REPORT UPON THE GEOLOGY OF STEUBEN COUNTY.

BY CHARLES R. DRYER.

Steuben County, situated in the extreme northeast corner of the State, is bounded on the north by Michigan, on the east by Michigan and Ohio, on the south by Dekalb County, Indiana, and on the west by Lagrange County. It is nearly twenty-one miles long east and west, sixteen miles wide from north to south, and comprises about 330 square miles. It includes the whole or a part of townships 36 and 38, in ranges 12 and 15, those in the northern and eastern tiers being fractional. For convenience the civil names will be used to designate the Congressional townships, as follows:

	R. 12.	*R.* 13.	*R.* 14.	*R.* 15.
Township No. 38,	Millgrove,	Jamestown,	Fremont,	Clear Lake,
Township No. 37,	Jackson,	Pleasant,	Scott,	York,
Township No. 36.	Salem.	Steuben.	Otsego.	Richland.

The first settlers in the county came to Jackson Prairie in 1831, and the county was organized in 1837, with Angola, a little south of its center as the county seat. But one railroad enters its limits, the Fort Wayne branch of the Lake Shore & Michigan Southern crossing from south to northeast. An extension of the Canada Southern was graded several years ago, along the southern border, and then abandoned.

Physically, Steuben County is wholly occupied by the moraines of the Erie, Maumee and Saginaw glaciers, two of which are clearly distinguishable, crossing it from south southwest to north northeast; consequently the bed-rock is covered with a very heavy mantle of drift, which is probably as thick as anywhere in the State, at least 300 feet, and possibly, in some places, twice that thickness. These moraines are not at all modest or obscure, but display their massive proportions and strong features in a manner unmistakable to the most hasty observer. A remarkable collection of domed hills and irregular valleys, each usually occupied by a lake, gives to the surface a picturesque diversity unparalleled in Indiana. The lakes constitute, both for the traveler and the scientific observer, the most attractive and interesting feature of the region. Their great variety in size, shape and character render this region one of the best in the country

for the study of morainic lakes, while their beauty and facilities for aquatic recreation render it delightful alike to the permanent resident and to the transient visitor. The area to be described comprises five natural divisions:

1. The Fish Creek Valley.
2. The Salamonie or Third Erie Moraine.
3. The Valley of Upper Pigeon River.
4. The Mississinewa or Fourth Erie Moraine.
5. The Region of Saginaw Drift.

THE WABASH-ABOIT OR SECOND ERIE MORAINE.*

This moraine touches the southeast corner of the county, and covers four or five sections of Richland Township.

The Fish Creek Valley comprises a portion of the townships of Richland and York. It is a level depression, about one mile wide, through which the stream meanders in a direction a few degrees west of south, from the southeast corner of York to the southeast corner of Otsego, where it is joined by the outlet of Fish Lake, and, turning abruptly to the southeast, cuts through the Wabash-Aboit Moraine to the St. Joseph of the Maumee. This valley forms a part of the interval between the second and third Erie Moraines, and is continuous with the more strongly marked interval occupied in Dekalb County by Cedar Creek.

The Salamonie or Third Erie Moraine† is a ridge of drift of extremely variable character, which extends from Mercer County, Ohio, along the right bank of the Salamonie River through the counties of Jay, Wells and Huntington, crossing the Wabash-Erie channel near Huntington City, and passes thence through the counties of Huntington, Whitley, Allen, Noble, Dekalb and Steuben to the northeast corner of the State. In Steuben County it comprises a belt about four miles wide, stretching from Clear Lake to Fish Lake and occupying the townships of Clear Lake and York, nearly the whole of Otsego, and portions of Fremont, Scott and Richland. This is by far the most strongly marked portion of the whole moraine. It is a belt of massive, rounded and dome-shaped hills, with moderate slopes, the valleys between being narrow and with no extensive marshes. Small kettle holes and large crystalline bowlders are numerous. The soil is chiefly bowlder clay, with occasional sand hills. The strongest features appear along the west shores of Fish Lake, where precipitous gravelly knobs, narrow ravines and innumerable dry kettle holes of all sizes monopolize the surface of the country. The whole topography probably lies within a vertical range of two hundred feet. A considerable tract around Cedar Lake is comparatively smooth and

* This moraine is fully described in the 16th Report of the State Geologist, page 119.
† Described in the Sixteenth Report of the State Geologist, p. 113.

covered with deposits of sand nearly worthless for agriculture. The greater part of this region presents one of the most beautifully diversified landscapes to be found in the State. At the same time the soil is the best quality of drift clay and the slopes are not too steep for agreeable farming. Magnificent forests of beech and maple timber still abound. It is strongly contrasted with the rest of the county by the absence of marshes and small lakes.

The Valley of Upper Pigeon River and its continuation in the sandy plain of western Otsego and eastern Steuben Townships constitute the interval between the third and fourth Erie Moraines. It is a very flat tract of country, three to four miles wide, in surprising contrast to the rugged hills on either side. It occupies the townships of Fremont and Scott and portions of Pleasant, Otsego and Steuben. This interval lies very near the crest of the Saginaw-Erie Moraine system, and has been largely filled up with overwash from both sides. It has been drained through transverse gaps in the range on the west, presently to be described, but at present has only one outlet. Pigeon Creek heads in Cedar Lake, sections 22 and 23 Fremont, once a large body of water, now buried under a muck meadow, and meanders southward to section 8, Otsego, where it turns westward and reaches the outlet gap at Pleasant Lake. It drains in its course several small marshy lakes in Scott Township, one buried or extinct in sections 2, 3, 10 and 11, one in sections 15 and 16, and Pigeon Lake, in section 20, also Johnson's Lake, in section 16, Otsego, and numerous tamarack swamps. The depressions are all shallow and mostly occupied by tamarack or other marshes of the "platter"-type. These are distinguished from the "kettles" and "bowls" charac' teristic of a moraine by their inconsiderable depth and indefinite margins. An extensive deposit of sand extends from Fremont village southeast three miles to the banks of the creek. In the eastern part of Steuben Township the valley becomes less distinguishable and merges into the relatively elevated plateau which forms the crest of the system in northern Dekalb. The Fort Wayne branch of the Lake Shore & Michigan Southern Railroad passes along the western edge of this valley and affords the following elevations:

Pleasant Lake	975
Angola	1,052
Fremont	1,055
State Line (Ray)	1,073

The same phenomenon of an elevated level interval along the western side of the morainic crest occurs also in western Whitley County.

