

THE GEOLOGY OF NOBLE COUNTY.

BY CHARLES R. DRYER.

Noble County was organized in 1836, and named after Col. Noah Noble.

It then comprised 432 square miles, or twelve congressional townships, numbered 33, 34 and 35 in ranges 8, 9, 10 and 11 east of the second principal meridian. It is bounded on the north by Lagrange, on the east by Dekalb, on the south by Whitley and on the west by Koseiusko. In 1860 the two southern tiers of sections 25 to 36, of township 33, range 8, were set off to form Etna Township, Whitley County, leaving in Noble County 420 square miles. Four sections in the geographical center of the county have been taken to form the township of Albion, which includes the county seat. For convenience the townships will be referred to by their civil names as follows:

	<i>Range 8.</i>	<i>Range 9.</i>	<i>Range 10.</i>	<i>Range 11.</i>
Tp. 35.	Perry.	Elkhart.	Orange.	Wayne.
Tp. 34.	Sparta.	York.	Jefferson.	Allen.
Tp. 33.	Washington.	Noble.	Green.	Swan.

Noble County is crossed by three railroads and touched by two more. The Grand Rapids & Indiana, built in 1873, passes north and south through the eastern part; the Baltimore & Ohio, built in 1873, east and west through the center, and the Lake Shore & Michigan Southern, built in 1857, east and west through the northern tier of townships. The Eel River division of the Wabash, built in 1878, crosses the south-east corner, and the new Detroit & Chicago Division, built in 1892, touches the northern border for about three miles in Orange Township.

The county seat, after much tossing about was finally located at "the center," now Albion, in 1846, where a beautiful and commodious courthouse was built in 1889, at a cost of \$114,000. The first land was bought and permanent settlement made in 1831, on Perry's Prairie, sections 27, 28, 31, 32, 33 and 34, Perry. One of the most important events in the early history of the country was the attempted construction of the Michigan and Erie Canal. At the session of 1836-7 the Legislature of Indiana authorized the construction of a ship canal from

Michigan City to Fort Wayne, passing through the townships of Swan, Green, York and Perry into the Elkhart River east of Rochester. A navigable feeder was provided for from Northport, a village then existing in section 9, Orange, to the point of intersection of the main canal with the Elkhart River. In 1837-9 surveys were made, a dam was built across a tributary of the Elkhart at Northport, forming the lake now known as Sylvan Lake at Rome City, and portions of the canal were built which can still be traced in Orange and Greene Townships. Two hundred and forty thousand dollars are said to have been expended upon the work in Noble County. The principal towns and villages have grown up along the railroads. The largest is Kendallville, with a population of 3,000. Ligonier has 2,000, Albion 1,300, and Avilla 600, while LaOtto, Swan, Rome City, Brimfield, Wawaka and Cromwell are of smaller size. Green Center, Noblesville and Wolf Lake are important centers in the southern townships, which are still devoid of railroad communication. Embryo towns of great importance in pre-railroad days, like Port Mitchell, Rochester and Northport, have nearly or quite disappeared, except in name. The population of Noble County according to the census of 1890 was 23,369.

Physically Noble County is almost occupied covered by what was originally described by Chamberlain* as the *Saginaw-Erie interlobate moraine*, an immense mass of drift about twenty-five miles wide and from 200 to 500 feet deep. The crest of this moraine, forming the divide between the basin of Lake Michigan on one side and of Lake Erie and the Wabash River on the other, transverses the southeastern part of the county, through the townships of Greene, Allen and Wayne. Thus three-fourths of the county lies upon the Saginaw side, of which about one-half of Washington and Noble townships are drained by the headwaters of Tippecanoe River, and the remainder by the Elkhart. This interlobate moraine is the joint product of a lobe of glacial ice which passed from Saginaw Bay southwestward across Michigan and northern Indiana, and another lobe which entered Indiana from Lake Erie and covered nearly the whole State south of the Wabash River. The moraine mass was differentiated in Whitley and Steuben counties by the present writer, in 1889, into three divisions,† a work which the herein described survey of Noble County (1893) has confirmed and completed. According to this scheme the territory of Noble County falls into three natural divisions:

1. The Salamonie or Third Erie Moraine.
2. The Mississinewa or Fourth Erie Moraine.
3. The Region of Saginaw Drift.

*U. S. Geological Survey, Third Annual Report, p. 330.

†See Reports upon the Geology of Steuben and Whitley counties, Seventeenth Report of State Geologist, especially p. 168.

