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THE DANSVILLE VALLEY

AND

DRAINAGE HISTORY OF WESTERN NEW YORK

BY

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Introduction

The handsome valley which holds the village of Dansville is unexcelled among the many beautiful valleys of central and western New York. All of these valleys have been carved by rivers in the horizontal rock strata. As the Dansville valley today has no river, only the weak and ineffective Canaseraga Creek, evidently there is something peculiar and anomalous in its history. The river which produced the valley is non-existent, and apparently became extinct long ages ago. What force, event or cataclysm suppressed the river? Can we, from the geologic record, unravel the story of the unfortunate river and learn its life-history; its origin, relations and disappearance? The search will involve the drainage history of all the western half of New York through the millions of years of geologic time. So the valley is an appropriate title or text for an essay on the evolution and history of the drainage and the valley topography of western New York.

The directions of the present stream flow in New York are diverse, inconsistent and contradictory.[1] And when we include some old and capacious valleys which have lost their producing rivers the complexity is greater. The mature and splendid Dansville Valley belongs in the latter class. It is the record of an ancient and far-extended phase in the development of the New York valleys which ended with the Glacial Period.

Rivers are the valley-makers. In regions of horizontal rocks no other agency can produce valleys. In regions of disturbance and wrinkling of the earth's surficial crust some valleys are produced by dislocation, or by the down-folding, of the rock strata. But in central and western New York the strata are practically undisturbed and horizontal. The slight dip or southerly down-slope, averaging perhaps sixty feet per mile, is negligible in this study of the valleys.

All the valleys of western New York were carved in the horizontal strata by stream erosion, with the co-operation of destructive atmospheric action on the valley walls. And the process is yet active and must continue while water runs down hill and can find dry land on which to flow.

It is evident, therefore, that for the origin of the Dansville Valley, as for other capacious valleys without rivers today, we must search in the past history of the region for an ancient river of sufficient erosional power.

For this study the reader should have in hand the following sheets of the New York topographic map: Caledonia, Honeoye, Canandaigua, Nunda, Wayland, Naples, Canaseraga, Hornell and Bath. Plate 82 is a reduced map from the last six of these sheets.

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[1] Turning to an atlas the reader will see the Genesee River flowing north entirely across the State; the Finger Lakes draining north and then east by the Seneca River; the Allegany finally turning south; the Chemung branches flowing southeast; the branches of the Susquehanna flowing southwest; the Tonawanda north and then westward; with minor streams in all possible directions.

DRAINAGE AREA OF THE PRE-GLACIAL DANSVILLE RIVER

The broken line is the present divide between northward and southward stream-flow

Stages in the Drainage Evolution

The history of stream work in New York, or the development of the valleys, is divisible into four fairly distinct geologic phases. They may be briefly described as follows:

(1). The original, primitive, stream work which was initiated when the ancient sea-bottom, of oceanic deposits, was lifted up to become dry land.

(2). The slow changes in direction of the river flow, produced by the adjustment of the streams to the unequal resistance (to erosion) of the rock strata.

(3). The blocking of drainage and final extinguishing of all the streams by the irresistible invasion of a continental ice sheet, the Quebec glacier.

(4). The present, Postglacial, renewal of drainage, but with greatly changed and inconsistent directions of flow.

Between the first and second stages there was no separation. Through many tens of millions of years the early drainage slowly changed into the second stage. The third stage came more promptly and lasted many scores of thousands of years. The fourth, or present-time, phase has been here only a few tens of thousands of years.

The Dansville valley was eroded in the Devonian sandstones and shales during the immensely long second stage. The ruthless work of the glacier, in the third stage, robbed the valley of its great producing river, and filled the upper stretch with rock-rubbish or glacial drift. The valley is a superior example of the evolution of western New York drainage, as its story illustrates all the phases and vicissitudes in the geologic history. It is necessary to describe the several stages with some detail.

Stage 1. Primitive Stream Flow

The western half of New York was slowly lifted out of the interior ("epicontinental") sea in very ancient geologic time. The rise was progressive from north to south. The northern district (Canada) emerged first, and the continued rise, with many minor ups-and-downs, forced the limit or shoreline of the oceanic waters southward into Pennsylvania.

The earliest rivers on the newly exposed land surface flowed southward into the receding ocean, and their courses were extended as the land rose and the sea retreated.

For this original or primitive drainage the physiographers apply the term "consequent."