The Mississinewa or Fourth Erie Moraine extends along the right bank of the Mississinewa River, through the counties of Jay, Delaware, Blackford, Grant and Wabash, crosses the Wabash River near La Gro, and extends thence through the counties of Wabash, Whitley, Noble and

Steuben. Like its neighbor on the east, it attains its highest elevation in Steuben County, where it occupies the greater part of the townships of Jamestown, Pleasant, Steuben and Salem, and a part of Jackson and Millgrove. It consists of an irregular range of knobs and hills, broken by transverse gaps into several groups, and interspersed with a great number of equally irregular lakes, among which are included the largest (with one possible exception) in the State. The southern section of this region lies in Salem Township, the southwestern part of Steuben and the southern half of Jackson. It is bounded on the north by the valley of Pigeon River, and on the south by that of Turkey Creek, both of which are depressed at least 100 feet below the general level. It consists of an elevated plateau comparatively level toward the south, but largely covered with massive hills of clay in the central portion, and of gravel with numerous bowlders toward the west line of the county.

The middle section in the townships of Pleasant and Jackson lies between the valley of Pigeon River and the basin of Centre, Crooked and Gage Lakes with their connecting streams. It is a region of knobs, gravel ridges, sand dunes, and medium sized lakes thrown together in extreme confusion. Its features are all on a moderate scale, but their variety and irregularity defy description. This portion of the moraine is bounded on the west by a valley of unique and interesting character, which seems to have been originally continuous from Hogback Lake to Gage Lake. It was probably once a large drainage channel through which the waters of the Pigeon River valley flowed to Crooked Creek, or *vice versa*.

Northeast of Hogback Lake the valley opens broadly to include Silver Lake and extensive bottom lands surrounding it, and sends an arm to the north occupied by Bass and Howard Lakes. Between the north end of Howard and the south end of Cheesebro and Grass Lakes, in section 24, Jackson, a gravel ridge a few rods wide and thirty feet high crosses the valley like an irregular railroad embankment or "fill." From this ridge the narrow valley of Grass Lake, 150 feet deep, extends northward a mile and a half, although the lake itself now consists only of a pool at the north end. On the north line of section 13, another gravel ridge is thrown across the valley, on the north side of which lies another small lake. A third and a fourth ridge, more massive than the others, with a third small lake between, separates Grass Lake from Gage Lake. Grass and the other two have no visible outlet. That the lakes of this chain occupy one continuous valley is obvious to any one who examines the region carefully, and that they are fragments of a once continuous body of water is equally plain. The original lake or stream has been dammed by subsequent intrusions of gravel and sand. This valley is an important feature in the topography, because it marks distinctly the dividing line between the Erie and the Saginaw drift. The

difference between the general *facies* of the country on opposite sides of it is easy to see, but difficult to describe. On the east the hills and dunes of the fourth Erie moraine are piled in indescribable confusion. The country on the west has about the same general elevation, and is distinctly morainic in character, but is very much smoothed out. The slopes, whether gentle or steep, are broad and plateau-like, their evenness being broken only by an occasional small kettle-hole. The difference may be compared to that between the plump, rounded and dimpled face of a child and the prominent features, harsh outlines and wrinkled skin of an old man.

North of Angola a level, sandy plain two miles wide is continuous on the east with the valley of Pigeon Creek, and on the west with the basins of Crooked and James Lakes. This plain and its western prolongation through Crooked and Gage Lakes, forms the southwestern boundary of the northern section of the fourth moraine. On the northwest this section gradually smoothes out in western Jamestown and eastern Millgrove, but on the north it is very abruptly bounded by a deep gorge which extends from section 30, Fremont, westward to the north end of James Lake. This is the culminating point of the moraine, both in massiveness, grandeur and absolute elevation. It is a roughly trapeziform mass of sand, gravel and bowlders about twenty miles in perimeter, piled up at the highest possible angles, and in the wildest possible confusion, its numerous peaks attaining an elevation of about 200 feet above the surrounding valleys. Near its northeastern angle the station of the United States Lake Survey, in section 31 Fremont, has an elevation of 1,141.5 feet above tide, and a higher point in section 1, Pleasant, attains an elevation little, if any, below that of the highest land in Indiana. In the midst of this elevated mass, the valley of James Lake, extends from the southern angle to the northern, cutting it into two nearly equal triangles. The descent to the lake, as well as upon the outer sides of the highland, is generally very abrupt.

The two ranges of hills just described are known to be Erie drift, because their connection with the moraines of the Erie system, south of the Wabash River, can be traced. The exact boundary line between Erie and Saginaw drift can be traced only in favorable localities like the Grass Lake Valley. For the most part no definite boundary exists, because the material from both sources was, to some extent, mingled together, both during the original deposit from melting ice, and still more by the wash of escaping waters. Probably that part of Salem northwest of Mud Creek and the southern half of Jackson owe the greater part of their soil to the Saginaw glacier, but the confusion is there too great for differentiation.

The Region of Saginaw Drift includes Millgrove and the north half of Jackson, the character of this region differs decidedly from that of the rest of Steuben County. The surface is almost uniformly level, or gently

rolling, broken only by a few bowldery knolls. The soil is a rich, sandy loam. Jackson Prairie, in sections 3, 4, 5, 8, 9 and 10, Jackson, comprises about three square miles of as beautiful rolling prairie land as ever lay under the sun. The remainder of the region was originally covered with "oak openings," grown up to bushes over which a wagon could be driven anywhere. The land was broken up with large plows, drawn by several yoke of oxen, and its agricultural character is still strongly contrasted with that of the heavy timbered lands. The soil is not so poor as the sand and gravel hills, nor so inexhaustible as clay or black land. It is quickly responsive to good treatment, which at first meant gypsum and clover. It will not bear deep plowing or abuse of any kind. It requires more careful and intelligent farming than the heavier and deeper soils, and crops of corn and wheat grow less rank, but, with proper management, more uniformly good returns can be obtained.

DRAINAGE.

