WILLIAM A. RITCHIE

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WAVE-CUT TERRACES in KEUKA VALLEY, OLDER than the RECESSION STAGE of WISCONSIN ICE.

A FORM of OUTWASH DRIFT.

By Frank Carney.

existed in this region in front of the advancing Wisconsin ice, nor to those which on *a priori* grounds probably existed in connection with both the retreat and advance of preceding ice-sheets. There is very slight reason for thinking that the topographic relations of the lowland area north from the Niagara escarpment and the Allegheny plateau section of central and western New York have changed much since the beginning of the Pleistocene period. Such being the case, then the duration of the pre-Wisconsin ice-dammed lakes determined the emphasis of the shore phenomena attained. Existing evidence of these old shore lines must, in most cases, stand for sharp initial development, as the vigorous Wisconsin ice with its great amount of debris tended to obliterate such minor details of pre-Wisconsin topography.

Landwarping.

Geologists early recognized the proof of instability in the altitude of land areas. It was further recognized that the range of vertical variation is not constant for any great horizontal distance. The Great Lakes area has already been shown to be rich in the evidence of such deformations.

That the oscillations in the altitude of northeastern North America incident to the late Wisconsin* stage and the succeeding stage of the Hochelagan formation† represent the entire range of such variations during the Pleistocene period is not necessarily true. With marine fossils in clays and sandy clays 540 to 560 feet above present sea-level,‡ and stream-cut channels at least 630 feet below present sea-level,§ we have an interval of altitude that probably dates from the earliest ice-epoch or even earlier. The surprising erosion in the Seneca Lake Valley at Watkins, N. Y., reported by Tarr, has increased significance when connected with the deductions made by Fairchild concerning the ancient valley that leads into the Sodus Bay arm of Lake Ontario.‖ These deeply buried valleys far inland, and mature but riverless valleys seaward, suggest landwarping of like nature, but of far greater antiquity than that proved in the investigations of the Iroquois beach.

The Alteration of Shore Lines by Later Ice-Invasions.

Partial or complete effacement of the constructional and destructional products of wave and current work in these pre-

* DeGeer, Proc. Boston Soc. Nat. Hist., vol. xxv, pp. 454–477, 1892.

† J. B. Woodworth, New York State Museum, Bulletin 84, p. 204, 1905.

‡ J. B. Woodworth, ibid., pp. 215–216, 1905; ibid., Bulletin 83, pp. 46–50, 1905.

§ R. S. Tarr, American Geologist, vol. xxxiii, p. 277, 1904. Professor Tarr reports a well boring at Watkins, N. Y., 1080 feet deep without reaching rock.

‖ Bulletin Geol. Soc. Am., vol. xvi, pp. 70–71, 1905.

Wisconsin ice-dammed lakes would be expected. The sweep of an ice-invasion, followed by the destructional work of the slowly falling bodies of water marking the period of ice-recession, would necessarily modify, remove or cover such features as terraces in unconsolidated materials, as bars, spits, cusps, etc.; whereas the cliffs and terraces in rock would be much less altered.

The potency of ice as a factor in erosion does not make an identical appeal to all observers; this is when the sculpturing

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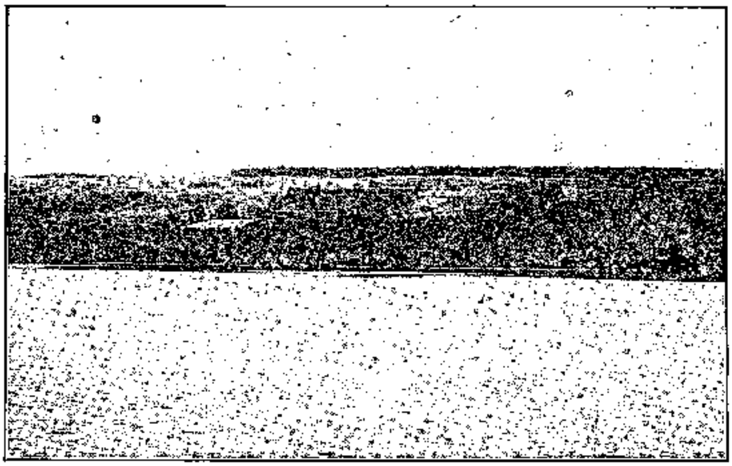

FIG. 1. View just north of Dunning's landing. Terraces No. 2 and No. 3 show here. The steepened slope nearest the lake may represent the lowest terrace altered by ice-erosion.

of bed-rock is under consideration. So it is possible that all will consent to the general, though not complete, removal by erosion of the constructional products of lake waves and currents. As a matter of field study, however, it may as well be granted that these constructional forms have been entirely obliterated; the differentiation of a bar, or delta belonging to some pre-Wisconsin lake, from the water-laid portions of glacial drift would require an environment unusually free of other deposits. But we must grant that cliffs and terraces formed in rock would be less affected by glacial erosion.