These divisions could not have been distinguished by a survey of Noble County alone, but a knowledge of the general glacial geology of northeastern Indiana enables any one to see that they are actual and natural. They are more sharply distinguished both to the north and to the south of this region, and using such previously discovered and undisputed evidence as a guide it becomes possible to explain the structure of Noble County, which would be otherwise unexplainable.

THE SALAMONIE OR THIRD ERIE MORAINE.

So called because its southern wing extends along the right bank of the Salamonie River, crosses the southeastern corner of Noble County, occupying the township of Swan and small portions of Green and Allen. It is a plain, gently sloping to the southeast and drained by Willow, Black and Little Cedar creeks, all emptying into Cedar Creek in Dekalb and Allen counties, which in turn emptied into the St. Joseph River, whose waters flow through the Maumee to Lake Erie. Its surface presents the succession of swell and hollow, characteristic of mild morainic topography, which sufficiently distinguishes it from its neighbor on the northwest. There is not in the whole course of this moraine in Indiana north of the Wabash River an elevation of sufficient magnitude to be called a hill, except in the eastern part of Steuben County. As a whole it is decidedly less massive and more feeble than either the second or the fourth moraine. Except in Steuben County it is closely contiguous to the fourth, to which it bears a relation similar to that of foot-hills to a mountain range. Small lakes are not wanting but most of the kettle holes have passed beyond the lacustrine stage and have become peat bogs or meadows. Originally small and shallow, natural and artificial agencies have conspired to extinguish them, so that the area of land now uncultivable is very small. The irregularity of surface is sufficient to give a pleasing variety to the landscape, a profitable diversity of soil and easy drainage. In Whitley County the third moraine is separated from the fourth by the valley of Blue River, but in Noble County there is no interval, the boundary being a line along which hills or considerable rises in elevation appear. This line is most distinct in sections 36, 25, 24 and 13, Green, and 7, 8 and 4, Swan. In Allen Township and in Fairfield Township, Dekalb County, the two moraines are not only contiguous but coalescent, while in Steuben County they are separated by the valley of the Upper Pigeon River, five or six miles wide. The ascertained elevations of this moraine in Noble County are, Swan, 905 feet, and Potter's Station, 881 feet, A. T.

THE MISSISSINEWA OR FOURTH ERIE MORaine.

So called because its southern wing extends along the right bank of the Mississinewa River, is the most massive and pronounced of all the moraines of northeastern Indiana. It occupies the townships of Greene, Jefferson, Allen, Orange and Wayne. It has a width of six miles in Greene and ten miles in Orange and Allen, and an average elevation of one hundred feet above the country on either side. Its crest forms the principal watershed of the county and the backbone of the whole morainic mass, against which the third Erie moraine is banked up on one side and the Saginaw moraine on the other. In fact, it is impossible to determine just how much of its constituent material was furnished by the Saginaw glacier, but it is classed as the outer Erie moraine because south of Noble County it is separated by a wide interval from morainic masses which are certainly of Saginaw origin. This interval begins in Noble County where the depression, about three miles wide, occupied by the Tippecanoe and Muncie groups of lakes and by extensive marshes in Noble Township, separates the chief moraine from the outlying masses to the west. Between the Muncie Lakes and Albion it is joined by a spur of very rugged country which connects it with the Saginaw moraine. From Albion to Brimfield the border is indefinite, the western slope fading out imperceptibly into almost level country which has no recognizable morainic features. From Brimfield to the south end of Waldron Lake, section 17, Orange, the border is a low but distinct bench. North of the last mentioned point it is joined at right-angles by another Saginaw spur. This moraine rises from either side by successive elevations to an undulating tableland which presents considerable diversity of feature. In Greene Township it is characterized by a group of sand knobs among which are scattered small lakes forming a chain along the distal tributary of the south branch of Elkhart River. From Summit Lake, section 12, Greene, the chain extends westward including Long, Sister, Dock, Indian, Sand, Webber and Rivir lakes, the largest not exceeding one hundred acres in area. They lie fifty to seventy-five feet below the general level. Almost from the margin of the valley occupied by these lakes and their connecting stream, tributaries of Blue River flow southward, cutting channels into the plateau seventy or eighty feet deep. In Jefferson and Allen townships the plateau is undulating, but without knobs or lakes, except Skinner Lake, section 16, and Sackrider Lake, section 1, Jefferson. The former covers about 150 acres and has a depth of only twenty-five or thirty feet. The shores are low and tame. The streams in this region flow in channels so narrow and abrupt as to appear almost artificial. Compared with the broad drainage valleys to the west they