Athough the relief of Steuben County is extremely diversified, its area thus falls into a few well marked natural divisions. The drainage, always intimately dependent upon the relief, of course conforms to it here, as upon every other portion of the earth's surface. Yet, the influence of conditions which no longer exist, but were dominant thousands of years ago, is so strong as to compel the streams apparently to violate the fundamental principles of hydrography, to behave in a manner largely independent of the topography, and to take courses surprisingly different from those which the prominent features of the region would lead one to expect. Two considerable ranges of hills cross the county in a southwest and northeast direction, yet the principal streams flow at right angles to these ranges toward the northwest. The higher range, the principal axis of the region, is scarcely a water-shed at all, and exerts but an insignificant influence upon the drainage. The large streams flow directly across it, through ample gaps, and do not appear to turn one foot to either side on account of it. Many of the smaller streams treat the lower range with equal indifference, so that the great water-shed in Steuben County, between the Michigan basin and the Erie basin, lies not upon the crest of a ridge, but along the border of a nearly level valley.

Again, the county may be nearly equally divided into two drainage areas—the southeastern, in which the principal streams flow parallel with the moraines toward the southwest, and the northwestern, in which they flow at right angles to the moraines toward the northwest. The L. S. & M. S. R. R. marks almost exactly the dividing line between these areas. In the first the streams occupy channels of their own making and of comparatively recent origin. In the second the streams and

lakes occupy channels which were lines of drainage during the glacial period, and once served to carry much greater volumes of water than at present. Here the valleys and streams are older than the hills, and have been open water-ways since a period before the great masses of sand, gravel and clay were piled up on either side of them. The most important of these water-gaps is the Pigeon-Fish Valley, which cuts through the entire morainic system from the St. Joseph of the Maumee to the St. Joseph of Lake Michigan. Its course across the moraines is thirty miles long, its average width about one mile, and its depression below the surface on either side varies within the limits of 150 feet. From a point midway of its length, in section 24, Steuben, it slopes gently both ways, carrying the waters of Fish Creek and its tributary lakes southeastward, and the waters of Pigeon River and its lakes northwestward. Into this valley Upper Fish Creek falls in Northeastern Dekalb County, and Upper Pigeon Creek, in section 14, Steuben, the latter stream rises in Cedar Lake, Fremont Township, near the northern border of the State, flows in a southerly direction twelve miles, and then turns westward; the result is that only the area of Steuben County occupied by the third morains is drained toward Lake Erie. In the southwestern corner of the county the valley of Turkey Creek and its connected lakes extends from Hudson, parallel with the Pigeon River valley, which it joins in Lagrange County. The third transverse valley opens from Pigeon Lake, section 29, Scott, through the basin of Centre, Crooked and Gage Lakes, connected by Concord Creek, to the Crooked Creek valley in section 22, Millgrove. The fourth valley, already partially described, begins south of Fremont village and extends westward to James Lake, where it joins a north and south depression occupied by the basins of George and James Lakes, and their connecting streams. This in turn opens into another valley which lies in the normal transverse direction and contains Jimerson Lake and its outlet, Crooked Creek, which pursues a course generally parallel and in close proximity to Pigeon River. This is still an important drainage channel, a rather swift stream, twenty or thirty feet wide and four or five feet deep; but its former superior dimensions are shown by the width of the bordering marsh, in many places half a mile.

THE LAKES.

No thorough and extensive examination of the lakes of Northern Indiana has ever been made. In 1875 Dr. G. M. Levette, of the Indiana Geological Survey, and Cable Cook, of Salem, Mass., made a hasty reconnoissance of certain lakes in Fulton, Laporte, Kosciusko, Noble, Lagrange and Steuben counties,* and determined to some extent their

*Seventh Report of the State Geologist, 1875, p. 469.

depth and temperature. In the summer of 1889, the writer made as careful a survey of the lakes of Steuben County as circumstances would permit, in which he tried to determine their origin, form of basin, character of bottom and shores, quality of water, sources of supply and the various agents which tend to their destruction, and to construct from these materials their life history in the past and the future. No more favorable region could have been chosen for the work. Within the area of Steuben County there are more than one hundred lakes which have names upon the map, an average of one to every three square miles. Probably no similar area possesses such a variety of lakes, or so many of the largest and finest of their kind, more than thirty of them exceeding half a mile in diameter. They are all intra-morainic lakes, lying within the mass of the moraine, and owing their origin to the irregular deposits of drift. The lake basins are the counterparts of the hills and knobs among which they lie, and may be regarded as huge kettle-holes with clay bottoms.

Along the northern border of the county are a few lakes which lie partly in Branch County, Michigan, and are drained through a channel parallel with Crooked Creek into the St. Joseph, near Three Rivers. Among these are the Walter's Lake, section 18, Fremont; Hog Lake, section 17, Jamestown, and Lake Pleasant, section 18, Jamestown, and 13 and 14 Millgrove. The latter is a mile and a half long by half a mile in width, with low and sandy shores. The northwestern half is less than ten feet deep, and most of the remainder is less than twenty feet deep. The deepest sounding was forty-two feet near the center of the southeastern half. Vegetation is scanty, as is usual in lakes with sand bottom, and confined to a few species of *potamogeton* and *scirpus*.

The Crooked Creek Chain of lakes begins with Lake George, the greatest part of which is in sections 14 and 15 Jamestown, and the rest in Michigan. It is slightly irregular in outline, about one mile in its longest diameters, with low bowldery shores, and clear, clean water. The northwest arm was not sounded, but is apparently shallow. The main body of water was found to have nearly a uniform depth of from 50 to 60 feet, sinking to 80 feet a little south of the center, the depth being far in excess of what might be expected from the character of the shore. This lake is famous for its eels, an accumulation of which amounting to 200 pounds once stopped the mill wheel at Jamestown. About twelve years ago Crooked Lake was planted with these fish, which have now become very abundant in all the connected waters, single specimens sometimes attaining a length of seven feet and a weight of ten pounds.