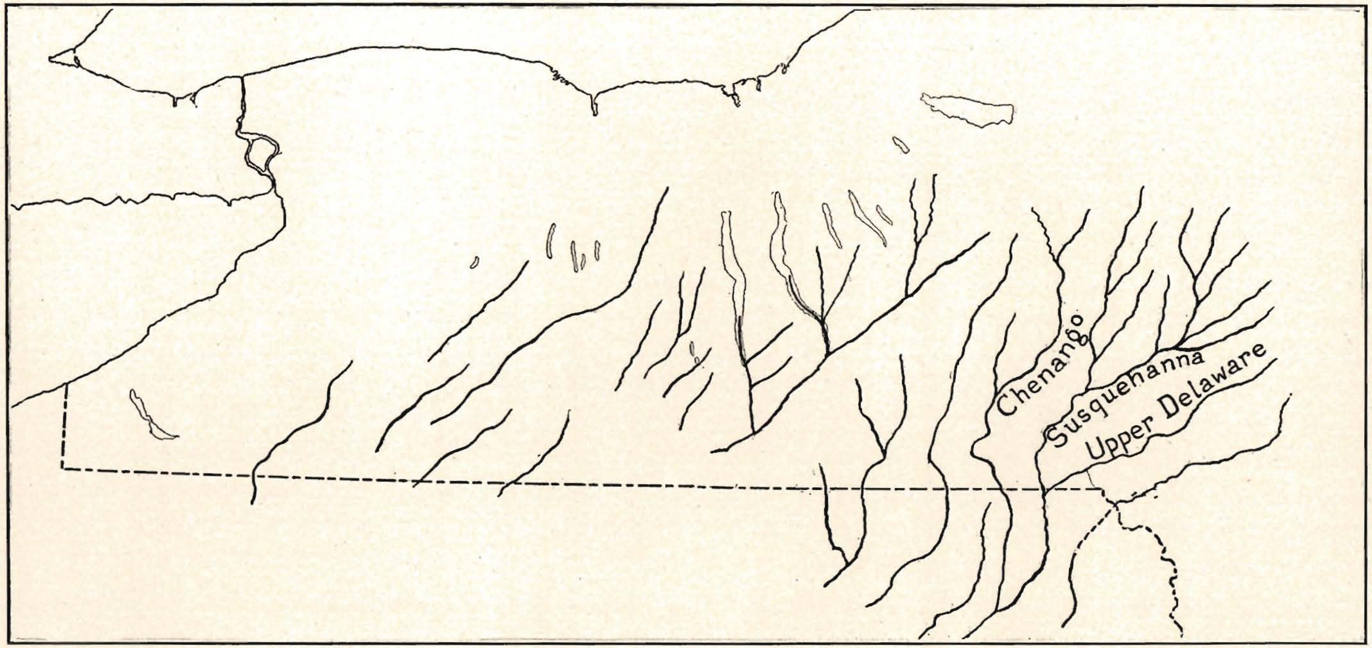
At that early stage there was no Ontario basin, nor Mohawk valley, but an unbroken south-sloping plain extending from Canada to Pennsylvania.

Most of that very ancient (Paleozoic) drainage is obliterated or obscured, but fortunately, a few existing valleys appear to be inheritances from that earliest drainage. The upper branches of the Susquehanna river lie in valleys with southward or southwestward direction, and are regarded as descendants of the primitive flow. Passing eastward these main branches are Otselic, Chenango, Unadilla, Susquehanna and Schenevus. The two upper branches of the Delaware river apparently belong to the primitive drainage.

The original streams, now partially represented by those just named, must have had their sources in the district now occupied by the Adirondack mountains. Their headwaters were cut off by the subsequent development of the east-leading Mohawk valley. In physiographic lingo the primitive, consequent rivers were beheaded by the transverse development of the "subsequent" Mohawk valley, which valley therefore belongs in the second stage of the drainage history. Perhaps some of the streams now flowing southward from the Adirondacks into the Mohawk may be descendants of the original Susquehanna headwaters.

Judging from the general direction of the Susquehanna and Delaware tributaries, and from some older abandoned valleys, (plate 83) the uptilting of the continent which accompanied the primitive drainage, and which was continued later, appears to have been in a general way from northeast to southwest. Some relics of that earliest river-flow are suggested in the wide valleys with southwestward trend that have been abandoned by the streams which produced them. For example, the capacious valley from De Ruyter (Madison County) past Cortland to Freeville (Tompkins County) holds no continuous or effective stream. Other illustrations are suggested in plate 83, which maps the more striking valleys of this class.

It must be realized that the land surface of that early time is not at all the present surface. Atmospheric decay and stream erosion have removed some unknown thickness of rock from all the uplands, while the valleys have been deeply intrenched. The rivers may now be flowing 1,000 or 2,000 feet below the level of their ancestral streams.



LINES OF VERY ANCIENT DRAINAGE

Stage 2. Reversal of Drainage

Plate 84 depicts the supposed drainage of central and western New York after the flow, through many millions of years, had been radically changed in direction. This very remarkable change was produced through the control exercised by the rock strata in which the rivers sank their channels. During the long geologic ages the continent had risen, probably a few thousand feet, and the enlivened ("rejuvenated") rivers were subjected to an influence other than gravitation. This factor was the character of the rocks, not only of the superficial strata, but especially of the underlying and deeper strata which the down-cutting streams encountered. Streams in weak or less resistant strata had erosional advantage over the streams which lay in harder or more resistant rocks. The difference in resistance to decay and to erosion of the rocks in different areas, and even of the same strata in different directions, compelled an adjustment of the stream lines. Eventually this resulted in a complete reversal of the direction of stream flow in all of western New York.