are very young and strictly post glacial. In Orange and Wayne townships the character of the moraine again changes and becomes more pronounced in all features peculiar to a moraine. High, rounded domes, hills and ridges alternate with deep valleys of corresponding outline. Lakes are numerous, though small, but are greatly exceeded in number by marshes which occupy the former sites of lakes, many of which still contain a small pool of open water. More are of sufficient importance to require particular description except two. Rome City Reservoir, now known as Sylvan Lake, is an artificial lake created by a dam built in 1837 for a feeder to the proposed Michigan and Erie Canal. It covers 1,200 acres to a depth of twenty-five to thirty feet and is extremely irregular in outline with numerous points, narrows and islands. Its extreme length is about three miles. It has no geological interest or significance, but in the hands of the G. R. & I. R. R. Co. it has become a very pleasant and popular summer resort. The Island Park Assembly, an institution of the Chautauqua character, under the management of the Methodist Church, holds here its regular summer sessions. Picnic and excursion parties are of almost daily occurrence, while numerous cottages furnish accommodations for permanent summer sojourn. Tamarack Lake, section 1, Orange, and 6, Wayne, formerly occupied a valley two miles long, extending northwest and southeast, with a considerable arm to the northeast; the removal of a dam and clearing out of the channel has now drained it to an elliptical body of water of sixty acres. Its southern shore rises steeply to a table-land about forty feet higher than the general level of the country north of the valley, and marks here the boundary of the fourth moraine. One feature of this moraine was noticed in both Dekalb and Noble counties.

The Erie slope is characterized by a heavy deposit of bowlder clay upon all the higher points, sand and gravel being found only in the valleys, the result of the wash of streams. On the Saginaw slope absolutely no clay occurs near the surface, everything from the highest hilltops to the lowest depressions being composed of coarser or finer sand and gravel, except where covered by deposits of peat. This is probably the result of the conditions of drainage which prevailed during the glacial period. All the evidence points to the fact that the Saginaw glacier was a much smaller and feebler mass of ice than the Erie glacier. The former was a narrow tongue, originally shaped by the basin of Saginaw Bay, and hemmed in by its more powerful neighbors from Lakes Michigan and Erie. It may have advanced somewhat earlier in time than the others, and thus offered an obstruction which deflected the Michigan glacier westward into Northern Illinois, and the Erie glacier southward toward the Ohio River, compelling it to heap up its burden of drift into the very massive and closely contiguous moraines of Whitley, Allen, Noble, Dekalb and Steuben counties. During the period of glacial retreat the

weaker and less massive Saginaw glacier melted first and the whole drainage from the Erie ice in this region found an outlet into the territory just evacuated by the Saginaw ice. Thus the water upon the Erie side of the moraine found sluggish and inadequate outlets, and settling back under the ice, deposited a thick mantle of clay over the whole sub-glacial surface. On the other hand, the water which escaped over the crest of the moraine found free and rapid escape into the present St. Joseph and Kankakee valleys. The streams, at first voluminous and torrential, washed vast quantities of coarse materials over the crest and down the Saginaw slope, carrying the finer materials farther westward.

Railroad and canal surveys furnish the following elevations upon the fourth moraine in Noble County:

Summit three miles east of Kendallville	1,018 feet A. T.
Summit near Lisbon	1,017 feet A. T.
Summit one and one-half miles west of Avilla . . .	1,015 feet A. T.
Avilla.	981 feet A. T.
Kendallville.	977 feet A. T.
General level of watershed	973 feet A. T.

The Region of Saginaw Drift presents features differing widely from those of the compact and well defined masses of drift just described. It is characterized by extreme diversity of character and irregular distribution. Smooth, almost level country, wild, undulating, morainic topography, sharp and irregular ridges, isolated groups of gravel knobs, and broad valleys, now or once occupied by extensive lakes and marshes, are distributed over the western half of Noble County in such a manner as to render intelligible description difficult, if not impossible, without a detailed map to aid the reader. Much of this diversity and irregularity is due to the fact already alluded to, that during the period of glacial retreat and rapid melting of ice, vast volumes of water escaped over the crest of the outer moraine, and flowing across the face of this country, cut and gashed it into irregular gorges, leaving corresponding ridges between. The greater part of the material left by the Saginaw glacier has been washed away or redistributed to such an extent as to leave few of the original features recognizable. Scattered patches of hills and the more prominent ridges are probably all that escaped the action of the flood of water. The valleys themselves, originally cut to a depth of perhaps one hundred feet below their present bottom levels, have since been filled up with silt and vegetable growth, forming large areas of marsh and muck meadow, with frequent pools of open water. The area of marsh land has been estimated to comprise ten or fifteen per cent. of the whole county, and in some townships it must be nearly fifty per cent.