From the southwestern extremity of Lake George, Crooked Creek flows southward through a broad and beautiful valley, studded with clear pools of a few acres extent, one mile to the north basin of James Lake. Into this basin also enters from the east the outlet of the deep transverse

gorge, which bounds the northern section of the fourth moraine. This valley contains Marsh and the twin Otter Lakes, in sections 25, 26 and 27, Jamestown, the latter about one mile long, the former half as long. The whole valley for three miles east of James Lake was evidently once a continuous and open body of water. It is now a marsh in which the present lakes remain as pools. In the very heart of the hills, sections 35 and 36, Jamestown, lies the Failing group of lakes, originally a single body of water one mile and a quarter in length, now reduced by drainage to a chain of six:

Failing's Lake, 29 acres, 55 feet deep.*
Medsker Lake, 20 acres.
McClew Lake, 10 acres.
Hollis Lake, 8 acres.
Wooldridge Lake, 8 acres.
Whistler Lake, 12 acres.

The Failing chain presents in miniature all the characteristic features of a mountain lake. The highest peaks of the moraine look down upon it, and its shores rise very abruptly on all sides to a height of 200 feet or more. The basin opens out northward into the valley of Marsh and Otter Lakes.

James Lake, the largest in the county and equaled in size by but one other in the State (Turkey Lake, Kosciusko County), is a very irregular body of water, has a total length of five miles and an average width of half a mile. It lies in section 10, 3 and 4, Pleasant, and 33, 28, 27 and 21, Jamestown. It consists of five distinct basins, separated by narrow and shallow straits or by bars. The southern and largest basin is one mile by a mile and a quarter, with very irregular shores and bottom. The shores are abrupt, and upon the east side rise to a height of one to two hundred feet. Bold promontories, sequestered coves and precipitous bluffs give it an almost Alpine character. Three small islands stud its surface, and the water between varies from thirty to sixty-five feet in depth. Through a narrow strait on the west side, with a small island in its middle, the second basin is entered. This is more regular in outline, with a length of one mile and a maximum width of half a mile. The east shore is still very high and steep, and only a few rods from it sixty feet of water can be found. The greatest depth found was eighty feet. Northward it narrows to a strait, with only two feet of water over the bar, which opens into the third basin, which in shape, size and depth closely resembles the second basin.

Eagle Island, a high peak rising abruptly from the water, is a conspicuous landmark on the north shore. A few rods from its west side the deepest sounding in the lake was made, 87 feet. The island is now joined

*For these data I am indebted to Mr. Charles Young, whose farm borders upon the lakes.

to the mainland on the north by an extensive bog, but a narrow passage on the east side admits to the fourth basin, the longer axis of which extends northeast and southwest, and is continuous on the east with the valley of Otter and Marsh Lakes. Its depth varies from thirty to fifty-five feet. Deer Island, similar to Eagle, but smaller, a bog on the west of it, and a long bar, separate the fourth from the fifth and northernmost basin, which is larger than the fourth and of about the same depth. These two basins together are sometimes called Snow Lake.

James Lake has a head at both ends, and Crooked Creek flows out of it about midway of its length on the west side of the second basin. A navigable channel of less than half a mile leads to Jimerson Lake, the open water of which lies in the form of a St. Andrew cross, and from its center a beautiful view is obtained into the four arms, each about half a mile long. The depth varies from thirty to fifty-four feet. From the northwest extremity a narrow neck or finger reaches out a mile or more to Nevada Mills. The group of lakes including James and its companions furnish about ten miles of boating, every rod of which is rendered delightful by repeated surprises and a changing variety of picturesque scenes which rival on a smaller scale Lake George, the gem of the Adirondacks, and the famous Thousand Islands of the St. Lawrence. The region around it might be fitly characterized as the Alps of Indiana, and although Alpine only in miniature, is worthy to attract more attention than it has yet received. It needs only to be better known to become a favorite resort for many who now travel hundreds of miles in search of the beautiful and the picturesque.

A second chain of lakes belonging to the drainage system of Crooked Creek lies parallel with James and Jimerson on the south, and only about one mile distant. Its largest member is Crooked Lake, the best example of the bottle or gourd-shaped lakes. The main body lies in sections 8, 9, 16 and 17, Pleasant, and is nearly two miles long by one mile in breadth. This is nearly divided midway into two by a long point projecting from the north side. The eastern basin is shallow, scarcely deeper than thirty feet, but presents along its east shore a broad sandy beach, very popular with bathers. Vegetation is comparatively scanty. Various filiform species of *potamogeton* form a thin line off-shore, and some areas are thickly grown with *chara* and tangled masses of filamentous green *confervæ*. These plants seem to be covered with an organic slime, and the water is full of gray particles partly organic, partly a deposit of lime, which is very heavy upon the bottom, forming greenish-brown crusts especially thick upon fragments of mussel shells. From the west end a rather wide neck, nearly choked with vegetation, extends to the northwest two miles. Loon Lake, in sections 20 and 21, and Centre Lake, in section 22, Pleasant, are tributary to Crooked Lake. They are shallow bodies of water, originally 200 and 300 acres in extent, but their areas have been

largely reduced by ditching, the latter having been nearly all converted into meadow land and tamarack swamp.

The outlet of Crooked Lake, called Concord Creek, a clear and rapid stream, empties into Gage Lake, section 2, Jackson, and 35 Millgrove. This is a compact body of water, one mile by three-quarters of a mile in diameter, surrounded by high bluffs of sand and gravel. It is clear and clean, without marsh or vegetation except a few rushes (*scirpus*), and has a very uniform depth of over fifty feet. A line northwest and southeast through its long axis gave soundings of nearly seventy feet. It is the finest specimen in the county of a lake with a single deep and symmetrical basin, and presents especial attractions for the pleasure-seeker and the fisherman. The country east and south of Gage Lake is hilly with large kettle holes in every field; on the west more level and threaded with marshy channels, holding occasional pools of clear water. Among these the various fragments which occupy a once continuous glacial drainage channel, and are now known collectively as Grass Lake, have already been described.

Tamarack Lake, sections 22, 23, 26 and 27 Millgrove, is all that remains of a lake formerly much more extensive. It now covers about forty acres and is surrounded by marsh and tamarack swamp. Twenty-five years ago it was twenty-five feet deep, but has been lowered by drainage and filled with sediment and vegetation until there are few places over ten feet deep. Its complete extinction is an event of the near future. Tamarack Lake is scarcely separated from the ancient channel of Crooked Creek, and in fact once formed an expansion or side inlet of it. In late glacial times this was the point where two large rivers met, one from the James Lake system and one from the Crooked Lake system.

