, being bordered on the east by the high western face of the recurred end of the Van Wert ridge, and on the west by a similar ridge hereafter to be described. The banks of the channel have an average height of 15 feet, but the levels of the P., Ft. W. & C. R. R. show that the bottom of it is 60 feet below the summit on the west, and 40 feet below that on the east. It cuts completely through the St. Mary's ridge and may have afforded passage for ice or water either way. That a considerable stream once traversed it toward the north is shown by the terrace or delta of sand at the New Haven end.

THE NEW HAVEN DELTA

Is a deposit of sand which might be regarded as a western extension of Irish Ridge. Its eastern end is half a mile wide at middle of south half of section 5, Jefferson, whence it extends westward and occupies nearly all the space between the margin of the St. Mary's Ridge and the Maumee. The Maumee touches it in section 1, Adams, and again in section 3, and it continues as a narrow terrace nearly to Ft. Wayne. It is exactly opposite the Six Mile Creek gap, and was undoubtedly formed from materials washed through that gap. Its average elevation above the lake bottom is 10 feet, frequently rising along its margin to twice that height.

THE WABASH-ERIE CHANNEL

Is a part of the axial channel of the Wabash-Erie trough, and once carried the waters of the Maumee Lake to the Wabash River. It begins in section 3, Adams, where between the before mentioned angle of the Hicksville ridge and the margin of the New Haven delta it has a width of only half a mile; but to the margin of the St. Mary's ridge is a mile and a half. Thence westward four miles to Ft. Wayne, the channel cuts through the St. Mary's and St. Joseph moraine, and narrows to a width of five-eighths of a mile. This portion is bordered on the north by a prolongation of the Hicksville ridge, and on the south by the cut edge of the moraine which rises in the city to a bluff 50 feet high. At the western border of the moraine the channel turns to the southwest in a line which is a direct continuation of the valley of the St. Joseph River. For the next eight miles it is one mile wide, and has for its northern bank a line of bluffs 60 feet high, formed by the border of the Wabash-Aboit moraine. The Wabash & Erie Canal follows closely the foot of these bluffs. It is bounded on the south by a system of kames hereafter to be described. In section 35, Aboit Township, it is joined from the east by a former channel of the St. Mary's River, and its width is increased to a mile and a half. It then turns westward along the south line of that township and cuts through the Wabash-Aboit moraine. Here it again narrows to one mile, and its banks attain their highest elevation, the bluffs on either side at the mouth of the Aboit River being more than 100 feet above the present bottom of the channel. On entering the northeast corner of Huntington County it curves southward along the western face of the Wabash ridge, to the south line of Jackson Township, where it turns again westward. Just above Huntington it expands to a breadth of more than two miles, narrows again in passing the city, and enters the present Wabash Valley two miles below.

The Wabash-Erie channel has a total length of 30 miles, two-thirds of which is occupied by a marshy prairie and traversed by the insignificant

Little Wabash, or Little River. The peat bed is about four feet thick and underlaid by blue clay. At Lewises' ford, three miles above Huntington, the peat and clay end, and below there the bottom is of Niagara limestone. This channel was undoubtedly the avenue of escape for the waters of the Maumee Lake and the St. Joseph and St. Mary's rivers, and its level is about 150 lower than that of any other pass crossing the divide out of the Erie basin. The present level of its bottom rises from 737 feet at the mouth of the St. Joseph to 756 feet at the summit four miles west, then falls to 744 feet at the margin of the Niagara outcrop, and to 699 feet at its junction with the Wabash. The silt at the summit is about 40 feet deep, and if it were removed the summit of the rock bottom would be the limestone ledge at Lewises' ford. The water in this channel may have had originally a depth of 70 feet, and the river which post-glacial man may have seen there was comparable with the Niagara itself.

THE ST. MARY'S AND ST. JOSEPH MORAINES.

This is the longest and most important ridge in the Wabash-Erie region, and has been described by both Winchell and Gilbert; but concerning its course east of Lima, Ohio, they do not agree. From Lima it runs west and northwest along the right bank of the St. Mary's River to Ft. Wayne, thence northeast along the left bank of the St. Joseph to Hudson, Michigan. Winchell describes it as being "like a dead wave on the surface of the ocean, hardly perceptible to the eye on account of its smoothness, but revealed by its effect upon everything that encounters it." This effect is most striking upon the course of the St. Mary's River. Its headwaters in Auglaize and Mercer counties, Ohio, flow directly northward toward the Maumee until they encounter the ridge and by it are deflected to the west. The crest of the ridge can be easily traced upon the map, since it forms the watershed between the St. Mary's and the Auglaize at a distance of about 4 miles from the former and 30 miles from the latter. In Allen County the Wayne trace, or old Piqua road follows the crest. Its inner slope is gentle, its outer more abrupt, the fall from the summit to the St. Mary's at south line of Allen County being not less than 80 feet. In the southern townships the ridge is perceptible only upon the map, that is by its influence on the course of streams; but in Adams and Wayne townships it becomes rolling, with bluff margins, kames and other notable features of a terminal moraine. The inner margin has already been described from the center of Jefferson township to the Six Mile Creek gap. On the west side of that gap it begins near west line of section 15, Adams, and continues as a bold bluff 40-50 feet high across sections 9, 8 and 6 and through the city of Ft. Wayne to the point where the Wabash and Erie Canal (now N. Y., C.

and St. L. R. R.) crosses the St. Mary's. The peculiar features of the ridge south of that point will be described in another connection. The summit in section 7, Adams, is 76 feet above the mouth of the St. Mary's. The ridge is composed chiefly of bowlder clay with a border of sand and gravel around its northern end.