The extent to which these cliffs might be modified by erosion would depend upon their topographic relations. Ice abrasion is more effective on the slopes opposed to ice motion; it is more effective also along the lower contours of the walls of the valleys trending with the direction of the moving ice. Hence in a series of terraces along a valley wall, the lowest one would be the most modified by glacier ice.

The beach structures of these former lakes have suffered further from wave work of more recent water bodies, especially of the high-level lakes. The degree of effacement through this agency depends upon the coincidence of the surface-planes of the two bodies of water, or upon their approximation to coincidence; if these planes intersected at a very slight angle, the vertical range of beach agents would at least partially overlap for a considerable horizontal distance; if the planes were actually coincident, then the extent of the defacement would depend largely upon the relative duration of the two bodies of water.

Probably the most effective agency in the obliteration of these shore structures is the deposit of drift made by an ice sheet. Within the belts of thickened drift the burial must be quite complete, the chances of survival being greater with the higher beaches. But at all levels the mantle of ground moraine would in any event partially cover the weaker expressions of wave and current work. And even the pronounced cliffs and terraces might be covered in places.

Furthermore, normal subaerial weathering has tended to render less obvious such remnants of these old beaches as have survived the factors above described; the least changed would be the forms cut in the more resistent rocks.

Forms which Simulate Wave-cut Terraces.

1. Variation in the texture of rocks is manifest in differential weathering;* sharp slopes simulating cliffs may be thus produced. The resemblance, however, leads to confusion only when the plane of the lake surface coincides with, or is parallel to and vertically within a few feet of the hard layer or horizon of rock which marks the bench; such a ledge, in the absence of a terrace or other evidence of a beach, cannot be defined finally as a wave-cut cliff. The attitude of a bench resulting from weathering, in reference to the horizon, depends upon the dip and strike of the hard layers; because of this fact, it is not difficult to distinguish the wave-cut cliff, except when the bench is discontinuous, showing only in short segments, a condition not unusual in the coarse sandstone horizons because of the horizontal variations in texture.

2. Streams held against a slope, or against a rock salient, by ice, often form a bench somewhat simulating a wave-cut terrace and cliff.† Such benches have been investigated by Fair-

* T. L. Watson, N. Y. State Mus., 51st Ann. Rep., vol. i, p. r76, 1897.

† G. K, Gilbert, Bulletin Geol. Soc. Am., vol. viii, p. 285, 1897.

child,* who shows how the banks of glacial drainage streams differ from the wave-cut cliff.† The latter is not so localized as the former, nor, in general, so marked in development.

Considerable effort was devoted to explaining the terraces in question as the result of differential weathering. The other explanation, ice-stream work, was easily eliminated. The third interpretation discussed in this paper suggested itself after it became apparent that neither of the other two was pertinent.

Stratigraphy of Bluff Point.‡

The succession of formations as given in Bulletin 101 of the N. Y. State Museum (which appeared after the close of the

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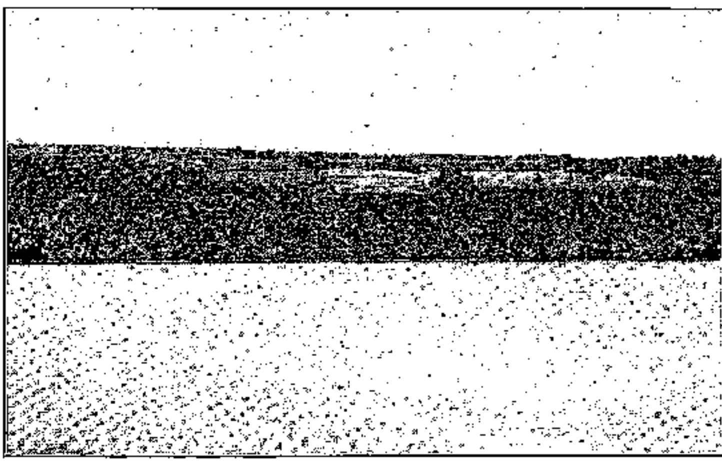