Lime Lake, near the northwestern corner of the county, section 18, Millgrove, deserves special notice. It is a symmetrical oval of ten acres. The water looks like milk on account of reflection from the bottom, which is covered with a deposit of marl, said to be ten or fifteen feet thick, and formerly burned for lime. It has a nearly uniform depth of twenty feet, with a maximum of twenty-eight. A small species of *chara* is the only vegetation, and even that is scanty. Analysis of this "marl" shows it to contain:

Calcium carbonate	86.00
Magnesium carbonate	9.42
Iron carbonate	1.16
Silica	1.08
Organic matter	2.32
	99.98

Recognizable organic remains are very scarce and the deposit seems to be almost entirely a chemical precipitate from solution in the water.

The Lakes of the Pigeon River Chain are strung along the course of that stream for twenty-five miles, and are more numerous than those drained by Crooked Creek, but they do not include any lakes of the first class in size. At the head of the stream, in sections 22 and 23, Fremont, stands Cedar Lake, represented upon the map as more than a mile across. In fact, at the present time there is no lake there; most of the water has been drawn off by artificial drainage, and the remainder is now covered by a quaking and probably floating bog meadow, with a few open lagoons. This lake can scarcely be said to be either living or extinct, but rather buried alive. The water which drains from this bog has the amber color of clear coffee, a peculiarity which it preserves throughout the course of the stream. It drains numerous swamps and small lakes in Fremont, Scott and Otsego townships, and in section 9, Steuben, empties into Long Lake in the great transverse Pigeon-Fish gap. Analysis of the water of Pigeon Creek shows it to contain twenty-eight grains of solid matter to the gallon, seven grains of which is organic. Before reaching Long Lake Pigeon Creek receives the waters of a stream from Fox Lake, which lies in the body of the middle section of the fourth moraine, section 34, Pleasant. This is a little gem, three-quarters of a mile by half a mile in diameter, with high abrupt shores and a very uniform depth of more than forty feet. The deepest sounding was sixty feet. The water is clear and cold, with clean shores and no marsh, except at one point near the west end. This lake is a reduced copy of Gage Lake, which it resembles in all its characteristic features. It has been recently stocked with fish, in 1887 with three thousand Mackinac trout, and again in 1889 with three thousand Mackinac trout and thirty-five hundred California trout,* for the growth and multiplication of which the waters of this lake seem to be peculiarly favorable.

Pleasant Lake, section 15, Steuben, differs widely in character from its companions in the Pigeon River chain. It is not more than half a mile long by one-quarter wide, but has a symmetrical kidney-shaped basin of unusual depth. The water is thirty feet deep quite near the shore, all around, and through the middle from forty to fifty feet. There is no marsh, and the water is clear.

The village of Pleasant Lake extends around two sides of it, and the well-kept grounds give the place a somewhat artificial air like that of a lake in a park. A few rods to the west, but at a considerable lower level, lies Long Lake, sections 15 and 16, Pleasant, a pointed ellipse, like a willow leaf, one mile in length, and having a depth which varies between twenty-five and forty feet. It is nearly surrounded by marsh, and the water is of the rich amber color characteristic of Pigeon Creek, which enters the lake at a point west of the middle, on the north side, and flows

*For this information I am indebted to Prof. L. D. Creel, of Angola; also for valuable assistance in the examination of Crooked and Fox lakes.

out at the western extremity. On leaving this lake the stream deserves to be called a river. The open water is fifteen to twenty feet wide and four feet deep, with a scarcely perceptible current, bordered by a marsh impassible to boat or foot. It winds through a jungle of cattail (*typha*), wild rice (*zizania*), swamp loosestrife (*decodon*), willow and other shrubs as impenetrable as those of Central Africa. Nothing is visible but the brown water full of *chara*, duckweed (*lemna*), milfoil (*myriophyllum*), bladderwort (*utricularia*), and pond lilies (*nuphar and nymphaea*) beneath, the wall of flags and trees on either side, and the sky overhead. It is a place to look for a tiger to spring out or an alligator to rise, but nothing is seen more exciting than a mud-turtle, whose efforts to climb down into the tangle are very amusing.

Golden Lake, in section 5, 6 and 8, Steuben, is a counterpart of Long Lake, except that its outline is more irregular. Its depth is exactly the same.

A half-mile farther down stream, in section 36, Jackson, is Hogback Lake, which in shape and size bears a close resemblance to Jimerson Lake, being four lobed. This lake takes its name from a precipitous ridge of coarse gravel and bowlders, seventy or eighty feet high and about forty rods long, which stands upon its northeastern shore. It is known as "the hogback," and constitutes a small but typical kame. Owing to the high wind and scarcity of good boats on two different visits, no soundings were made. A short distance to the northeast, in sections 29, 30, 31 and 32, Pleasant, Silver Lake lies like a coin or plate dropped down among the hills. It is an oval, one mile by half a mile, and over a portion of its area, the water seen from a distance glitters with the white luster of burnished silver. This is due to the fact that an irregular patch of several acres has a depth of only one foot, and the marl on the bottom gives the water its milky color. The water all around this area has a depth of from twenty to thirty feet. It has recently been lowered three feet by drainage, and the northeast half is filled with rushes (*scirpus*). The remainder is very free from vegetation, to which the character of the bottom seems unfavorable. The marl of Silver Lake contains numerous fragments of the shells of the fresh-water mussel, yet analysis shows that it does not differ materially in composition from that of Lime Lake.

Calcium carbonate	84.00
Magnesium carbonate	6.46
Ferrous carbonate	1.34
Silica and silicates	4.52
Organic matter	3.68
Total	100.00

Bass and Howard, small lakes in section 25, Jackson, also tributary to Hogback Lake, have been previously mentioned. Below Hogback Lake,

the valley of Pigeon River continues to be nearly a mile in width, but is less marshy. It contains but one more lake worthy of description in the county. Otter Lake, section 20 and 29, Jackson, is a typical lake of another class. It is a pear or gourd-shaped body of water one mile long north and south. Around the lower end the land is low and marshy, but the upper half is a symmetrical, boat-shaped basin between high hills. The shore descends uniformly at the rate of one foot in three to a depth of twenty-eight to thirty-three feet. The bottom is covered with a tenacious black mud-like paint or thick India ink. Its composition proves to be:

Lime and magnesium salts	41.00
Silicates (clay)	29.50
Organic matter	29.50
Total	100.00

This mixture forms a soil of exceeding fertility and a rich growth of vegetation surrounds the lake in the depths above fifteen feet. The various plants having capillary leaves in dense whorls around a single stem are especially abundant, so that the water seems filled with scared cat's-tails eight or ten feet long, among them milfoil (*myriophyllum*) *bidens, Beckii*, and bladderwort, *utricularia vulgaris* were found in blossom (August 15).