The St. Joseph Ridge is more simple in structure and direct in course than its southern complement. It extends from Ft. Wayne along the left bank of the St. Joseph River beyond the borders of Michigan. It fills the space between the river and the Hicksville Ridge. In Indiana its breadth is four miles, but it widens toward the north. It is a slightly rolling strip of country, which occupies the greater part of the Townships of St. Joseph and Springfield, and a portion of Cedar Creek and Scipio. According to ditch levels the crest is 50 feet above the Maumee Lake bottom in St. Joseph, and 70 feet in Springfield. The following levels show the very uniform longitudinal slope of the ridge from the extremities toward the apex :

Hudson, Lenawee County, Mich	927 feet.
Summit west of Bryan, Williams County, Ohio	873 "
Summit west of Hicksville, Defiance, Ohio	849 "
Wabash-Erie channel, head of Maumee River	737 "
Summit east of Ft. Wayne, Allen County, Ind	813 "
Summit, section 32, Madison, Allen County, Ind	846 "
Two miles south of Spencer, Allen County, Ohio	872 "
Two miles south of Lima, Allen County, Ohio	895 "
One mile north of Hog Creek Marsh, Hardin County, Ohio	914 "

If there was ever any reason to doubt the morainic character of the St. Mary's and St. Joseph Ridge, there can be none now, since its connection with the great morainic system of North America is evident. The shape and position of the ridge, regardless of its structure, show it to be a terminal or frontal moraine of the Huron-Erie ice lobe, and to mark the position where the ice-foot halted for a time in its retreat toward the Canadian highlands. It is simply a place where the bowlder clay is 50-75 feet thicker than usual, and there is no evidence to support the conjecture of Gilbert that it is the surface manifestation of a buried mass of material different from the common drift of the region.

THE ST. MARY'S BASIN.

The St. Mary's River rises in Auglaize County, Ohio, and follows the outer face of the St. Mary's moraine for about 60 miles. Near the center of Wayne Township, Allen County, Ind., it cuts through the apex of the moraine, emerges from it in section 10, and follows thence the southeast bank of the Wabash-Erie channel to its junction with the St. Joseph. It is a sluggish, muddy stream, without bluffs or flood plain, the

highest water seldom being more than sufficient to fill its channel. Its minimum flow is estimated to be from 1,500 to 2,000 cubic feet per minute.* Its basin lies almost exclusively upon its left bank, and consists in Indiana of a strip of flat country 10 or 12 miles wide, lying between the St. Mary's and the Wabash ridges. In its lower course the river has been tossed about from one channel to another repeatedly. The Six-Mile Creek channel is probably the oldest and has already been described. A second abandoned channel leaves the river at the southeast corner of section 22, Wayne township, turns southwest across sections 28, 29, 30 and 31, Wayne, and 36 and 35, Aboit, where it joins the Wabash-Erie channel. It now forms an arm of the prairie 6 miles long, half a mile wide, at a level 15 feet above the present bottom of the river. A third and later channel at a lower level leaves the river one mile below the second, and passes directly westward through sections 21 and 20, to the Wabash-Erie channel. It is two and a half miles long and a quarter of a mile wide. The greater part of the triangular space between the second St. Mary's channel and the Wabash-Erie channel is occupied by a system of sand ridges, which form a projection from the apex of the St. Mary's moraine, and a continuation of the kames, which are a part of that moraine. For convenience of description I shall call them all kames, leaving the question of their true nature for future discussion. On the east the system is almost continuous with the Van Wert ridge.

Kame No. 1 forms the western wall of the Six-Mile Creek gap in section 15, Adams. It is 20 rods wide, 20 feet high, and half a mile long, composed of gravel in anticlinal stratification. It is a reduced counterpart of the recurred western end of the Van Wert ridge.

Kame No. 2 lies upon the summit of the St. Mary's ridge, in the eastern part of the city of Ft. Wayne. It is a broad sand ridge extending from the east line of section 7, Adams, westward a mile and a quarter. It has been leveled for the new freight yards of the Pennsylvania Co., but west of the railroad it rises into a conical hill 30 feet high.

Kame No. 3, very symmetrical and quarter of a mile long, lies north of and parallel with No. 2, just east of the center of Section 7.

Kame No. 4 begins near the crossing of the Wabash & Erie Canal (now the N. Y. C. & St. L. Railroad), over the St. Mary's River (west end of Berry street, Ft. Wayne), and extends thence as a massive ridge of sand and gravel southward a mile and a half. It has been extensively excavated for gravel by the P., Ft. W. & C. R. R. Co., and is cut through along the Wabash R. R. by the valley of Shawnee run. An eastward branch crosses the Bluffton road (Broadway) just south of Creighton avenue. It fades out in the east half of section 15, Wayne, between the St. Mary's River and the Bluffton road.

*Report of Maj. John M. Wilson, Engineer Corps of U. S. army to Secretary of War, 1880, p. 60.

Kame No. 5 lies on the west side of the river in the west half of section 15, upon the Allen County Poor Farm. It is an irregular, curved and branched ridge of sand extending southward one mile. Where the river abuts against it the bank is 30 feet high.