Noble Township is occupied in great part by an intermoranic interval continuous on the south with that of western Whitley County,* but

*Seventeenth Report of State Geologist, p. 163.

differing from the latter in being relatively a depression instead of a table-land. It is bounded on all sides, except the south, by elevations rising fifty to one hundred feet above its bottom. On the east, the slope of the fourth moraine gradually rises from it along the east line of the township. On the northwest a prominent ridge skirts it from Port Mitchell to Wolf Lake, and from Wolf Lake to Loon Lake, a tract of tumultuous morainic hills separates it from the smoother country to the west. About one-half its area was originally occupied by lakes and marshes; but these have been considerably diminished by drainage. On the south line of the county the part of Crooked Lake projects into section 33, which contains also Little or Crane Lake. In sections 32 and 33 lies Tippecanoe Lake, which is probably the largest body of water lying wholly in Noble County. It is a compact oval with a long diameter of more than one mile and a short diameter of more than half a mile, and covers five or six hundred acres. The shores are low, except upon the south, where it is skirted by a considerable bluff. The body of the lake is clear, open water, but little obstructed by shallows. Although visited several times, no boat was ever found available for sounding. Its depth probably corresponds with that of its neighbors, Crooked and Loon,* which are both over one hundred feet. These lakes form the extreme head waters of Tippecanoe River, which, after a very circuitous and troubled course empties into the Wabash at Lafayette. The south fork of the Elkhart River enters this valley in section 12, Noble, and drains an irregular depression in sections 11, 10, 1 and 2, Noble, and 35 and 36, York, known as the Muncie Lakes. The main body is now a marsh containing half a dozen small ponds. At the northern extremity at Port Mitchell the river cuts through the retaining ridge and escapes by a deep and tortuous channel to the lowlands in northern York.

York Township forms a structural as well as civil unit. It is chiefly occupied by a morainic knot or connecting spur between the fourth Erie moraine on the east and the more irregular masses of Saginaw moraine on the west, and is the most rugged and diversified tract in the county. The narrowest portion of the spur, from the north line of the village of Albion to the foot of the Muncie lakes is two and a half miles wide. It joins the Erie moraine in the southwestern part of Jefferson, where the branches of the Elkhart drain its western slope. The surface of this region is cut up into a succession of deep valleys and high, sharp ridges, having a general northwest and southeast trend. There is a temptation to use the word *canons*, so far as it may be applicable to drift gorges. The same formation extends and widens westward to cover the greater part of York Township, although the ridges in that direction grow lower and broader, and the valleys wider and less profound. The latter appear to have been half filled up since their original erosion, and are now

* Seventeenth Report of State Geologist, pp. 164, 165.

occupied by extensive marshes through which the river winds, passing frequently from one basin to another, through a dividing ridge. Upper and Lower Long lakes, sections 28 and 33, occupy a narrow north and south valley, resembling the valley of Grass Lake in Steuben County.* As in that case, also, the country west of it, although of the same general elevation, is decidedly smoother in contrast with the tumultuous hills on the east. A more important contrast, however, exists a little farther west, where a line of bluffs extends along the eastern line of the western tier of sections. Here the general level drops quite abruptly about fifty feet, and from the top of the bluff a smooth, gently sloping plain may be overlooked, extending through Sparta and Washington townships to the western line of the county. In a line directly north of this bluff, in the northeast quarter of section 18, is a patch of knobby sand hills, rising 150 feet above the river valley on the north and east. Directly east of these hills, in the southwest quarter of section 10, a single lenticular, drumlin-like hill rises to about the same height. The northern two tiers of sections in York, and the northwest corner of Jefferson, are low and level, with a small area in sections 3, 4, 9, 10 and 11, which may be recognized as distinctly morainic. Sections 5 and 6, York, and 1, Sparta, form the basin of Eagle and Diamond lakes, an embayment three miles long and a mile and a half wide, nearly surrounded by more or less strongly marked moraine. The Elkhart flows northward across its eastern end. Diamond Lake, sections 6, York, and 31, Elkhart, is one-half mile by one-quarter, its shores flat and marshy except on the north side, where it washes the foot of the highest and most precipitous hills in the county. They are as rough and irregular a pile of gravel knobs as can be found in Indiana, rising 150 to 200 feet above the lake, with a southern descent almost too steep for a horse and wagon. They are prolonged westward at a lower elevation through section 36, Perry. The range is two and a half miles long east and west, and from one-half to three-fourths of a mile wide. It is completely isolated by the valley of the Elkhart on the east and north, and the valley of the lakes and their outlet on the south and west, and forms one of the most remarkable as well as conspicuous features of the region. The Diamond Lake hills stand like an Egyptian pyramid amid the ruins of an ancient city, a monument to show us what the Saginaw glacier could do upon occasion.