FIG. 2. View of west shore of Penn Yan branch about two miles north of Dunning's landing. Shows terrace No. 2, and what is apparently the lowest terrace altered probably by ice-erosion.

field season during which this study of wave-cut terraces was prosecuted), a report prepared by Luther, has been used by the writer in checking up his field notes on the stratigraphy of the area involved; these notes concern only the lithological aspect of the formations exposed, and since the slopes of Bluff Point are rather sharp, the rock section is almost complete.

The compact sandstone layer, referred to by Clarke and Luther, about 125 feet above the base of the Cashaqua as revealed in the Naples region,§ appears near Keuka Park and

* N. Y. State Mus., 22d Rep. of State Geologist, pp. r23–r30, 1902.

† Ibid., 21st Rep. of State Geologist, pp. r33–r35, 1901.

‡ The Penn Yan Quadrangle will serve as an index map for this region.

§ N. Y. State Mus., Bulletin 63, p. 31, 1904.

persists southward about one and one-half miles; much of this distance it forms a prominent bench.

The next formation that might include beds for registering differential weathering effects is the Hatch shales and flags, which attain a thickness of about 300 feet.* Along the slopes of Bluff Point the sandy layers of this formation, though irregular in both horizontal and vertical distribution, are conspicuous. The greatest thickness of shale noted in any exposure is about 12 feet; the base of this horizon is 261 feet (corrected aneroid reading) above lake-level; it could not be demonstrated that this horizon of shale had much horizontal extension. Likewise the arenaceous layers, the heaviest noted being under 2 feet, do not persist horizontally.

Next in rising section is the Grimes sandstone, estimated by Luther to be 75 feet thick.† This formation is above the terraces in question, so its characteristics do not concern us.

It appears, therefore, that there is no factor in the stratigraphy of this area to account for the marked benches. No conditions could be more favorable for registering the differential effects of weathering than the topography formed by this peninsula of rock dividing the two arms of Keuka Lake.

Cliffs in Keuka Valley.

The succession of post-Wisconsin high level lakes that formerly occupied this region has been worked out by Fairchild. He designates the overflow channels of the principal stages, correlates the deltas, and points out some localities of wave-work.‡

The terraces and cliffs which occasion the present paper have been studied in some detail along the flanks of Bluff Point. Terraces apparently of the same age have been noted elsewhere on the walls of Keuka valley, but have not been critically examined.

The most obvious reason for not associating these cliffs and terraces with the work already done is the fact that they are overlain and intersected by lines of Wisconsin drift. This drift is in place, and so far as observed, shows no evidence of wave-work along the planes of the terraces in question; furthermore, the drift is particularly well developed where it crosses the terraces (fig. 3).

These terraces, designated by numerals, are described in regular order ascending from present lake-level:

No. 1. This is not a clear case. For some distance south-

* D. D. Luther, N. Y. State Mus., Bulletin 101, p. 47, 1906.

† Ibid., p. 49, 1906.

‡ This Journal, vol. vii, pp. 255–56, 258, 1899; Bulletin Geol. Soc. Am., vol. x, pp. 4–41, 1899.

ward from Keuka Park is a bench and terrace; the relation here is conspicuous enough, but the cliff consists of the hard beds in the Cashaqua already alluded to; it stands about 70 feet above the lake, but descends southward. There is, however, a persistent suggestion of a bench southward to vicinity of Dunning's, not a continuous shoulder, but a recurrence of over-steepened short slopes forming a plane that ultimately dips beneath the water. That the intervals of these benches are connected genetically with the more continuous shoulder and terrace to the north is not established. Furthermore, the