The remaining kames are of fine, light yellow sand, without admixture of gravel or bowlders, and wholly unstratified.

Kame No. 6 lies west of No. 5, in the north halves of sections 21 and 20. It is very irregular and built upon three parallel axes, but is not complete on either. Two branches extend north into the southeast quarter of section 16, and in the northwest quarter of section 21 it is broken up into conical hills. At the west end it is broad and slopes gently into the Wabash-Erie channel, above which its highest points are 30 feet.

Kame No. 7 begins in a broad mass occupying nearly the whole of the southwest quarter of section 22, and sends two branches westward 40 to 50 rods apart. The south branch extends along the south line of section 21, and disappears at its west line. It is quite regular and 15 feet high. The north branch is low, broad and irregular, until at a point opposite the west end of the southern branch it suddenly rises to 30 feet, and is thence very strong to the middle line of section 20, where it has a double end like a thigh bone.

Kame No. 8 has two branches which separate at the center of the northwest quarter of section 29, and diverge eastward to the east line of the section.

Kame No. 9, three-quarters of a mile long, lies a little north of the center line of sections 29 and 30.

To this system belong several small islands in the Wabash-Erie channel. The Wabash R. R. crosses one in the northwest corner of the southwest quarter of Section 20, and another, Midway Island, a half mile long, in the west halves of Sections 19 and 30. The largest, known as Fox Island, in Sections 25 and 26, Aboit, is more than a mile long and a half mile wide.

Kame No. 10, on Fox Island, is the last and most remarkable one of the system. A beautifully symmetrical ridge, lithe and graceful as a serpent, sweeps in a gentle curve like the Italic letter *S*, or like the human clavicle, westward through the south half of Section 25, three-fourths of a mile long, twenty to twenty-five feet high, and as steep as sand can be piled. Near the west end it sends two parallel branches southeastward. Further west in Section 26, is a straight ridge parallel with these branches, nearly as long as the main ridge, and extending into the southern peninsula of the island. Between the two is an oval, land-locked bay. North of the east end of the main ridge lies a broader and more massive ridge one-fourth of a mile long. The two touch at their eastern extremities but diverge westward. These ridges form the skeleton of the island, the

shore lines being filled out in general conformity to them. Fox Island is covered with a light growth of oak, and with the water restored to its bays, would form one of the most charming and unique parks in the world. It is now accessible only to the pedestrian.

The system of ridges just described presents considerable variety of structure and a remarkable gradation between the extreme forms. The Van Wert ridge is plainly a beach deposit, but its western end is 35 feet high, very steep, and bent back southward. All its features are repeated in Kame No. 1, and an examination of the spot, or even an inspection of the map, gives a strong impression that something more unyielding than water must have passed southward through the Six-Mile Creek gap. Kames 2 and 3 are not upon the margin, but upon the summit of the moraine. Nos. 4 and 5 again are marginal, also curved, branched and transverse to the general direction of ice motion. The others are parallel to that direction. No. 6 is broken up like a typical kame, while No. 10 is, in shape and direction, a typical osar. The various forms run into each other so completely that it is impossible to make any but arbitrary distinctions. The series from No. 5 to No. 10 is embraced between and threaded by present and former channels of the St. Mary's River, and the whole region bears the relation of a delta to that river. The river may have furnished the material but it could never have put it into its present shape. The popular notion that these ridges were blown up by the wind is obviously untenable. That they were in some way produced by sub-glacial streams, or in dry tunnels under the ice, seems most probable. The materials may have fallen in from the top as observed by Professor Wright in the Muir Glacier of Alaska,* or it may have been squeezed up from below like the "creeps" in coal mines. The problem of their origin is a puzzling one, and I may be permitted to add my conjecture. The sight of two road scrapers running side by side, and a few feet apart, suggested a possible explanation. Suppose a fissure or tunnel in the glacial mass a few rods wide at the bottom, the motion of the ice would not be exactly parallel and uniform upon both sides of it, and partly by the enormous pressure, and partly by the differential motion, the material of the ground moraine would be squeezed, scraped and plowed up into a steep, symmetrical, continuous and unstratified ridge like the Fox Island kame.

THE ST. JOSEPH VALLEY.

The St. Joseph River rises in Hillsdale County, Michigan, and after flowing in a very direct course southwestward 75 miles joins the St. Mary's at Ft. Wayne, and its waters turn back upon themselves through the Maumee channel. Originally it did not do so, but continued its di-

*American Journal of Science, January, 1887.

rect course through the Wabash-Erie channel to the present Wabash River. The main stream of the Wabash was then a large River for 100 miles above Huntington, to which the present upper Wabash was a small tributary. The basin of the St. Joseph lies almost wholly upon its right or western bank, its largest tributaries rising from the Saginaw-Huron interlobate moraine of Chamberlain, in Steuben and Noble counties. Its minimum flow is estimated by Major Wilson to be 4,000 cubic feet per minute. The river is narrowly hemmed in between the St. Joseph moraine on the east and the Wabash-Aboit moraine on the west, the space between averaging less than half a mile wide. Its bed is largely of sand and gravel, and its water much less muddy than that of the St. Mary's. Its valley is bounded by an almost continuous line of bluffs, and numerous terraces reveal its former breadth and higher level. Its waters now rise occasionally to a level less than ten feet below the summit of the divide in the Wabash-Erie channel. Its basin and tributaries will be further described in the next section.