Diamond Lake, though small, is not unworthy of its gigantic neighbor, showing an average depth of 50 feet, with a maximum of 82 feet, the deepest lake of its size which the writer has yet examined. Eagle Lake, in section 1, Sparta, covers a larger area, but is said to be shallower than Diamond. The Elkhart flows through the embayment only half a mile east of Diamond Lake, with no elevation between, yet the lake adds to

*Seventeenth Report of State Geologist, p. 117.

its other surprising characters by emptying westward into Eagle, and thence by a small stream which cuts through the highland around the west end of the hill range and joins the Elkhart near Rochester.

Elkhart Township presents, as a whole, a condition and topographical type which is shared by portions of York, Jefferson and Orange. With a few exceptions, it shows no morainic features, whatever. It is a level and comparatively low plain, through which the numerous tributaries of the north fork of the Elkhart River wind sluggishly, bordered by wide marshes. On the eastern border the marshy expanses are broken by a group of lakes. Sanford, in sections 12, Elkhart, and 7, Orange, is said to be 30 feet deep. Lower Lake, in sections 12 and 13, is an irregular horseshoe, of which only the eastern segment was visited. It proved to average 30 feet in depth, with a maximum of 47 feet near the south end. Waldron Lake, section 18, Orange, is a tributary of about equal depth, with a maximum near the head of 39 feet. These lakes lie close against the morainic border, which is marked by a line of conspicuous hills extending along their northeastern sides. The range is highest in section 6, Orange, and forms a spur of the Saginaw terminal moraine which trends northwestward into Lagrange County.

Two miles north of the Diamond Lake hills, in section 24, Perry, is another group of knobs, similar but lower and less massive. From these a belt of moderately strong moraine extends through sections 17, 18 and 19, Elkhart, to the centre of section 8 and southwest corner of 9. This patch is about one mile wide by four miles long, and is separated from the morainic masses to the South by the Elkhart Valley, one mile and a half across this isolated area, and the Diamond Lake hills, may be regarded as morainic outliers whose connection with the main range, if it ever existed, has been cut off by the escaping floods of the period of glacial retreat.

Perry Township is divided diagonally from southeast to northwest by the valley of the Elkhart River, which, having gathered the waters from its numerous and wide-spreading branches, and escaped from all entanglements of lakes, marshes and hills, flows in a direct course about thirty miles to join the St. Joseph at Elkhart. The northern half of Perry is popularly included in what is known as the Hawpatch, although the Hawpatch proper originally consisted of about 4,000 acres in Noble and Lagrange counties. This and an indefinite area surrounding it comprises some of the richest and most valuable farming lands in Indiana. The southern part of it now contains many tracts of magnificent beech and maple timber. Southwest of Ligonier lies Perry's prairie, comprising two or three sections of beautiful level land, which slopes gently westward to lower and more marshy country in Kosciusko County. Sections 34 and 35 form part of a hilly ridge lying between the valley of Eagle Lake on

the east, and the valley of Solomon's Creek on the west. It is a continuation of the spur which branches from the Erie moraine south of Albion, and occupies sections 1, 2, 3, 11, 12, 13, 14 and 24, Sparta. This ridge is only about two miles wide, but is cut lengthwise near its western border by a straight, narrow gorge, about eighty feet deep, which extends from Sparta Lake, section 23, to the Elkhart just east of Ligonier. It is five miles long and scarcely anywhere more than a quarter of a mile wide, with very steep bluffs, unbroken by any tributaries. A small stream flows in a narrow channel at the bottom, which has been deepened to drain Engle Lake, a slight expansion in sections 2 and 3.

Sparta Township is divided by the valley of Solomon's Creek, parallel with the Elkhart valley in Perry, from section 25 to the northwest corner of the township. It is a depression about one mile wide and eight miles long, chiefly occupied by marsh and numerous small pools of water. It is now being drained by a ditch, the main line of which is ten miles long, sixteen feet wide and six feet deep, with branches aggregating an equal length. The cost will be about \$20,000 and the estimated benefits \$30,000.