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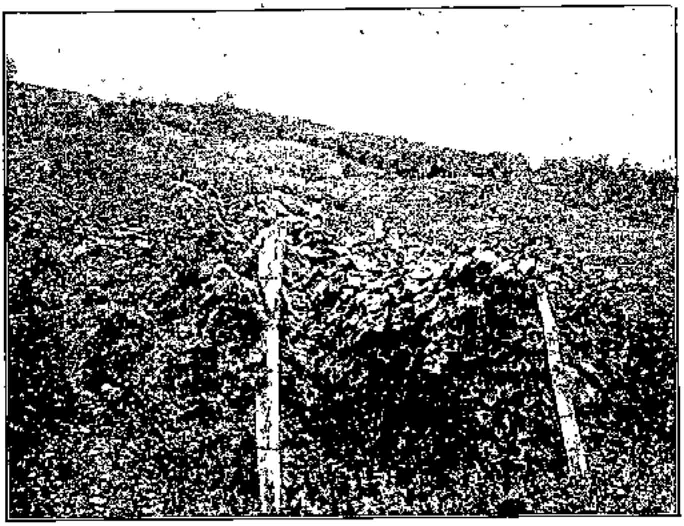

Fig. 3. Shows a lateral moraine which crosses the middle and highest terraces, and descends to lake level south of Ogoyago.

discontinuity southward of the better developed cliff is possibly due to the vigorous ice-erosion that altered the lower horizons of the walls of these longitudinal valleys.

No. 2. This bench and terrace first shows about two and one-half miles north of Dunning's Landing. It is remarkably continuous (figs. 1, 2), and generally sharp in development. At one locality towards the north, where the eastern slope of Bluff Point blends into the northern slope, the twelve foot horizon of shale, mentioned in preceding section, was noted; here the shale is nearer the top of the bench; not much importance, however, is attached to this vertical position, further than to note that it could have no genetic association with the bench. The original relationship of terrace and cliff, so far as analysis of a particular cross-section is concerned, has been given much indefiniteness by the agents of degradation; whereas this relationship is still conspicuous when viewed from a distance.

As a distinct feature of the slope, this terrace disappears where the valley wall becomes very steep towards the southern end of the *Bluff*. The till at the end of the Bluff is made up largely of local material; there is other evidence also of vigorous corrasive work by the glacier on the slopes near the end of Bluff Point.

No. 3. On the supposition that these terraces represent a body of water that fell successively to the levels indicated, terrace No. 3 is the oldest; but the difference in the degree of weathering attained, or in the sharpness of profile, is not noticeable. This terrace apparently does not extend as far north as No. 2; there is, however, some obscurity in this direction due to its disappearing beneath a wide band of drift. Furthermore its identification is not obvious quite as far south as Ogoyago; so terrace No. 3, in linear extent, falls short of the next lower terrace.

Time Periods of these Cliffs.

The measure of post-Pleistocene time has been attempted through several lines of observations: The years involved in the carving of the Niagara and other gorges, in the construction of flood plains, etc., have been estimated relatively to units which do not admit of very accurate determination because of the interdependence of degradational activities, a variation in any one of which would give the units quite different values. Time-ratios of the continuity of certain phases of geological activities are less objectionable.

From a study of the extent to which erosion has effected the several sheets of till, certain ratios have been deduced using the erosion period of the Late Wisconsin drift as a time-datum. The approximate value of this ratio, which may be subject to alteration through the acquirement of new facts, for the Early Wisconsin is 2; for the Iowan, 4; for the Illinoian, 8; for the Kansan, 16.* The drift of the Mississippi Basin has furnished most of the data concerning these epochs of glaciation. It has already been established that the glacial period in the East

* Chamberlin and Salisbury, Geology, vol. iii, pp. 413–421, 1906. Here is found a succinct presentation of the data on which are based the relative time-periods of the stages of the Glacial Period.

was also composite;* but a parallelism of epochs has not been worked out.

For the purposes of the present paper, however, it is assumed that the Lake Region of New York had been glaciated previous to the Late Wisconsin stage, an hypothesis already used by others;† and that the interval or intervals of deglaciation were not shorter than the time-ratios held tentatively for the Mississippian area.

Illustrations of the wave-cutting work done by some of the Finger Lakes since they were lowered to their present levels are common in geological literature.‡ One who is acquainted with Seneca Lake will recall the high cliff on the east shore near Watkins, at the head of the lake; and other localities along this lake show quite as marked wave-work. Along the present shore of Keuka Lake the cliffs are not so well developed, but benches of 20 feet or more are not uncommon.