THE WABASH-ABOIT MORAINE.

The Wabash Ridge of Winchell is described as lying along the north side of the Wabash River in Mercer County, Ohio, and extending eastward even as far as Crawford County. It was supposed by him to fade out toward the west, but in fact the Wabash Ridge in Indiana is more strongly defined than the St. Mary's. I have not examined it in Adams County, but in Wells County the levels of the Ft. W., C. & L. R. R. show, in the distance of two miles from the summit at Murray Station to the river near Murray Village, a fall of 80 feet. From this point I have traced the outer face of the ridge across sections 8 and 6, Lancaster, 37 and 30 Jefferson, and 25, 24, 13, 14 and 15, Union Township. It forms a line of bluffs often very steep, averaging 50 feet in height, and rising at some points 20 feet higher. From section 16, Union, the bluff fades out into a gentle southwestward slope, across which Langlois Creek cuts transversely. The Wabash River now leaves the ridge at Murray, and flows nearly westward, but it once followed the bluff closely to the Wabash-Erie channel. Two miles below Murray the old channel leaves the present river and runs northward to the south line of section 26, Union, where it joins the channel of Flat Creek, which is amply capacious to carry a river the size of the present Wabash at Murray. From the mouth of Flat Creek (section 2, Union Township, Huntington County), the bank of the Wabash-Erie channel is high and bold, and is formed by the outer force of the Wabash Ridge as far as the northeast corner of Huntington County. The inner margin of the Wabash ridge, in Allen County, is not bold, but can be easily traced from Zanesville northward into section 22, Lafayette, thence trending east of north to the north line

of the township, along which the ridge is cut transversely by the Wabash-Erie channel. On the borders of the channel lies a series of ridges and hills, one of which, in section 8, rises at least 125 feet above the level of the channel. The material is everywhere boulder clay.

The existence of a northern wing to the Wabash ridge seems never to have been noticed previous to the present survey; yet it is the most massive and strongly characterized of all the morainic ridges in the Wabash-Erie region. It extends along the west side of the St. Joseph River from Hillsdale County, Michigan, to the Wabash-Erie channel in Aboit Township; I shall call it the Aboit ridge, and the two together the Wabash-Aboit moraine. The Aboit ridge is bounded on the west in Allen County by the valley of the Aboit River and the marshes about the head waters of the Aboit and Eel Rivers; in Dekalb County by the valley of Cedar Creek; in Steuben County by the valley of Fish Creek, and in Ohio and Michigan by the valleys of other tributaries of the St. Joseph. All these streams behave in a peculiar and remarkable manner. They rise from the Saginaw-Huron interlobate moraine, flow southeast six or eight miles, then, on striking the western face of the Aboit ridge, they turn southwest parallel with it, and after pursuing that course ten to fifteen miles, they turn again at a right angle and cut through the ridge to the St. Joseph River. The interval between the Saginaw-Huron moraine and the Aboit ridge is in Steuben County one mile, in Dekalb County three or four miles. The Aboit ridge in Allen County has a width of from five to six miles and occupies a portion of Aboit and Wayne Townships, nearly the whole of Washington and Perry, and more than half of Cedar Creek. In Dekalb County its width is from six to eight miles. It is crossed by several railroads. Near its southern extremity the levels of the N. Y. C. & St. L. R. R. show a rise from the Wabash-Erie channel to the summit one mile east of the Aboit river of 98 feet, and thence to the Aboit a fall of 50 feet. The P., Ft. W. & C. R. R. rises from the channel to the summit near Hadley, section 36 Lake, 85 feet, thence the Aboit falls 36 feet. The P. R. and I. R. R. crosses it diagonally, and rises from the channel to the summit north of Wallen 121 feet, thence falls to the marsh near Hunteertown 50 feet. The B. & O. R. R. rises from the St. Joseph River at St. Joe, Dekalb County, to the summit one mile east of Auburn Junction, 110 feet, thence falls to Cedar Creek 48 feet. The general elevation of the Aboit ridge above the St. Joseph River is in Indiana about 100 feet, and above the interval in the west 50 feet, the crest being usually within one mile of the western margin.

It is a broad rolling table land, the chief material of which is gravelly clay; but mounds, patches and ridges of sand and gravel are abundant, especially in Perry township. In northeastern Dekalb County Fish Creek crosses it through a gorge fifty feet deep, flanked by extensive terraces of sand and gravel. In central DeKalb it is flat and swampy, but