The southwestern half of Sparta, with the northeastern corner of Washington, is generally level, with slight undulations and irregularities which render its affinities doubtful. If it is to be classed as a part of the moraine, its morainic characters are among the mildest recognizable. The writer is inclined to exclude it and to draw the border of the moraine at the line of bluffs already described from section 32, York, along the east side of Solomon's Creek valley to Perry's prairie. The whole mass of unmistakable moraine then forms a very irregular spur or promontory from Albion and Port Mitchell to Rochester and Ligonier, with a large bog in northwestern York and a hooked extremity extending into western Elkhart. It is probably the remains of the eastern extremity of a terminal moraine of the Saginaw glacier, which extends in a fragmentary condition along the course of the Elkhart River to the St. Joseph.

The southwestern corner of Noble County contains the beginning of another Saginaw terminal moraine which extends along the south side of Turkey Creek into Kosciusko County. It is connected with the knot in York Township by the ridges and hills of northwestern Noble Township, which occupy the greater part of sections 3, 4, 5, 6, 7, 8, 9, 17, 18 and 19. This area also includes two important and interesting lakes. Bear Lake, sections 8, 7, 17 and 18, Noble, covers 420 acres, and has an elevation of 903 feet A. T., and a depth of about fifty feet. It is a clean, compact body of water with rather low shores and but a small area of marsh except in the interval between it and High Lake. The latter is in sections 18, Noble, and 13, Washington, 300 acres in area, and scarcely anywhere more than thirty feet deep. It is interesting from the

fact that its basin seems to belong to a type hitherto undescribed in Indiana. The western half of section 7, Noble, is occupied by a series of sand ridges, perhaps twenty feet high, extending north and south. At the north end of High Lake they divide into two branches which follow the east and west shores respectively. Thus the lake basin lies between the arms of the Y in a space which is nearly closed up by a cross ridge along the south shore. These ridges are generally of moderate slope and from twenty to forty feet above the lake, composed chiefly of sand; but, at the point on the east side where the outlet leaves the lake, the ridge is not more than three feet high and composed almost entirely of small angular boulders. At this point it was first observed and was mistaken for a beach ridge. A few excavations in the higher part of the ridge show yellow sand intermingled with angular stones from the size of a man's fist to the size of his head. We evidently have here a specimen of the kames or eskers which are so numerous in other portions of the great morainic belt of North America. Another example occurs a few miles to the west of this. In sections 9, 4 and 5, Washington, and 31 and 32, Sparta, a chain of small lakes occur in the course of Turkey Creek. Like Bear and High lakes they belong to the Elkhart system. The valley is about half a mile wide, and its left bank is bordered by a continuous esker for about two and a half miles, nearly to Indian Village. Its average height is not far from forty feet above the valley, and it is as distinctly separated from the land of about equal elevation on one side as from the valley on the other. The crest is generally smooth and even, but is broken occasionally by gaps through which small marshes on the land side are drained. The valley contains a half dozen lakes—Big, Moss, Hindman's, Gordy, etc., of varying size and shape, determined apparently by the arrangement of branches and subordinate eskers. In section 5, the main esker strikes northward, crosses the valley, and sweeps around to the west, forming an almost complete loop, within which lies Gordy Lake, of probably fifty acres extent. In the southeast quarter of section 31, Sparta, lie three curious marshes or huckleberry swamps. They are long, narrow and parallel, extending east and west, separated from each other by narrow ridges which branch from the main esker and join the high land, and dammed back from the valley at a much higher level by the esker itself. They have no outlet, although a cut of a few feet in length and depth would drain them into the creek. This valley, with its eskers and lakes, is, so far as the writer is informed, unique.

In section 9, Washington, a low ridge separates the lakes at the head of Turkey Creek from a chain which empties southward into the Tippecanoe, thus forming a part of the divide between the basins of the St. Lawrence and the Mississippi. The southwestern half of Washington Township exhibits the swell and sag topography of moderately developed

moraine in beautiful perfection. It is crossed from east to west by the valley of the Tippecanoe River, about one mile in width, with gently sloping sides, and containing a chain of small lakes, of which Smalley Lake, sections 13 and 22, is the largest. The view from the bluffs along the north side, comprising a wide expanse of upland and valley, with half a dozen lakes glittering in the distance, forms one of the most pleasing landscapes in Indiana.