To explain this singular change requires a brief description of the rock strata, or the stratigraphic geology. All the rocks of central and western New York are the consolidated sediments which were laid down on the sinking floor of the shallow inland seas. These are sandstones and shales, composed of sand and clay washed in from adjacent regions of dry land, and limestone, produced from the lime shells and skeletons of marine life.

It so happened that the great thickness, thousands of feet, of the rocks which outcropped at the surface along the northern belt, next to Canada on the west and the Adirondack area on the east, were relatively weak and non-resistant.[2] They were shales, which are easily eroded by atmospheric decay, storm-wash, and stream erosion, and limestone which is soluble in atmospheric or other water charged with carbonic acid. The rocks of the middle belt, and especially of the southern belt, next to Pennsylvania, are more resistant, being mainly sandstone.

While the primitive southwestward-flowing rivers were intrenching themselves in the rising land their east-and-west tributaries that

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[2] Tables, maps and descriptions of the New York rock strata, in their vertical succession and geographic display, are given in publication Nos. 19 and 20 of the appended list of writings.

were lying in the northern belt of weak strata, had great erosional advantage. Eventually these east-and-west flowing streams were able to unite in one great river, with probably westward flow. This "subsequent" river captured all the streams flowing south from Canada, diverting that flow westward to the Mississippi. This master stream we call Ontarian River. During the long geologic eras (Mesozoic and Cenozoic) of many million years, this great river, with the aid of the atmosphere, produced the vast Ontario valley. The continent then stood much higher than today, for the bottom of Lake Ontario is now 500 feet below sea level.

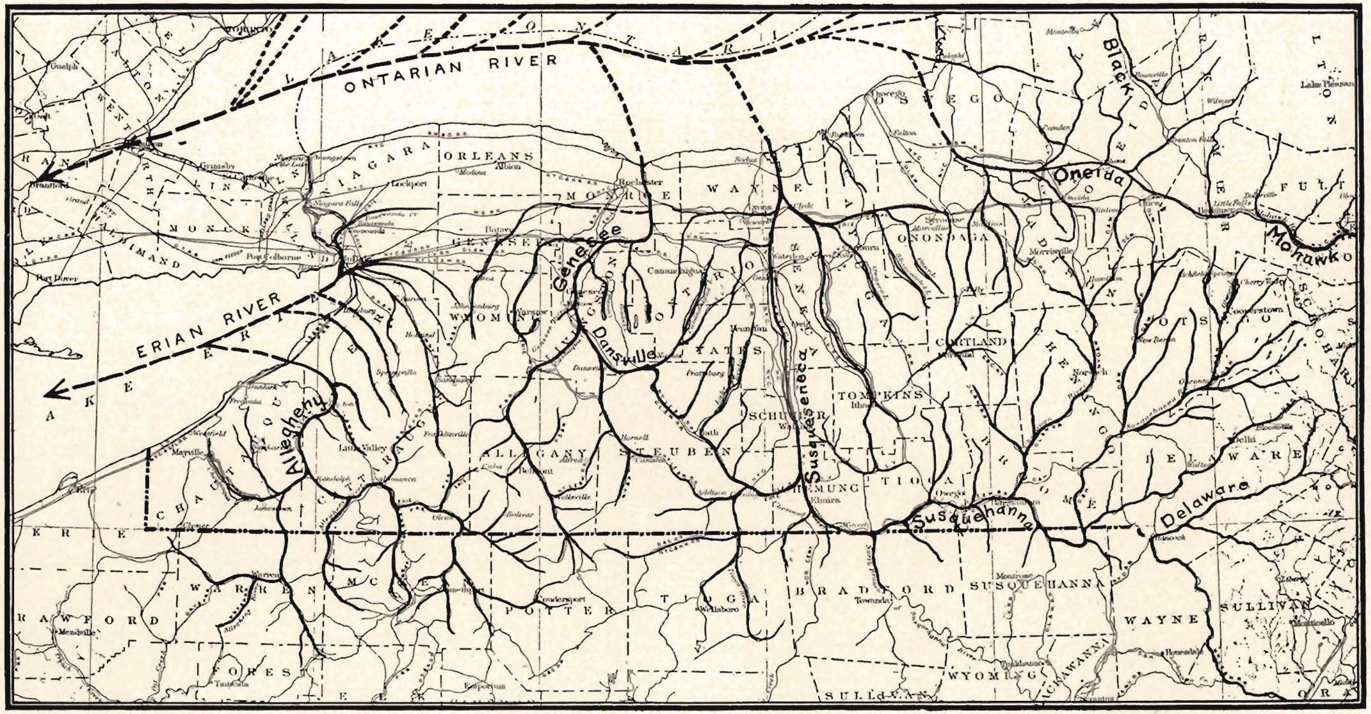
Probably contemporary with the Ontarian river the Mohawk river was developed in similar manner, and diverted the Adirondack flow eastward, as already noted.