in the southern part of that county it becomes ragged and broken. In the northern part of Allen county it is crossed by Cedar Creek through a gorge 50 to 100 feet deep, and 800 to 1,000 feet wide. At the bend of the creek, in sections 3, 10 and 11, Perry, the ridge rises to an extraordinary elevation. Here "Dutch ridge," 50 feet higher than the general level to the north and 100 feet above the creek, extends east and west about two miles. The highest point near northwest corner of section 11 is more than 900 feet above sea level and the highest land in Allen county. Duncan's Lake, section 31, Jackson township, DeKalb county, 80 acres in extent, is the largest lake upon the ridge. In sections 7 and 8, Cedar Creek, Viberg's Lake contain 40 acres. In the northeast corner of section 7, Hollopeter's Lake of three acres is 40 feet deep and fed by copious springs at the bottom. On the same farm, but in section 12, Perry, is a little gem which exhibits in miniature the typical character of a morainic lake. It is a perfect oval in outline, about one acre in extent, and is like a crystal mirror set in an elaborate frame. At the edge of the water is a gold and purple rim of *nuphar* and *pontederia*; outside that a strip of pale grayish green shrub, with procumbent branches; then a fringe of higher shrubbery, willow and the magnificent *rhus venenata*; outside of that a straight impenetrable wall of vivid green formed by the tamaracks, *larix Americana*, 40 feet high. The lake was formerly 30 feet deep, but a ditch has lowered the level of water and shores six feet. It is surrounded by an extensive peat bog, which on account of the draining away of the water has settled, forest and all, leaving cracks a foot wide running parallel with the shores and encompassing 15 acres. Other morainic lakes differ from this in size, depth, regularity of outline, and continuity and extent of bog; but they all show various stages of progress from a clear, open kettle of water to one entirely filled with peat; from a living lake to an extinct one.

The winding ridges, rounded domes, conical peaks, mounds and hollows which figure so largely in the moraines described by Chamberlain, Cook, Lewis and Wright are not wanting in the Aboit moraine, but are of a subdued type. Characteristic moraine features are present on a small scale. Lindenwood Cemetery, section 4, Wayne, owes its charming beauty to this style of topography, and the same structure prevails over a large part of northern Wayne, Washington, Perry and Aboit townships. At the forks of Spy Run (sections 26 and 27, Washington) there is an extinct lake one mile long and half as wide. Kettleholes occur everywhere, many being shallow, saucer-shaped depressions which have been artificially drained and are now marked only by a few tufts of marsh grass. Upon the bluff near the mouth of the Aboit River (sections 29 and 32, Aboit) there is an interesting group of typical potash kettles, seven within a space of about 30 acres. The largest forms an irregular depression 750 feet long and from 100 to 200 feet wide. The rest are

smaller, of oval or circular outline, and about 20 feet deep. Most of the streams which drain the moraine flow at the bottom of gorges of which they now occupy an insignificant portion. Boulders are common everywhere, but are especially abundant along the outer or western edge of the moraine and in the channels of the streams. They are of all sizes up to ten or twelve feet in diameter. The materials are mostly metamorphic, granite, syenite, gneiss, quartzite, conglomerate, slate and divrite, among which a very compact, fine-grained green diorite is most common. All are much worn, some being rounded and polished like a billiard ball, and many planed and striated. Fragments of Huron shale are occasionally found, and fossiliferous limestone occurs in small pieces. The gravel of the clay is often highly calcareous.

ELEVATIONS ON THE WABASH-ABOIT MORAINE.

Osseo, Hillsdale County, Michigan	1,113 feet.
Summit E, of Auburn, Dekalb County, Indiana	900 "
Dutch Ridge, Allen County, Indiana	923 "
Summit M, of Wallen, Allen County, Indiana	887 "
Hadley Station, Allen County, Indiana	853 "
Summit N. Y. C. & St. L. R. R., Allen County, Indiana	865 "
Wabash-Erie channel mouth of the Aboit, Allen County, Indiana . .	746 "
Bowman's Sec. 8, Lafayette Township, Allen County, Indiana	873 "
Summit near Murray, Wells County, Indiana	874 "
Summit C. R. & Ft. W. R. R., Adams County, Indiana	865 "
St. Mary's, Auglaize County, Ohio	894 "
Wassakonetta, Auglaize County, Ohio	923 "
Kenton, Hardin County, Ohio	941 "

THE ABOIT AND EEL RIVER REGION.

This region in the northwestern part of the county occupies the townships of Lake and Eel River, and small portions of Aboit and Perry. The lower Aboit River flows through a narrow valley which grows deeper toward the mouth, where it becomes nearly 100 feet in depth. In Lake and Eel River townships the valley broadens to five or six miles, and is occupied by marshy prairie, mostly in wide, tortuous channels with tongues, peninsulas and islands of dry land between. Lakes, living or extinct, are numerous, the largest being Hull's, or Mud Lake, in section 8, Lake, about 150 acres in extent, and White Lake, section 3 Eel River, one-fourth as large. The northwest corner of Lake and northwest half of Eel River lie upon the borders of the Saginaw-Huron inter-lobate moraine, and are quite rolling, the latter being even hilly. The islands and peninsulas upon the western side of the marsh present very curiously and distinctly the morainic topography of mound and hollow upon a miniature scale. The boundaries of marsh and dry land are too irregular for de-

scription and can be delineated only upon a map. This variety and irregularity render Eel River Township the most picturesque portion of the county. In sections 13, 14, 23 and 24 the prairie is two miles wide, the north shore being a bluff of 30 or 40 feet in height, from which the view southward across the marsh, sprinkled with wooded islands and projecting points, is worthy of an artist's pencil. The northern portion drains through Willow Creek into Cedar Creek by a channel 20 feet deep and 300 feet wide, the remainder drains into Eel River. The water-shed between the latter and the Aboit is a scarcely perceptible ridge. It is now difficult to determine which way the water does flow or ought to flow, and there is no perceptible reason why Cedar Creek may not once have emptied into Eel River, or the Aboit. Certainly it is impossible to conjecture why its waters should have turned aside from this easy outlet. The present stream would be utterly powerless to excavate the gorge which it occupies through the Aboit ridge. That gorge must be as old as the ridge itself, and must owe its origin to the same conditions and agencies.