In the survey of Noble County one of the problems which arose for solution was the determination of the boundary between the Erie and the Saginaw drift. It had already been located to the north and to the south of the area under consideration, and the work herein described has filled up the gap with as much certainty and definiteness as the nature of the problem could lead any one to hope for. The conclusion briefly stated is this: *A line extending north and south through the middle of Noble County* will nowhere, except at the north end, lie more than one mile from the boundary between the Erie and the Saginaw drift. East of that line by far the greater part of the material which covers the native rock to a depth of several hundred feet was brought by a mass of land ice from the highlands of Canada and the bed of Lake Erie. West of that line the greater part of the material was brought by a similar but smaller mass of ice from Lake Huron and Saginaw Bay, all the Erie drift present being the result of water transportation from the east. The exception above noted refers to the northwestern half of Orange Township, where the boundary probably should be deflected from Brimfield to Tamarack Lake. This division is unexpectedly corroborated by the observation of Prof. W. B. Van Gorder in his remarks upon the flora of Noble County, appended to this report, that "the flora of the western half of the county contains many forms different from the eastern half of the county." This fact is doubtless due to differences of soil and situation, but it emphasizes a contrast for the causes of which we must go back to the earlier portion of the glacial period.

The approximate boundary of the Erie drift has now been traced by the writer from the northeast corner of Wabash County through South Whitley, Larvill, foot of Crooked Lake, Noble County; Albion, Brimfield, Tamarack Lake, Turkey Lake, Steuben County; Hogback, Grass and Gage Lakes to a point on the State line about six miles east of the northwest corner of Steuben County.

The topographical structure and surface features of Noble County may be briefly summarized as follows:

The eastern half of the county is occupied by a massive ridge composed of two contiguous Erie moraines, the crest of which has an average elevation of 400 feet above Lake Erie, or 973 feet above tide, rising at some points fifty feet higher, and forming the divide between the basins

of Lake Erie and Lake Michigan. These moraines are terminal, rather than interlobate, in relation to the Erie glacier, because the north segment of its rounded end impinged against the side of the Saginaw glacier. The prevailing surface deposit upon the Erie slope up to the crest is boulder clay.

The western half of the county contains the eastern portions of three terminal moraines of the Saginaw glacier, which join the Erie moraine at right angles: (1) the Turkey Creek moraine in southern Washington, with its connecting spur in western Noble; (2) the Elkhart moraine in southeastern York, extending thence through that township and northeastern Sparta into southeastern Perry and western Elkhart; (3) the Rome City spur of the Pigeon River moraine in northwestern Orange, extending thence into LaGrange County.*

The intermorainic intervals occupy nearly the whole of Elkhart, the northern third of York, small portions of Jefferson and Orange, three-fourths of Perry and Sparta, northeastern Washington and the central part of Noble.

The whole mass of Saginaw drift has been profoundly modified by running water. The drainage from the Erie ice having cut and gashed the material into numerous deep valleys which have since been half filled up with silt, and having spread over the country large quantities of sand and gravel, the overwash from the crest of the Erie moraine. There is almost no clay in sight, the streams having been too rapid to allow of its deposit. The whole region abounds in unusual and surprising features; the half-filled valleys, the large and numerous areas of marsh, the isolated patches of knobs, the irregular and abnormal drainage lines, the chains of lakes strung along the threads of the streams, and the eskers with their accompanying lakes, point to an origin from peculiar conditions and conspire to give to the region an unique interest.

Boulders are everywhere numerous, chiefly granitic and gneissoid in character. Masses of the peculiar jasper conglomerate, which has been traced to its original home in the region north of Lake Huron, are of frequent occurrence, while boulders too large to be handled before breaking up are plentiful, none of extraordinary size were seen. They are rounded and subangular, and devoid of distinctly planed or striated faces.

The vertical range of relief lies within 150 feet, the lowest point being the Elkhart River at the west line of the county, 868 feet, and the highest either the summit in Wayne Township, 1018 feet A. T., or the peaks of the Diamond Lake hills. Other elevations not already given are:

*For knowledge of these moraines west of Noble County, I am indebted to Mr. Fran Leverett, of the United States Geological Survey.

Railroad track at Albion	927 feet A. T.
Summit of hills at Albion	975 " "
Railroad track at Cromwell	938 " "
Railroad track at Brimfield	951 " "
Railroad track at Wawaka	903 " "
Railroad track at Ligonier	893 " "
Railroad track at Rome City	920 " "

The mantle of drift in Noble County is probably nowhere less than 200 feet thick, while upon the crest of the moraine it is nearly 500 feet. Its internal structure, so far as known, presents the usual alternations of sand, gravel and clay. Fountain or flowing wells are numerous, of which the following section of the well of John Pasch, one and a half miles west of Wawaka, is typical.