Another river system, called Erian, carved the shallow basin that now holds Lake Erie.

Of course the valley of the Ontarian river had a southern wall, down which tributary streams flowed northward. As the Ontarian river deepened and widened its valley its southern tributaries were enlivened, and correspondingly deepened their channels. And as they developed their valleys their headwaters gnawed back (southward) into the hard uplands of the southern belt of the State. Before the Glacial Period (close of the Tertiary) the north-flowing tributaries of the Ontarian and Erian rivers had taken possession of all of central and western New York, and a wide belt of northern Pennsylvania. The Genesee river is a clear example of that northward flow, as it was able to resist the efforts of the ice sheet to wholly block or divert it. With the Dansville valley the glacier was successful, entirely suppressing the river and largely obscuring the former drainage of the district.

West of the upper tributaries of the Susquehanna the direction of flow in New York was practically reversed, turned from southward to northward. It may be incorrect to say that the individual rivers were reversed in direction, but the drainage was reversed by creation and substitution of new north-flowing streams. Probably some of the valleys of the earlier drainage were occupied by the later flow. Physiographers call such reversed drainage "obsequent."

This history explains the origin of the valleys of the Finger Lakes, which are part of the most remarkable series of parallel valleys in the world. These valleys, with or without lakes, are named, passing from west to east, Tonawanda, Oatka, Genesee,



LATE TERTIARY, PRE-GLACIAL, DRAINAGE OF WESTERN NEW YORK

Dansville, Conesus, Hemlock, Honeoye, Bristol, Canandaigua, Flint, Seneca, Cayuga, Owasco, Skaneateles, Otisco, Onondaga, Butternut, Limestone and Chittenango.

The map of Tertiary or Preglacial drainage, as shown in plate 84, requires little explanation. It will be seen that the Susquehanna waters were carried west and then north through the present Seneca valley. We might call that ancient river the Susqueseneca. The story of that river has been told in publication No. 18. The Allegany system drained north into the Erian river. Only the valleys of Canandaigua and Keuka retained their original southward flow, the former being tributary to the Dansville river, while the Keuka drained into the Chemung-Susquehanna.

The three master streams of this reversed (northward) drainage were the Susqueseneca in central New York, and the Dansville-Genesee and the Allegany in the western area.

During this stage of northward drainage, in Tertiary time, the control of stream flow by the rock formations produced not only the great Ontario valley and its north-flowing tributaries, described above, but also important, though subordinate, east and west flow.

The "Ontario Plain" is the wide lowland between the scarp or north edge of the Allegany plateau and the shore of Lake Ontario, being some 30 miles broad. On this plain three rock formations (plates 85, 86) influenced the drainage. These are two limestones and an intervening shale. The Niagara (Lockport) limestone outcrops to form the "Big Ridge," which stretches from Rochester westward to Niagara Falls. Beyond the Niagara River it is yet stronger and forms the "Mountain" at Hamilton, Ont. The Onondaga limestone lies in a belt from Syracuse to Buffalo.

Between the two limestone outcrops the thick and weak Salina shales, which contain the salt and gypsum of New York, have been eroded so as to produce an effective, though not conspicuous, east and west depression, about 15 miles wide. In this depression a lower portion of the Dansville-Genesee river flowed eastward for some 12 miles, and then in northward flow excavated the Irondequoit valley. It is important to note that only one other strong valley cut across, or breached the Niagara limestone. This is the Sodus Valley, which carried the Susqueseneca river. Plate 84 shows how these two master rivers gathered all the water of central New York. This map also shows the dominating control, east and west, exercised by the Salina depression.

This extremely long era of northward drainage into the Ontarian River, with complete mastery of central and western New York, came to end at the close of the Tertiary Period with the oncoming of the vast continental ice sheet.