GENERAL CONSIDERATIONS.

The peculiar topography of the Wabash-Erie region in Indiana would be strikingly shown by a section along any line radiating southwesterly or northwesterly from Paulding, Ohio. Such a line would run nearly level across the Maumee Lake bottom to the Van Wert and Hicksville Ridge, thence rise 80 or 100 feet in four or five miles to the crest of the St. Mary's and St. Joseph moraine, then fall 50 feet in about one mile, then cross a level interval of from one to ten miles, then show a second gradual rise and more abrupt fall, across the Wabash-Aboit moraine, the second terrace averaging about 60 feet higher than the first. In the southern portion two more similar terraces lie beyond the Wabash Ridge. A portion of one has been described by Winchell under the name of the St. John's Ridge, and is said to extend from the southeast corner of Allen County, Ohio, southwesterly through Auglaize and Mercer Counties to Fort Recovery, where the Wabash River passes through it. D. S. McCaslin has described* its continuation through Jay County, Ind., north of the Salammine River; also, a ridge known as "Lost Mountain," in the southern part of the same county on the north bank of the Mississinewa River. They are precisely similar in character to the St. Mary's and Wabash Ridges. The levels of the Ft. W., C. & E. R. R. plainly reveal their presence in Wells, Blackford and Delaware Counties, and the courses of the Salammine and Mississinewa indicate that they extend along those rivers, as the Wabash Ridge does along the Upper Wabash, nearly to their junction with the axial stream. The corresponding

*Twelfth Report Ind. State Geologist, p. 155.

northern wings, if such exist, must be crowded together in northern Huntington and Wabash and in Whitley Counties, or merged with the Saginaw-Huron interlobate moraine in Steuben, Dekalb and Noble Counties. The remarkable accumulation of bowlders in the Wabash-Erie channel at and above Huntington may indicate the point where that channel cuts the Salamonie Ridge. The Wabash River probably cuts the Mississinewa Ridge near LaGros. Without having examined every mile of the ground, the writer deems the evidence sufficient to justify the statement of the following conclusions :

1st. The Wabash-Erie channel between the Ohio State line and the west line of Wabash County cuts through four morainic ridges at regular intervals of 12 or 15 miles.

2d. In passing the ridges its direction is from east to west; between them from northeast to southwest.

3d. The principal non-axial streams of the Wabash-Erie region flow along the outer faces of terminal moraines of the Huron-Erie glacier.

If Chamberlain's distinction be maintained and the word *terminal* be used to designate only that moraine which marks the extreme limit of the ice sheet, then the Wabash-Erie ridges are *peripheral* or *frontal* moraines. They probably belong to the later stages of the second glacial epoch, during which, according to Chamberlain and Salisbury,* there was a succession of glacial retreats and re-advances; and who can assert with any confidence that they were not made by the advance of four distinct and successive glaciers, and are thus *terminal* in the strictest sense? It seems more probable, however, that they are moraines of recession and mark halting places in the retreat of one and the same ice-lobe. When their uniformity of mass, strict parallelism and occurrence at regular intervals are taken into account, the whole arrangement will perhaps prove to be unique among the glacial phenomena of North America. Their greatest importance lies in the evidence which they afford of regular periodical oscillations of climate. The outer edge of the ice-lobe occupied a certain position long enough to form a moraine five miles wide and 100 feet high; it then fell back fifteen miles and occupied another line long enough to form a similar moraine. These alternating halts and retreats were repeated four or five times, the last retreat being 30 miles, and the last moraine, the Blanchard ridge of Winchell, being smaller and less symmetrical.

The general interpretation of the phenomena of the drift in the Wabash-Erie region is obvious. A portion of the great continental ice sheet, driven against the hard limestone of northwestern Ohio, emerged from the Huron-Erie basin and deployed upon the plain to the southwest. It was compelled by a *vis-a-tergo* to move up a gentle slope, and like a

*6th Annual Rep. U. S. G. S., p. 315.

mountain stream which has reached the plain, it ceased in great measure to erode its bed, and, to a corresponding extent, began to deposit its accumulated materials. The deep and comparatively uniform mass of drift in northern Indiana bears the relation of a delta to the ice stream. That deposit took place by simultaneous surface melting, ground melting and interior decay is a conclusion almost unavoidable. To suppose that a *glacial condition of climate* ever actually existed in Indiana is as unreasonable as to suppose that it now exists at the *foot* of the Alps. If such had been the case the ice mass would have been thickening in this region instead of thinning, and would have extended far south of the Ohio River. The moraine material of Western New York, Wisconsin and other localities has exactly the appearance of having been *dumped* from above, and its contours could be easily imitated by depositing upon a nearly level surface successive loads of sand, gravel and clay, the loads being extremely variable in size and placed at very irregular intervals. This would necessitate a great relative thickness of ice and the existence of much surface debris. In the Wabash-Erie region this tumbled topography is nearly wanting, and the uniformity of surface, broken only by the long, symmetrical slopes and curves of the moraines, indicate that the ice sheet was comparatively thin, and that its deposit was chiefly subglacial and marginal. The first glacial mass rested upon and passed over the bed rock, forming the characteristic striæ found in so many localities. In consequence of an *ameliorating climate about the sources of the ice-stream* in the northeastern part of the continent, that stream dwindled in size or disappeared entirely. Upon the recurrence of glacial conditions another invasion or invasions occurred from the same source. Whether the glacier which formed the Wabash-Erie moraines was the second or the twenty-second it may be now impossible to determine. Whatever the number, each would obliterate, as far as it went, the distinctive traces of previous glaciers, and each would pass over, push along, heap up and rearrange the material left by its predecessors. The outline, directions and extent of the last one are revealed by the moraines. The southern portion was allowed to expand with considerable freedom, but on the northern side of the trough in Indiana it met some obstruction, probably the lateral edge of the Saginaw glacier, by which it was crowded back and heaped up, and the principal axis of flow was thrown ten to twenty miles south of the axis of the trough. During the melting of the ice certain great drainage channels were kept open by the floods of water, such as the Wabash-Erie channel, the gorge of Cedar Creek, and others which cut directly through the moraines. At the same time temporary lakes, extra, intra and inter-morainic were formed, the most considerable of which, the Maumee Lake, lay at first between the St. Mary's and St. Joseph moraine and the retreating edge of the glacier, afterward between that ridge and the Blanchard moraine. When the ice dam had retreated