The lakes of the Turkey Creek chain, Little Turkey, section 35, Limekiln, section 28, and Big Turkey, sections 7 and 18, Salem, were not personally examined. Both valley and lakes resemble in all essential features those of Pigeon Creek. Big Turkey Lake, lying partly in Lagrange County, has a total length of two and one-half miles and a maximum width of half a mile. It is divided midway into two basins, the depth of the upper being forty-five to fifty feet, that of the lower twenty-five to seventy-five feet.*

The Lakes of the Third Moraine, which empty into the St. Joseph of the Maumee, remain to be described. They are few in number, but among the most interesting in the county.

Fish Lake, in sections 21, 27, 28 and 33, Otsego, has a length of nearly two miles, a breadth of one mile, and a very irregular outline. Its elevation was found by U. S. Engineer Stansberry, in 1827, to be 887 feet above tide. Its area, according to the report of Col. J. M. Wilson, U. S. A., is 740 acres, the largest lake in the St. Joseph basin. Its basin is only a larger depression in the surface of a country which is made up entirely of conical and dome-shaped drift hills, with corresponding depressions between. Here the kettle holes are in every field and of every size and shape, the lake basin being but a broad and irregular kettle hole.

* These depths are reported by Henry Wright, who is very familiar with the lake.

Numerous soundings show that the bottom is very uneven and occupied by several depressions of varying size, shape and depth. It contains two large islands and one very small one. Its character is partly due to the fact that it was raised about fifty years ago by a dam on the outlet at its southeastern extremity. The small basin just above this, called the mill-pond, is shallow and nearly covered with a most luxuriant growth of *nymphæa odorata.* It opens into the main body of the lake through a channel thirty feet deep between the mainland on the east and a large island on the west. A short distance north of this is a high wooded point, a typical drift hill, which once formed an island, but is now connected with the west shore by a growth of peat. The channel between the islands is thirty-five feet deep. Northwest of the high island or peninsula is a large and nearly land locked basin, called Muskrat Bay. North of the bay a point is extended by several acres of peat nearly to the third island, which, although the area above water is minute in size, proves to be the southern extremity of a long bar. The space between the shore and this bar was known to the Indians as "the slaughter pen," on account of the facilities it afforded for entrapping and killing deer. The open water between these islands and the east shore, from one-quarter to one-half a mile in width, varies in depth from two to sixty feet, probably averaging forty feet. The north half of the lake is an unbroken expanse of water with an average depth of forty or fifty feet, the maximum found being sixty-eight feet. The northwestern extremity of the lake is bordered by a growth of peat which rises abruptly from the water with a clean edge two feet high. From the eastern side of this basin a long funnel-shaped arm, known as "the Devil's Neck," extends half a mile to the southeast. The eastern shore of the lake is everywhere high, abrupt and free from peat and aquatic vegetation, although the water is in many places no more than from two to ten feet deep several rods from shore. A single patch about three feet in diameter has formed upon the most exposed point of the shore line, but seems to be washed away as fast as formed. A high point on the northeast side is known as "Cold Springs," from the fact that several copious streams of water, strongly impregnated with iron, there issue from the face of the bluff. One of these has formed a mass of peat 75 feet wide and 100 feet long upon the steeply-sloping face of the bluff. The peat seems to slide slowly downward to the shore, where the waves break off large pieces like ice-bergs. This may be regarded as a peat glacier.

Careful examination of the masses of peat and vegetable growth around the shores of this lake was made with the view of determining, as far as possible, the conditions and rate of growth. One most striking feature is the fact that the encroachments made by vegetation are confined to the west shore, although the conditions, as far as shallowness of water is concerned, are equally favorable along a considerable extent of the east shore.

On the west side the area of the lake has been diminished by many acres of peat, while on the east side, which presents no discernable difference in character, one square yard is the sum total of peat to be found. Possibly this may be accounted for by the fact that the water is usually much rougher along the east side, and peat-producing plants require still water.

In the bays of the west shore the outer zone of vegetation begins at a depth of ten feet with a band of *chara, potamogeton* and *Vallisneria spiralis*, the latter peculiar to this lake. At a depth of five feet *nymphaea* flourishes, *nuphar* being scarce. At a depth of three feet *scirpus, polygonum* and *typha* form a floating margin too thick to push a boat through. Above water level, on the solid mass of peat, a great variety of plants flourish, among which, besides grasses, small sedges and ferns, *Lycopsis europoeus, Pilea pumila, Potentilla fruticosa, Epilobium coloratum* and *palustre, Sagittaria variabilis, Rudbeckia hirta, Impatiens pulva*, covered with tangled orange skeins of *Cuscuta gronovii, Galium asprellum, Campanula apariuoides, Pycnanthemum, Liatris spicata, Lobelia cardinalis, Asclepias incarnata* and *Scutellaria galericulata*, are conspicuous in August. In many places the strictly aquatic plants are absent, and the peat bed rises with a clean cut edge two feet above the water.

The large area of Fish Lake, furnishing a broad expanse of water visible at one sweep of the eye, its irregular outline and prominent islands, its bold shores and encircling hills, and the beauty and profusion of its aquatic vegetation, form a combination of characters which render this lake one of the most interesting and attractive in the State. The village of Hamilton, at its south end, is clean and quiet, and furnishes such accommodations to the summer visitor as can not fail to make his stay enjoyable.