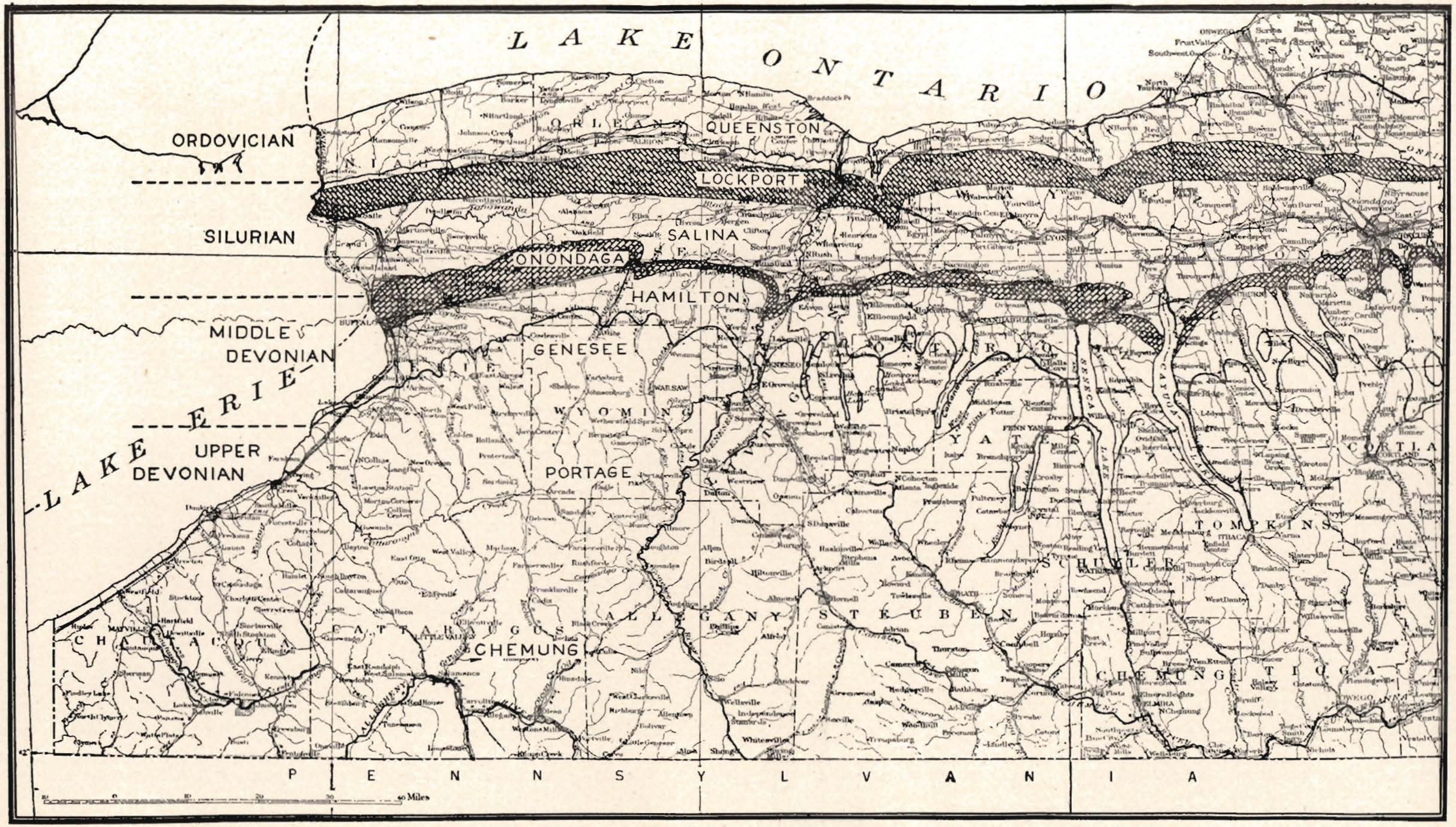
The Dansville River. The very wide and deep valley at and north of Dansville village could never have been produced alone, or as a distinct, individual valley. It is only a portion of some once far-extended, but now dismembered river course. The river which carved the valley required the drainage from a large territory, and must have had either a long course or heavy tributaries.

The Dansville Valley, it should now be understood, was developed during the long, long stage of northward drainage into the Ontarian-Mississippian flow, by one of the great obsequent rivers. Of the precise manner of its origin, and of the early phases or events in its history, we may not be confident. But of its mature character and its relations we have some good suggestions. Plate 84 gives the writer's conception of the relation of the river to the neighboring stream systems.