to a position near the present foot of Lake Erie, the Van Wert and Hicksville ridge may have been, for a short time, the shore of a body of water which included both Lake Erie and Lake Huron, and stood at a level about 200 feet higher than those lakes do at present. At that stage the Maumee River, of course, had no existence, the principal drainage system being the St. Joseph-Wabash, into which the Maumee-Erie lake discharged at Ft. Wayne, and to which the present St. Mary's upper Wabash, Salamonie and Mississinewa were unimportant tributaries.

PRE-GLACIAL GEOLOGY.

Concerning the rocks which immediately underlie the drift in Allen County very little is known. In the southern part they are probably upper silurian of the water-lime or Niagara group, and in the northern part almost certainly devonian, Huron shale and Corniferous limestone, but the position of the partings is purely conjectural. The chapter upon outcrops in Allen County is as short as the famous one upon snakes in Ireland. Rumors have been afloat of the existence of quarries in several localities, but upon the spot they have proved to be doubtful or wholly mythical. In 1860 Richard Owen, then State Geologist, visited a quarry in the northeast quarter of section 35, Adams, and reported the evidence as being indecisive in regard to the geological horizon of the rock.*

A search of this quarry resulted in the discovery of a "wallow-hole" in a pasture, three feet deep and twenty in diameter, where numerous small fragments of limestone were imbedded in the mud. The owner of the farm, Mr. A. J. Akey, said he had obtained from it stone enough for the foundation of his house, also several piles which lay in his yard, and that it was originally in slabs six feet by ten and eight to twelve inches thick. The fragments found were crystalline and fossiliferous brown limestone, with bituminous lignitic partings. One small fragment shows a perfectly glaciated surface. Of the fossils, only *strophodonta profunda*, *spirifera radiata* and a gibbous *orthis* were recognizable. In the uppermost rock borings from an artesian well in White's addition, Fort Wayne, occurred a few fragments of black shale (Huron); it is probable that Fort Wayne is situated very near the boundary between the silurian and devonian beds.

Of deep borings in Allen County there are nine (to September 1, 1888), six being within the limits of the city of Fort Wayne, and three within a radius of four miles from the city. The first well was sunk for artesian water in the Court House square in 1875, but without success. The others have been drilled within the past three years in the search for natural gas. They all pass through the same strata and show only trifling variations of thickness and level.

*Ind. Geological Report, 1869-60, p.

SECTION OF "ARTESIAN WELL" BORING, COURT HOUSE SQUARE, FORT WAYNE.

Surface of ground		772 feet above sea level
Drift	88 feet to	684 " " "
Limestones (Niagara)	802 "	118 " below "
Gray shales (Hudson)	260 "	378 " " "
Black shales (Utica)	260 "	638 " " "
Limestones (Trenton)	1,590 "	2,228 " " "
Total depth	3,000 feet.	

Sections of several other borings are practically identical with this, and the extreme variations from it may be accounted for by differences in level at the surface, which at other wells has not been determined. The results, so far as gas is concerned, are practically negative, one well, near the Berghaff brewery, furnishing gas enough to run an engine, the others none. The citizens of Fort Wayne have expended \$20,000 in the effort to obtain natural gas; they have persevered in spite of discouragements from the beginning; the territory in the immediate vicinity of the city has been thoroughly tested; further attempts seem hardly justifiable and probably will not be made. At the same time it is being demonstrated that a city surrounded by towns with gas can be prosperous and enjoy a rapid and healthy growth without it.

A boring near the bank of the Maumee River, in White's addition, proved to be a genuine artesian well, and furnishes a large quantity of excellent water, which is at present unutilized.

Partial analysis of the water gives the following results:

Temperature in January	49° F.
Temperature in August	53° F.
Total solids in 1 wine gallon	32 grains.
Calcium carbonate	20.2 "
Calcium sulphate	0.9 "
Magnesium carbonate	3.5 "
Ferrous carbonate	1.7 "
Sodium chloride	0.7 "
Hydrogen sulphide	0.4 cub. in

ECONOMIC GEOLOGY.