The Fish Lake basin opens southward into the great Pigeon-Fish transverse valley, a half mile up which, toward the west, lies Ball's Lake, in section 32, Otsego. It is one mile long and seventy rods wide, surrounded by steep wooded bluffs fifty feet high. Its basin is a symmetrical boat-shaped depression sixty-five feet deep,* and in regularity of outline and depth of valley, can scarcely be equaled. Both Fish Lake and Ball's Lake are now owned by the Fort Wayne Water Power Company, which, by the construction of proper dams and other means of regulating the flow of the water into and through the St. Joseph River, designs to use these lakes as reservoirs for the supply of the city of Fort Wayne, forty miles distant. If desirable, a cut through the low divide would turn the waters of Pigeon Creek or Pleasant Lake, or both, into Fish Creek and the St. Joseph. No better source of water supply can be found within an available distance from Fort Wayne.

* Reported by Eugene Swift, grandson of Gideon Ball, who once owned, surveyed and sounded it.

In the extreme northeastern corner of Indiana lies Clear Lake, in sections 19 and 20, Clear Lake Township. It is an irregular body of water, having a maximum length east and west of nearly two miles, and a breadth of over one mile. The shores are rather low. Along the east end a sand beach four rods wide lies between the water and the foot of a bluff twenty-five feet high. A broad shelf of shallow water extends nearly all around the lake, outside of which the depth increases rapidly. Its level has been lowered slightly by ditching, which accounts for the present sand beach; but the broad shelf of still wider water seems to indicate that the level of the lake now stands higher than at some more or less remote period. This conjecture is further supported by the fact that the lake consists of three very distinct basins, two of which would become separate lakes if the water level should fall ten feet. The south basin is regular in outline, one mile and a quarter in length by half a mile wide, and of great depth. It is separated from the basin on the north by a wide bar over which the depth is uniformly six feet; yet within ten rods of the bar a depth of ninety feet can be found. A descent of thirty to forty feet in five rods was found in several places, and the average slope of the basin outside the shelf is not far from one foot in two, or at an angle of over twenty degrees. The line of maximum depth near the centre of the basin varies from 70 to 101 feet, the latter being the deepest sounding made in the county, and one which can be equaled in very few lakes of the State.

The north basin has a more irregular bottom and a less average depth, but descends in some places to 80 feet, and one sounding of 90 feet was made a short distance from the island. The shelf around its north and east shores is very wide and furnishes excellent facilities for bathing. The western basin is much smaller than either of the others, with which it is connected by a strait and from which it is separated by points, and a small, high island which stands in the mouth of the strait. The basin itself is surprisingly deep in proportion to its size, the soundings varying from 54 to 77 feet. The northwest shore of the lake is bordered by an extensive peat meadow, containing spring mounds and small elevated islands. The soil around Clear Lake is largely composed of deep and barren sand, which appears also in the bottom of the shallow parts of the lake. It is very hard to drive a stake into the sand beach along the east shore, and on the bar a stake is easily pushed in, but pulled out with difficulty. Notwithstanding the shelf of shallow water, the shores are for the most part clean, and aquatic vegetation is everywhere very scanty. *Scirpus validus* is the most conspicuous species, thinly covering the bars. *Nymphaea-nuphar* and *Pontederia* occur only in small isolated patches. *Potamageton* and *Chara* occur, but are scarce. The water is very clear, black over the deeps, and said to be very cold in some places at the bottom. Over these areas ice seldom forms, and they probably

indicate the position of copious sub-lacustrine springs. Clear Lake empties northward, through a small stream, which by a circuitous course through Michigan and Ohio, empties into the St. Joseph of the Maumee. East of Clear Lake lies a group of these small lakes, one tributary to Clear, the others emptying eastward by a different channel. The largest of these, Long Lake, lies partly in Ohio. Two large hotels on the north side of Clear Lake, accessible from Ray Station on the L. S. & M. S. R. R., furnish accommodations for visitors, and the place is destined to become a favorite pleasure resort for sportsmen, and all who seek clean, safe and ample bathing, boating and fishing grounds.

Having thus described with considerable minuteness the natural features of the most important lakes in the county, it remains to sum up and classify the facts observed, and to draw from them such conclusions as seem to be warranted. Of all the varied features now presented upon the face of the earth there are probably none whose essential characteristics are obvious, whose life histories are more easy to read than those of the drift lakes. They are all geologically young, and the main events of the period which gave them birth have left a record so voluminous and unmistakable that the marvel is that its significance was not earlier recognized. It was only necessary that the interest and attention of geologists should be directed to glacial phenomena to discover such a wealth of material for study as was perhaps never before presented to any body of scientific investigators. But the mine had to wait until the seventh decade of the nineteenth century before the slowly opening eyes and awakening scientific interest of the human race found therein an almost inexhaustible field of discovery. The results of the last twenty years of work have been rich beyond all expectations, and to-day the glacialist is able to write the history of events which occurred thousands of years ago with as much certitude and detail as the historian of human affairs can claim for the events as many hundred years past. "The track of a glacier," says Prof. Newberry, "is as plain and unmistakable as the track of a bear or a man." In the region south of the great lakes the enormous masses of drift, largely composed of the debris scooped out from the great lake basins, tell plainly the story of the advance and retreat of the last North American ice-sheet. The disposal of this debris in crescentic or horseshoe-shaped ridges reveals the fact that the ice-sheet advanced much as an army advances into the enemy's country, not with a long unbroken front, but in separate but contiguous columns. The basins of the great lakes furnished the highways by which the solid columns of ice invaded the territory of the United States, and also determined largely the mass, force and direction with which those columns pushed forward. The one which occupied the bed of Lake Erie was broad, massive and strong, and, overcoming all obstacles, occupied the greater part of Indiana. The Lake Michigan column was also deep and heavy, but it seems to have

found the territory already occupied by the Erie ice, and to have been deflected westward, so that it got possession of only the northwest corner of Indiana. Between these two a much lighter column advanced from Saginaw Bay across Michigan, and in spite of being hemmed in by its more powerful neighbors on either side, succeeded in penetrating Indiana as far south as Fulton County. Where the outer edges of these ice-lobes came together was the battle ground of the glaciers, and there the drift is piled highest and in the most irregular forms. It may be supposed that the narrow belt of sand between them was the scene of repeated advances and retreats, and was alternately occupied by ice belonging first to one lobe and then to another, hence the material deposited along such a belt was plowed up, overridden, tumbled about, and finally left in the wildest confusion. Such a belt or drift forms the *Saginaw-Erie interlobate moraine*, which in Indiana stretches across the counties of Steuben, Lagrange, Noble, Whitley and Kosciusko. Thus are the peculiarities of topography and soil in that region accounted for.