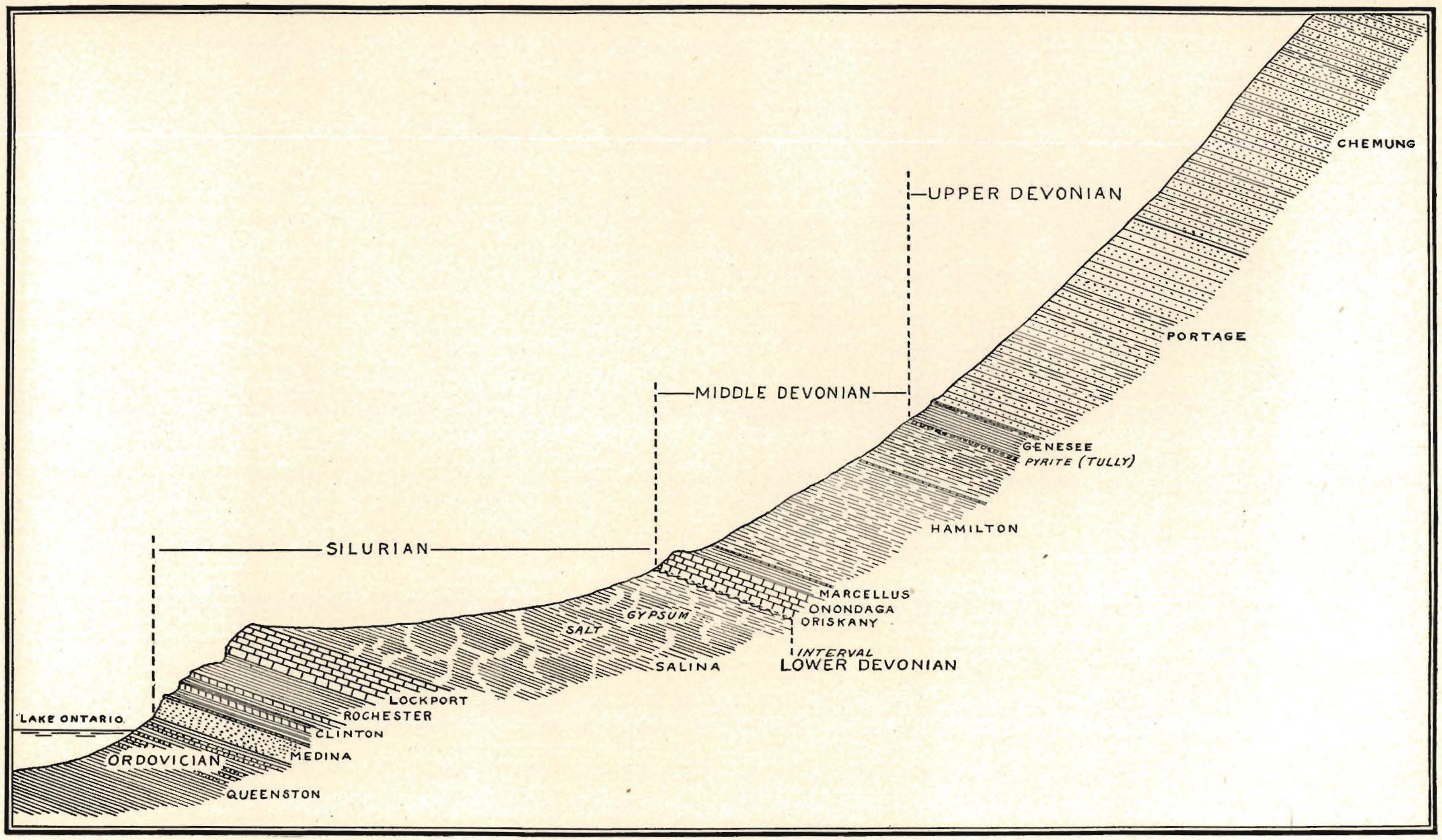
South of Dansville the great valley has been blocked and filled by glacial drift and lake deposits. But the more open valley northwestward, having only the deeper part filled with lake sediments, reveals what a splendid valley it must have been in its prime, with a noble river in rapid flow between the lofty slopes. The present smooth appearance of the curving valley walls has been produced by the rubbing action of the deep ice sheet.

North of Mt. Morris the ancient valley is occupied by the Genesee river, and we call it the Genesee valley. But before the ice age, judging from the forms of the valleys and their relations, the Dansville was the trunk stream and the Genesee was its tributary. But in glacial time, by local drift filling and blockade, the Genesee was diverted into a new course, producing the canyons at Portage and Mt. Morris. Before the ice age it probably passed northeast from Portageville through the valley at Nunda, and joined the Dansville in the neighborhood of Sonyea. From there to north of Avon the flow was the same as today. But at some point north of Avon it is thought that the river turned eastward, though the Salina depression, now drift filled and obliterated, to near Fishers. From there it passed north by the capacious Irondequoit valley. (Plate 84.)

The Dansville River appears to have had its main branch, or stem, in the Canandaigua Valley. With south flow in that valley



AREAL, OR SURFACE, GEOLOGY OF WESTERN NEW YORK



ROCK STRATA OF GENESEE VALLEY
Vertical north-south section; looking eastward

it turned southwest through the valley, where, on the drift filling, there now stand the villages of North Cohocton, Wayland and Perkinsville.

The Dansville system included the Cohocton valley nearly to Bath, and the Canisteo valley to Adrian. The Canaseraga was a tributary of the Canisteo branch. The reader may suggest names for these extinguished branches which will not confuse with names of present drainage.