If lakes occupied these longitudinal valleys during the interims of glaciation, cliff-cutting could have proceeded to such an extent as to make survival in certain localities, at least, probable. Even the shortest inter-glacial period, on the assumption that the stages of the ice age represent oscillations of the ice from continuously ice-covered dispersion areas, was much longer than post-Wisconsin time, which has sufficed for defining exact shore lines. But terrace No. 3 has an altitude that is impossible if the body of water with which it is genetically connected discharged over any of the present cols leading into the Susquehanna area; all of the overflow channels reported for the Keuka valley are too low. It may be said, however, that many of these interlocking valleys of the St. Lawrence-Susquehanna basins, through which the waters of the high-level ice-front lakes spilled, have local characteristics which are not normal to the regular development of valleys; the conditions here alluded to will be discussed in a separate paper, since the problem constitutes a unit of investigation. Nevertheless there is nothing incompatible between the altitude of terrace No. 3 and a land ice-locked basin for a body of water.

Deformation of these old Shore Lines.

From data supplied by Gilbert, it has been estimated that the post-Wisconsin deformation of the Iroquois shore line in

*R. D. Salisbury, Geol. Surv. of New Jersey, Ann. Rep. for 1893, pp. 73, etc.; J. B. Woodworth, N. Y. State Mus., Bulletin 48, pp. 618–670, 1901; F. Carney, Journal Geology, vol. xv, 1907.

†R. S. Tarr, American Geologist, vol. xxxiii, p. 284, 1904; H. L. Fairchild, Bulletin Geol. Soc. Am., vol. xvi, p. 66, 1905.

‡Natural Hist. of N. Y., Part IV, Geology, p. 192, 1843; R. S. Tarr, Elementary Geology, p. 279, 1898; LeConte, Elements of Geology, p. 236, 1905.

Cayuga valley is 2·7 feet per mile.* Fairchild measures the warp of the Dana beach in the Seneca valley at 3 feet per mile.† In reference to the shore phenomena with which we are concerned the latter beach is more pertinent in location, and slightly less dissimilar in age. The pre-Wisconsin shore lines embody whatever tilting is shown by the post-Wisconsin water-levels, plus any earlier deformation that remained uncorrected by later land movements.

The shore lines shown in figs. 1 and 2 have obviously a greater tilt than has been reported for the post-Wisconsin beaches. No instrumental measurements of the deformation have been made, though an attempt was made by a long series of aneroid readings, checked with a bench aneroid,‡ to approximate a degree of correctness; but the line of contact between cliff and terrace is so obscured by products of weathering and glacial drift that it is impossible to get any results from this method, although the line is distinct enough when viewed from a distance. It is apparent to the eye that the highest, and presumably the oldest, terrace is the most warped.

The existence of these wave-cut cliffs, older than the Late Wisconsin stage, and their present attitude in reference to the horizon, suggest a relation of factors that have a bearing on a phase in the drainage history of the St. Lawrence-Susquehanna divide region, and on the question of ice-erosion in the Finger Lake valleys. A reference to the drainage problem was made under the preceding section. The connection with the ice-erosion problem, briefly stated, is this: These old cliffs imply an ice-dammed lake that was not ephemeral; the topography admits such a lake only when the ice-front is nearby. With such a position for the ice west of the Seneca valley, both it and the Cayuga valley were occupied by lobes from the main body of ice. Such lobes, it has been suggested,§ would be competent to accomplish erosion; the non-existence of such lobes has been hypothecated on the absence of moraine belts, hence it is claimed that there was no erosion.‖ But since the stage of glaciation concerned antedated the Late Wisconsin which extended into Pennsylvania, the normal imbrication arrangement of drift sheets may explain the absence of the recessional moraine correlating with the ice-halt that was contemporaneous with the cliff-cutting and the over-steepening of

* R. S. Tarr, Journal Geology, vol. xii, pp. 79–80, 1904.

† Bulletin Geol. Soc. Am., vol. x, p. 68, 1899.

‡ In the Journal of Geology, vol. xiv, 1907, the writer explains this method of working aneroids in pairs. (p. 492.

§ H. L. Fairchild, Ice Erosion Theory a Fallacy, Bull. Geol. Soc. Am., vol. xvi, p. 58.

‖ Ibid., pp. 59–60.

the lower contours in the Seneca and Cayuga valleys by ice-erosion.