Among the materials composing this moraine, clay largely predominates, usually mixed with a liberal supply of gravel, and not unfrequently containing fifty per cent. of ground limestone. Over and under the clay are immense beds, sheets and ridges of sand and gravel, and scattered over and through the whole with little partiality a variety of bowlders as thick as plums in a pudding. The presence of elevations implies the existence of corresponding depressions, and the lake basins are the complements and counterparts of the hills. Deep and symmetrical hollows in the midst of a comparatively level country, of which the basins of Pleasant Lake and Clear Lake present striking examples, are accounted for by supposing that a large mass of ice became detached from the main body and was left partially imbedded in the drift, its final disappearance by melting left the hole now occupied by the waters of the lake. This theory is sustained by observations made upon existing glaciers. The great morainic belt which stretches across the country from Cape Cod to Dakota presents everywhere the same essential features, differing only in size and prominence. To this rule moranic lakes form an exception. The massive moraines of New York are almost devoid of lakes, in Ohio there are very few, while the map of Northern Indiana and Southern Michigan is thickly peppered with them. Throughout the whole extent of the morainic belt the peculiar symmetrical or irregular hollows between the hills exist; east of Indiana they are dry kettle holes, here nearly every one is filled with water to the brim. This phenomenon can be due to no other cause than a difference in morainic materials. In one case the bottoms of the basins are gravel through which the water drains away as through a sieve; in the other case the basins are lined or underlaid with clay and hold water like a cistern. Given a surface of country studded with innumerable

water-tight basins which rapidly fill until they overflow at the lowest point, in many cases several basins finally coalescing into one large body of water, and the lakes of Northern Indiana are the inevitable result. Such has been their origin; but from the day of their birth their progress has been toward remote but certain extinction. During the period of glacial retreat, torrents of water from the melting ice poured through the valleys, carrying with them loads of mud and sand, which in some places are still visible upon the face of the country. Thus the intermorainic intervals were filled, but to what extent it is now impossible to determine. In the case of the valley of Upper Pigeon Creek, this filling seems to have progressed far enough to raise its surface to the level of the lateral transverse gaps through the moraines on either side, and the lake basins which may have once existed there were nearly all obliterated. During this period the principal drainage lines were established and the great transverse valleys of Crooked Creek, Pigeon Creek, Fish Creek and Turkey Creek were opened. Other channels which once existed have been partially filled, and now only detached fragments remain. The greatest of these now traceable extends from Hogback and Silver Lakes through Grass Lake to Lake Gage. Other fragments, like the "necks" of Crooked and Jimerson Lakes, testify to the important changes which evasion and wash have accomplished. It seems obvious that in this manner all the lakes must have suffered a considerable diminution of their original depth. As soon as the surface of the country became covered with forest, general evasion and removal of material was greatly diminished, and at the present time the results of these processes are practically nothing. The streams which now empty into the lakes are few and small, and the quantity of mud or sand thus brought down is very trifling. In fact they are great springs fed chiefly by inflow at the bottom, and the subterranean waters are so strongly charged with lime and iron salts that the accumulation of marl is doing more to fill up the basins than surface evasion. Aquatic plants are, as a rule, incrusted with lime, and mussel-shells and other objects upon the bottom form nuclei for similar deposits which soon render their original form scarcely recognizable. These phenomena are especially noticeable in Lime, Silver, James, Crooked and Clear Lakes.

Another very efficient agent tending toward the extinction of these lakes is man himself. In the case of small and shallow lakes, artificial drainage has often resulted in their complete destruction, while the areas of large shallow ones have been reduced one-half or more. In general, the extent of encroachment, actual or possible, upon a lake by human agency, may be said to be a function of its depth.

A third agency, more effective than all others for the obliteration of morainic lakes, is the growth of aquatic vegetation. The character and extent of this growth depends somewhat upon the depth of the lake and

the slope of the shores, but chiefly upon the nature of the bottom. In this respect lakes may be divided into three classes: *lime lakes*, *sand lakes* and *peat lakes*. Of the first class, Lime and Silver lakes are typical examples; of the second class, Gage and Clear lakes. In all these vegetation is very scanty, apparently for no other reason than that their bottom and shores do not afford a soil sufficiently fertile to support an abundant growth.

A large majority of the Steuben lakes belong to the third class, and were characterized by the black, tenacious mud which constitutes their beds, and by the luxuriant growth of plants wherever the requisite shallowness and stillness of water permit. Of these, Otter Lake (Jackson Township) and Fish Lake are typical specimens. These are literally being filled with air, the great bulk of the solid material which composes the plants being absorbed from the gaseous ocean above and consigned to the watery depths below. This process is undoubtedly slow if measured by the years of man's life; perhaps the peat bed extends into the lake only a few feet in a century, but measured by the periods of geologic time, these lakes were born but yesterday and will disappear to-morrow. The present dominant race of men may pass away and leave these lakes still lying like bright jewels among the hills; but every one is nevertheless doomed to final extinction. The peat lakes will disappear first in the order of their size and shallowness; the lime lakes next, and the sand lakes last of all. In consideration of its size, depth and barren bottom, it seems safe to predict for Clear Lake a permanence and length of life not to be surpassed by any of its companions. As long as the lakes remain they will continue to contribute to the service and delight of man, feeding his eye with their beauty, and affording means for that relaxation and healthful pleasure which the conditions of life every year more imperatively demand. The time may come when the lakes of Steuben County will be the most valuable and profitable possession of her citizens, who will then seek and devise means for preserving instead of destroying them. Between the Great Lakes and the Ohio there is no more beautiful tract of country than Steuben County. At present comparatively few of the citizens of Indiana are aware of its attractions; but it can not long remain unknown and unvisited. Among its hills and lakes thousands of the coming generation will find their summer homes.

The great variety of soil and situation in the county implies a flora very rich in species, an influence which the most cursory examination will confirm. Fortunately the county numbers among its citizens a botanist whose powers of observation and devotion to his work are worthy of his opportunities. Mr. Elbert Bradner, of Angola, contributes to this report a list of the plants of Steuben County, the result of several years assiduous collecting. As the work of an amateur wholly without the assistance of professional botanists, it is worthy to rank with the best that has yet been done in the State.