Following the supposed course of the Dansville river as outlined above, the distance from the middle of Canandaigua lake around by the circuitous course to the middle of Lake Ontario is about 111 miles. The bottom of Canandaigua lake is 424 feet above ocean, and that of Ontario quite 500 feet below sea level. Ignoring the possible drift filling in the lakes this gives a drop for the Dansville-Genesee river of 924 feet, and an average gradient of 8.3 feet per mile. This is a rather steep slope for a great river, and gave great erosive power.

Stage 3. Glacial Diversion

History of the Ice Invasion. The continental ice sheet was nourished by snowfall, and from its central area in southern Quebec it spread by its own weight, as a plastic body. Melting was constant at the margin of the glacier, but as long as the spreading flow exceeded the marginal melting the ice sheet enlarged, until finally it covered all of New England and New York.

During the slow oncoming of the resistless glacier all the north-flowing drainage (Plate 84) was blocked and eventually extinguished. During the earlier phase a series of glacial lakes, ice-impounded waters, were held at successively higher levels in all the north-sloping valleys. All the glacial and drainage phenomena produced during the ice invasion are destroyed, or buried, or are at least indistinguishable.

The ice sheet finally covered all of the State, and then lingered for some time. Eventually, due to undetermined climatic and physiographic factors, the ice cap slowly waned and the margin receded, in the reverse of its invasion. All the various glacial phenomena, the sheet of till, the moraines, kames, eskers, etc.,[3] and

[3] For glossary and definitions of glacial terminology, see pages 144–148 of this volume.

the indirect effects, as the glacial lakes and their outlet channels and deposits, are assigned to the retreatal or withdrawal phase of the glacial process.

The story of the glacial waters in New York has been told in numerous writings (see the appended list). The beaches of the glacial lakes and the channels of the glacial rivers are witnesses of the ice age drama.

When the receding front of the ice sheet reached the east and west Salina depression, described above, the copious flow of water from the melting ice, with the added drainage from the exposed highlands on the south, was compelled to use that lower ground for the eastward escape to the Mohawk-Hudson. The channels cut by the glacial ice-border drainage are conspicuous and interesting features. These channels are mapped in paper 9, plates 1–5.

Effects of Glaciation. The work of the Quebec ice sheet over New York was partly erosional, but chiefly depositional, or constructional. Being heavily loaded in the basal layers with the rock-rubbish that it had accumulated, and pushing uphill, it had slight effect in deepening the valleys, which are all of stream production. But on the valley walls, especially the valleys trending in the direction of ice movement, it had sufficient erosional effect, by a sand-papering process, to produce the smooth surfaces of the graceful convex slopes so conspicuous in the Dansville Valley and in all the parallel valleys of central and western New York.

The glacial deposits were imposed on the old preglacial surface of the land. On the uplands the old and the new topography can usually be discriminated, but in the valleys the ice and lake deposits have mostly buried the ancient forms.

The greater work of the glacier was the piling of its drift burden in the valleys, with the consequent diversion of the streams, and the construction of the very singular and interesting Drumlins, Kames, Eskers and frontal Moraines. As drumlins and eskers do not occur in the Dansville Valley and are described in former writings they may be here omitted. But moraine and kame-moraine deposits are conspicuous.

The irregular topography, mound and basin, traversed by the highways and railroads south and east of Dansville is that of a frontal moraine. It is part of the belt of the heaviest moraine in the State, called the Valley-Heads moraine, being the massive filling which forms the head and drainage divide, or stream parting, in all the Finger Lakes valleys. (Plate 88). This glacial filling in the valley south to Rogersville, and southeast to Perkinsville, has unusual character due to a complex history. It was not deposited freely and openly in the atmosphere, but was laid down under the water of a glacial lake, which is described below. Subsequently, after the ice front had receded some distance, but while the lake waters yet existed, or were lowering, the streams from the uplands on three sides swept in detritus that partly buried the ice-laid drift under water-laid sands and clay. And after the lake disappeared the stormwash and the brooks flowing across the area from the south and east have eroded the deposits, producing the many stream

Figure 1. **DANSVILLE VALLEY**
Looking northwest from roof of Jackson Hotel and Health Resort

channels which converge towards the village. The present peculiar topography, shown in plate 87, is the complex product of glacier, lake, stream and atmospheric action.

The work of the ice sheet has been of distinct human benefit in New York, and especially in the Genesee country. On the northerly upland belt the drift sheet ("till") is rich in mineral matter that is plant food, derived from the rocks of Canada and the Adirondacks. On the lower ground of the Ontario lowland, and in the valleys, the commingled ice, lake and stream deposits are famous for fertility. The superior agricultural advantages of western New York are largely direct or indirect effects of the glaciation.

To the blockade of moraine drift in the deep preglacial valleys of river erosion, in stage 2 of the drainage history, the Finger Lakes are due; as are the valley plains in some of the parallel valleys where the postglacial lakes have been replaced by inwash and vegetable growth.