Summary.

The cliffs described in this paper are the product of wave-work since they show no connection with such variation in stratigraphical structure as often produce benches, and since it has been found impossible to account for them in any other manner; furthermore, the presence of a cliff-cutting body of water is attested indirectly by other phases in the drainage and ice-erosion history of the region. That these shore lines are older than the recession stage of the Wisconsin (Late) ice sheet, follows from their being overlain by intersecting bands of Wisconsin drift.

ART. XXXI.—*A Form of Outwash Drift;* by FRANK CARNEY.

THE triangular area indicated in fig. 1 encloses a formation of outwash drift in an association undescribed in the literature so far as the writer is aware. This drift forms a terrace in the gradual slope to the north, the decline being about 500 feet in three and one-half miles. Approaching the area along the highway from Bluff Point postoffice (v. Penn Yan Quadrangle, N. Y.), one notes the closeness of rock to the surface and the general absence of glacial drift. The slope, though gradual, is presumably the resultant of stream work, being the south wall of an old valley, and of ice-corrasion; but the marked change as one nears this triangle is due to an unusual accumulation of drift which is somewhat interlobate in origin; but the further differences between this and the typical outwash plain are so marked as to warrant a more definite description, and possibly a distinct designation.

Topography of the Region.

The drift under consideration lies on the north slope of Hall's peninsula,* designated on the Penn Yan quadrangle as Bluff Point, which attains an elevation of 700 feet above lake level. A nine-mile cross section, having a general east-west direction through the highest part of Bluff Point, resembles the letter "W", the inner legs being steepest but symmetrical to a vertical axis, while the left or west of the outer legs is the longer and has a gentler slope. The general relation of the two arms of Lake Keuka is strikingly suggestive of an originally south-flowing stream, the valley of which has been blocked by a great mass of glacial drift southwest of Hammondsport, a village at the southern end of this body of water, thus giving rise to the lake, which now has an outlet past Penn Yan into the Seneca valley. Obviously this cross-section, W-like in shape, is made at the junction of the old south-flowing river and a tributary.

The general topography of the Finger Lake region, so frequently alluded to in geological articles, is a systematic assemblage of trough-like valleys opening into the Ontario lowland. Presumably the bed rock of these troughs slopes northward, as do also the divides between them. The Penn Yan quadrangle extends almost to the edge of this Ontario lowland. The Drumlin region reaches its maximum southern extension north

* James Hall, Geology of the Fourth District, Natural History of N. Y., Part IV, p. 459, 1843.

of the Penn Yan sheet, and a few miles southwest of Geneva, which lies within the flaring walls of the Seneca valley.

Ice-Front and Drift as Affected by Topography.

The Ontario lobe, as the ice which occupied this lowland is designated, maintained along its southern margin, during the

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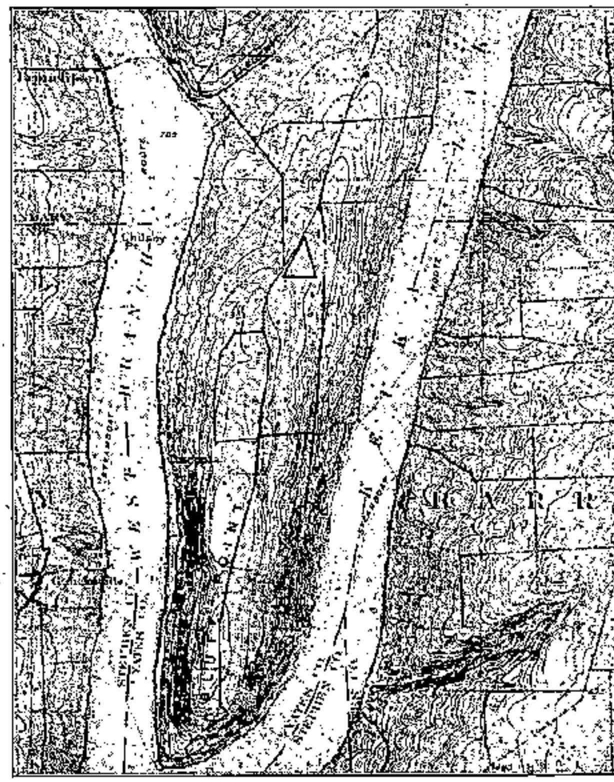