Aside from numerous brick and tile works, and the excavation of moulding sand, there are no industries in Allen County dependent upon its geology, except agriculture. Although the extremes of level differ by not more than 150 feet, there is a considerable variety of surface, soil and natural products. The land may be divided into four classes,

1. *Lacustrine Land.* Lake bottom without muck. Soil clay, sometimes laminated, with occasional streaks and ridges of sand and gravel. Drainage difficult.

2. *Bottom or Muck Land.* Marshy prairies, occupying old drainage channels and the basins of extinct lakes. Soil black and mucky.

3. *Moraine Land.* High and rolling. Soil gravelly clay, with mounds and ridges of sand and gravel. Drainage easy.

4. *Inter-Moraine Land.* A combination of the other three, chiefly flat and low, resembling No. 1, but embracing large tracts of No. 2, with occasional areas of very subdued morainic type.

The location and limits of each of these classes have been sufficiently indicated in the foregoing description. Evidently, to the people of Allen County the subject of drainage is one of the very first importance, and perhaps in no other county has drainage been undertaken upon a larger scale. Numerous ditches intersect every township, and nearly every natural water-course has been improved for the purpose. The most extensive work of this kind is involved in the drainage of the large tracts of marshy prairie which exist in the county. The Eel River ditch, completed in 1887, is 11 miles long, and drains 3,000 acres in Lake and Eel River townships.

The drainage of the Little River Prairie, which occupies the Wabash-Erie channel, in Allen and Huntington counties, is a project which has been long contemplated; but the magnitude and difficulty of the undertaking were such as to defer effectual effort until the year 1881, when a bill was passed by the Indiana Legislature authorizing the survey of all large bodies of marsh land in the State.

Under this law a survey of the Little River region was made in 1882, by Dr. John L. Campbell, of the United States Geodetic Survey. His report to the Governor strongly recommended its drainage. In 1883 a number of interested landholders filed the proper petition, and after the necessary surveys and legal proceedings, a plan of drainage was finally adopted in 1886, which provides for a main ditch twenty-six miles long, with branches, which raise the aggregate to forty miles, the different portions varying in width from four to thirty feet. Outlet is thus furnished for the water which falls upon more than 200,000 acres of land; 35,000 acres of marsh will be converted into rich farming lands, and a prolific source of miasma will be removed, greatly to the improvement of the sanitary conditions of 50,000 people. The total expense of the undertaking will be about \$170,000, and the amount which it will add to the wealth of the community is estimated at \$320,000. The whole work will be completed in 1888.

NATURAL HISTORY AND ARCHÆOLOGY.

The fauna and flora of Allen County have not been studied in the thorough and systematic manner which their variety and importance deserve. The county was originally covered with a dense forest of oak, walnut, hickory, beech, maple, ash and elm. A few tracts of the primitive woodland still remain, and the rivers are bordered by as fine specimens of elm, cottonwood and sycamore, as can be found anywhere. Chestnut, pine and hemlock are entirely wanting. The tamarack flourishes upon the site of extinct lakes, and some of the bluffs of Cedar Creek are still covered with white and red cedar, *Cupressus thyroides* and *Juniperus virginiana*. The variety of soil offers favorable conditions for the growth of a great variety of plants. The Little River Prairie alone constitutes a botanical garden of no mean proportions. Enough has been done to show that the plant list of Allen County when completed will at least equal that of any other county in the State.

Of the numerous wild animals which once made Ft. Wayne an important fur-trading post, the largest, including the deer, bear and wolf, are nearly extinct. Occasionally a hunter's story of having seen or shot a deer or a bear in the black swamp, near the Ohio line, gets into the newspapers. Numerous dams still remain as monuments to the beaver. The wild turkey and the golden eagle are occasional visitors. Of semi-fossil remains, a single mammoth tooth, and portions of the skeletons of five mastodons have been discovered in various parts of the county. The plants, insects, mollusks, fishes, reptiles and birds offer to the naturalist a promising and but partially worked field.

The Mound-Builders left but scant traces of their occupancy in Allen County. Col. R. S. Robertson, of Ft. Wayne, who is an authority upon the subject, reports the existence of mounds or earthwork at seven points along Cedar Creek and the St. Joseph River, but none in the southern part of the county. The usual implements and ornaments belonging to the stone age are plentiful in many localities, but the writer is not aware that anything which throws new light upon the subject has ever been discovered in this region.

SECTION OF WELL BORED BY W. T. ABBOTT AT FORT WAYNE, INDIANA, 1888.

Drift	106 feet.
Limestone.	868 "
Shale	176 "
Black shale	257 "
Trenton limestone	493 "
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Total depth.	1,900 feet.

The well filled with mineral water from the bottom up to about 900 feet.

Report of analysis of mineral water from well of W. T. Abbott, by Chas. R. Dryer, M. D., analytical chemist.

Specific gravity at 18° C. (66° F.) 1.04 Reaction alkaline.

	<i>Parts per Million.</i>	<i>Grains per Wine Gallon.</i>
Sodium chloride	51,250.	2,993.793
Magnesium chloride	2,551.	148.825
Magnesium sulphate	2,456.	143.283
Calcium sulphate	355.	20.71
Calcium carbonate	10,240.	597.401
Potassium bromide.	93.75	5.469
Ferrous carbonate	362.	21.119
Silica, alumina and organic matter	750.	43.755
Nitrates and phosphates		Traces.
Total solids	68,057.75	3,974.355
Carbon dioxide	2.31	cub. in. per gal.
Hydrogen sulphide	2.3677	" "