Gravel	6 feet.
Quicksand	40 "
Blue clay	34 "
Gravel	2 "
Blue clay	77 "
Cemented gravel (very hard)	1 "
	<hr/> 160

During the boring for gas at Albion a very accurate and complete record was kept by Prof. W. B. Van Gorder, who furnishes the following section of the drift:

Yellow clay	10 feet.
Blue clay	10 "
Sand and gravel	115 "
Blue clay	20 "
Sand and gravel with streaks of blue clay	50 "
Blue clay	2 "
Sand and gravel	81 "
Blue clay	2 "
Quicksand	5 "
Blue clay	24 "
Quicksand	4 "
Blue clay	7 "
Sand and blue clay	10 "
Gravel	5 "
Red boulder clay	15 "
Sand	5 "
Slate	1 "
Sand	9 "
Total depth	<hr/> 375 feet.

Some features of this section are worthy of note. Of the whole 375 feet only 100 feet contains any clay. Of the upper 295 feet only about 50 feet is clay. The occurrence of 15 feet of red boulder clay at a depth

of 345 feet, its surface 30 feet above bed rock, indicates a period of oxidation due to exposure to air and rain-water. The section of drift in the boring for gas at Butler, Dekalb County,* exhibits the same peculiarity, which was overlooked at the time. Under 275 feet of gravel and coarse sand was found 40 feet of "red quicksand," its surface 88 feet above bed rock. In the light of recent discussion and opinion among glacialists, it seems probable that these oxidized strata near the bottom may form the upper member of "the older drift," a sheet deposited during a previous glacial period, exposed to air and rain during a long interglacial period, and finally buried under the more voluminous deposits of the second ice sheets.

Details of the boring at Kendallville are not at hand, but the section is said by Prof. Van Gorder to have been very similar to that at Albion except that the drift was about 100 feet deeper.

Of the geological formations underlying the drift in Noble County, our only information comes from the careful observation of Prof. Van Gorder at Albion. He furnishes the following section:

Drift	375 feet.
Devonian black slate	65 "
Hamilton and corniferous limestone	65 "
Oriskany sandstone	5 "
Lower helderberg	168 "
Water line (containing crystals of gypsum)	152 "
Niagara limestone	400 "
Niagara shale	20 "
Clinton (red from presence of hematite).	30 "
Clinton shale	16 "
Medina (?)	59 "
Hudson River limestone and shale	85 "
Hudson River shale	200 "
Utica shale	156 "
Utica slate	94 "
Trenton limestone	24 "

1,914 feet.

The identification of Clinton beds is probably correct; of Medina, doubtful. Analysis of the supposed Medina rock from samples furnished by Professor Van Gorder, shows the following composition:

Calcium carbonate	25.8
Magnesium carbonate	38.0
Ferric oxide	5.0
Silica	14.0
Undetermined	17.2
	100.0

*16th Report of the State Geologist, p. 103.

In the absence of fossils the true relation of this stratum remains uncertain. A geologist who spends but a few days or weeks in a given region can report very little of value in regard to its natural history. Such work requires the patient and careful attention of years. Fortunately Noble County possesses a citizen who has had the happy combination of taste, ability and opportunity, which has enabled him to do thorough and trustworthy work in botany and zoölogy. Prof. W. B. Van Gorder, of Albion, is a native of Noble County, and was for several years County Superintendent of Schools. In 1884 he published at his own expense a catalogue of the Flora of Noble County, which has been ever since a standard authority upon the flora of this portion of the State. The catalogue is here reprinted with corrections and additions to date (1893), thus making available to all an important contribution to the natural history of Indiana. A hasty comparison of this catalogue with that of Mr. Bradner, of the Flora of Steuben County, published in the 17th Report of the State Geologist, suggests some interesting facts. Of the phænogams and ferns of Steuben County, 723 species are reported; of Noble County, 724. The two counties are contiguous at their corners and in general present much similarity of soil and situation; yet of the 723 species of Steuben, 199 have not been found in Noble, and of the 724 species of Noble, 182 have not been found in Steuben. Of the 900 or more species in both, only about 540, or 60 per cent., are common to both. (A more careful comparison would make these figures more accurate.) The largest percentages of disagreement occur in the orders Leguminosæ Compositæ, Cyperacæ and Gramineæ. A collaboration of all the material by both botanists would eliminate some of the differences, but it is reasonable to suppose that the apparent discrepancy in the two floras is much greater than the actual, and that prolonged study of the territory would increase the list in each county to at least 900 species.