Fig. 1. A part of the Penn Yan (N. Y.) Quadrangle.

advance and retreat of the ice sheet, valley dependencies, the development of which was directly in proportion to the depth of the troughs above alluded to. Of these troughs those of the Seneca and Cayuga valleys are the deepest and therefore probably were occupied longest by tongue-like projections of ice. Contiguous to these troughs are upland valleys which were also occupied by ice showing more or less dependence upon the lobes lying in the Seneca and Cayuga valleys. But as the general border of the ice retreated, the divide ridges separating these trough-like valleys were revealed farther and farther to the north between the converging lines of ice; and in an analogous manner the lesser divides marking and forming the valleys contiguous to the Cayuga and Seneca troughs became reëntrant angles between converging walls of ice. It is the work of two such lesser valley dependencies that is supposed to have given rise to the peculiar drift accumulation with which we are concerned.

A study of the drift about Penn Yan reveals a massive accumulation of debris which begins southward a mile or so from Milo Center and continues a mile or more north of Penn Yan. This moraine, approximately three miles wide, suggests a very slow retreat of the ice in this region. It is evident also that this wide band of moraine represents more than the decay of the ice reaching out from the Ontario lobe into Seneca valley. It more likely is an indication of the general northwest trend of the ice-front crossing Flint, Naples, and Canandaigua valleys. When the ice stood with a reëntrant angle approximately at Milo Center, the Seneca tongue reached many miles southward towards Watkins, while the lesser lobe in the Keuka valley was shorter. A detail of this lesser lobe evidently would give two tongues of ice, one occupying each arm of Keuka lake, with the reëntrant angle along the north-south axis of Bluff Point, and the drift of our triangular area (fig. 1) in process of construction.

Along the margin of these valley lobes drift ridges, often widening into morainic areas, were being formed. The uniformity of such ridges as traced by Tarr on the Watkins quadrangle has suggested the characterization, "almost diagrammatic in their simplicity."* Each such moraine is indicative of stability in the reach of a valley lobe. Two contiguous valleys as those of Keuka and Seneca lakes would give us contemporaneously formed contouring moraines. The particular form assumed by the glacial debris at the angle of two such contiguous moraines will depend in the first place upon the northward slope of the divide; in the second place, upon the debris melted out of the ice at this particular point; and, in the third place, upon the amount of glacial drainage diverging at this point, carrying the material thus melted along the margin of the valley lobes.

From a study of these intertrough divides of the Finger Lake region, it is noted that their northward slope is gradual. The

*Bull. Geol. Soc. Am., vol. xvi, p. 218, 1905.

normal condition then of drift where the lateral moraines of two adjacent lobes unite reveals no special thickening. Where, however, the slope of the divide in question is steepened, and the ice immediately northward is perhaps more stagnant, or where it contains less debris, then we would anticipate a tendency toward the general removal of such debris, and the axis of the slope or divide would have less than the normal veneer of drift. On the other hand, when the axis of the northward slope is more in line with the general deployment of the ice, the chances for the accumulation of drift will certainly be enhanced. It should be noted that the northern part of the longitudinal axis of Bluff Point does trend to the east quite in unison with the direct deployment of ice from the Seneca lake lobe. This being the case then, we have the hypothetical conditions favorable to an assemblage of debris in the triangular area.

There is, however, still a further factor that favors accumulation of the drift, which is operative when the divide flattens immediately to the north, a topographic relationship due to the drainage history of the uplands or divide areas between these northward opening troughs. This fact taken in conjunction with the one just mentioned, that is, when the topography favors free movement from the major lobe, thus directing thitherward more active ice with this load of debris, will give us the conditions that account for the peculiar localization of the drift of the area under discussion.

Description of the Drift in Question.

A detailed study of this particular interlobate outwash material reveals the following facts: (1) the ice-contact face is not accentuated, that is, there is no cliff or terrace to suggest the speedy withdrawal of the ice from a position of long halt; (2) the northern part of the accumulation presents a subdued morainic surface; (3) rather numerous bowlders may be seen, some of which are the largest noted in the region. To the southward, however, this morainic topography gradually blends into a normal outwash slope. The control exercised by the falling contours of the rock slopes both east and west, is manifest in the expanding outwash when considered in connection with the moraine to which it belongs, and in the gradual falling contours of the outwash, i. e., this development of drift has something of a saddle form. Judged from the surface appearance—there is an absence of sections—the outwash material is entirely normal; there is a blending distally from coarser to finer sediments, with a few bumps suggestive of kame topography.

Proceeding southward from this area along the east slope of Bluff Point, one traces a very sharp lateral moraine marking the position of the valley tongue which occupied the Penn Yan arm of the lake contemporaneously with the building up of the outwash. This band of lateral moraine may be traced without a break until it disappears beneath the surface of the lake at a point a little south of Ogoyago. The counterpart of this band of drift on the eastern wall of the Penn Yan branch has not been traced continuously. It has been picked up, however, along the highway directly west of Warsaw, also to a point northeast of Crosby, and continuously traced where it makes the angle around the divide west of Himrods, blending then into marginal drift of the Seneca valley lobe.

But the moraine which marks the position of the valley dependency occupying the west branch of Keuka lake, at the time the outwash was developing, attained only faint expression. Its most pronounced development exists through the first mile and one-half southwest of the drift in question. From that point one cannot be certain of the outline of this valley dependency. Its form, as suggested by drift flanking the west wall of this branch of the lake, has not been investigated.

The Normal Outwash Plain.

Chamberlin cites* references to descriptions of the general type of "glacio-fluvial aprons," variously named by geologists from 1874-1893. But a precise summary of the terminology of the deposits made by glacial waters, together with accurate distinctions on genetic and topographic principles,† appeared in 1902 in Salisbury's Glacial Geology of New Jersey, from which we quote: "Where the subglacial streams did not occupy subglacial valleys, they did not always find valleys at hand when they issued from the ice. Under such circumstances, each heavily loaded stream coming out from beneath the ice tended to develop a plain of stratified material (a sort of alluvial fan), near its point of issue. Where several such streams came out from beneath the ice near one another for a considerable period of time, their several plains, or fans, were likely to become continuous by lateral growth. . . . . Thus arose the type of stratified drift variously known as overwash plains, outwash plains, morainic plains, and morainic aprons."‡

This definition of an outwash plain leaves no uncertainty: genetically it results where there is a lack of alignment between

*Glacial Phenomena of North America, in Geikie's "The Great Ice Age," footnote p. 751, 1894.

†Brief descriptions are also given in Chamberlin and Salisbury, Geology, vol. i, p. 306; vol. iii, p. 372, 1906.

‡Geological Survey of New Jersey, vol. v, pp. 128-9, 1902.

subglacial valleys and subglacial loaded streams; topographically these streams should flow out upon a plain where their individual fans may coalesce. It is also evident, as Salisbury states elsewhere, that the degree of development of this drift-form varies with the time the ice stands at a given halt.

Woodworth alludes* to a washed drift which confronts the terminal moraine on Long Island; this formation, as described, is a normal outwash plain.

In his description of the drift in southern Wisconsin, Alden† describes an "outwash apron" which constitutes a portion of the deposits in the interlobate angle between the Lake Michigan Glacier and the Delavan lobe; his usage of the term outwash elsewhere in the paper is also in accord with the standard of definition.

In applying this definition to the localization of drift referred to on the north slope of Bluff Point, we note the following facts: (1) the absence of an initial plain, (2) the probable absence of a strong subglacial stream, (3) a constancy in the position of adjacent ice-lobes which built up lateral moraines, (4) a synchronous accumulation of debris at the reëntrant ice-angle, (5) diverging slopes to the south that insured rather active drainage away from this angle, and (6) a single alluvial fan-like body of washed drift blending northward into moraine.

The normal outwash plain is an assemblage of such alluvial fan-like units. The drift in question is quite identical with an outwash plain in structure, but different from it in degree of development and in topographic environment; ignoring the latter discrepancy, we may say it is a very subdued form of outwash plain that represents a constant position of the ice at the junction of two rather small valley dependencies.

Since Bluff Point is a not uncommon type of topography in the Finger Lake region, and since the writer has mapped on the Moravia quadrangle similar deposits of drift, he suggests, as a designation for such deposits, the term *inter-lobule* (or inter-tongue) *fan*.

* N. Y. State Mus., Bulletin 84, p. 90, 1905.

† Professional Paper, No. 34, U. S. Geol. Surv., pp. 31-2, 1904.