Another effect of the ice sheet, inconspicuous but geologically very important and interesting, was the overweighting of the land which it covered and the consequent depression of the earth's surface. Since the removal of the ice cap the land has risen, slantingly in New York. At Dansville the theoretic amount of postglacial

Figure 2. DELTA OF STONY BROOK
Southern point. Looking north

land uplift is about 160 feet. At Rochester it is 250 feet, and on the international boundary, west of Lake Champlain it is 740 feet. (Papers 11–14.)

Glacial Lakes. The most romantic episode of the glacial his-is that of the ice-dammed waters. During the slow oncoming of the implacable ice sheet all of the northward drainage was blocked, and a series of water-bodies of successively higher and higher levels were held in all the north-declining valleys. All the features produced by those lakes of ice-advance, and by their outflowing streams, were obliterated by the continued expansion of the glacier. But when the full-grown ice sheet was finally conquered by ameliorating conditions, and grudgingly yielded by marginal melting, the receding front in its northward retreat impounded a second series of lakes. These glacial lakes of ice recession were the reverse of the earlier series by ice invasion, as they fell from higher to lower levels, as successively lower outlets were uncovered. All the varied and interesting features of standing waters and their outlet channels belong to this phase of ice removal. The glacial lakes were the closing act of the glacial drama (paper 16).

The larger glacial lakes were the ancestors of the present Great Lakes. The present Finger Lakes are successors of the later glacial

Figure 3. **MORAINE**
Three miles south of Dansville. Looking south from the Bluff Point School, seen in figure 2

lakes in New York. And the glacial Lake Iroquois which occupied the Ontario basin was the last of the ice-bound waters and has left the most complete record. (Paper 15.)

The study of the glacial lake history, by tracing their shorelines and correlating their outlets, is largely a determination of elevations. And this involves another geologic factor. If there had been no change in the position or attitude of the land since the lakes existed the old shorelines would yet be horizontal, and mapping would be more simple. But such is not the case. The great and long-enduring burden of the ice-cap seriously depressed the land. Since the ice disappeared the land has risen, in only partial recovery of its preglacial attitude. It appears that the downthrow and the recent uplift have been somewhat proportional to the thickness and weight of the ice sheet; and consequently in New York the land rise has been a tilting, or an upslant northward, amounting to over two feet per mile. Hence in tracing lake shores, as through the Dansville Valley, one must recognize the land deformation, rising northward and declining southward. In the Dansville district a correction of 2.25 feet per mile should be used.

The glacial lake history of central and western New York has been told in several publications (4, 6, 9, 10, 21) and that of the Genesee drainage basin in papers 2, 8, 19. The series of Genesee lakes doubtless forms the most remarkable and complex drainage history of any district in the world.

Figure 4. **FLOW CHANNELS ON DELTA GRAVEL**
One and one-fourth miles east of Canaseraga. Looking southeast

In this writing it is appropriate to discuss only those glacial waters which had relation to the Dansville Valley. Several successive lakes were held in the Genesee Valley above (south of) Portageville while all of the present Dansville Valley was yet covered by the glacier. And when the ice front was piling the massive moraine south of the village a lake was held in the Canisteo Valley, which we may name Lake Hornell. The lake and stream phenomena related to the Hornell and Dansville waters are complex and involved, and the reader must not require either brevity or simplicity in their description.

The control, or outlet, of Lake Hornell was at Adrian, where the glacial outflow, and the subsequent Canisteo River, have produced a handsome canyon, in the southward flow to the Susquehanna. Before the ice age the valley at Adrian is supposed to have had a col, or drainage divide, between north and south flow; the northward stream being tributary to the Dansville River (plate 84).[4]

Lake Hornell expanded northward as the ice front receded, until it reached nearly to the site of Dansville. At that time the glacier was piling its frontal moraine in the lake waters, south of the village. At the same time Stony Brook had come into existence and was busy sweeping the abundant drift from the upland and dumping it to form a wide delta plain in the lake. This handsome lake plain lies both sides of Stony Brook Glen and is traversed by the P. S. & N. Railroad. The Bluff Point School stands on the

Figure 5. **STREAM TERRACES**
One mile northeast of Canaseraga. Looking north

southern point of the delta (figure 2), and commands the view shown in figure 3. The hamlet of Rogersville is on the wide plain stretching northward that was built in the earliest phase of the lake in that district, with contour elevation of 1,280 feet. The elevation of the Stony Brook delta plain is 1,260 to 1,280 feet.

The glacial history of the Canisteo Valley and the Lake Hornell may be described briefly. A glance at the Hornell sheet shows the narrow pass west of Adrian. Doubtless the channel has been deepened considerably by the Canisteo River during the many thousands of years since the pass was the outlet control of the glacial lake. The present channel is 1,100 feet, but the terraces along the valley

[4] When the former papers were written the lake history of the Canisteo Valley had not been recognized.

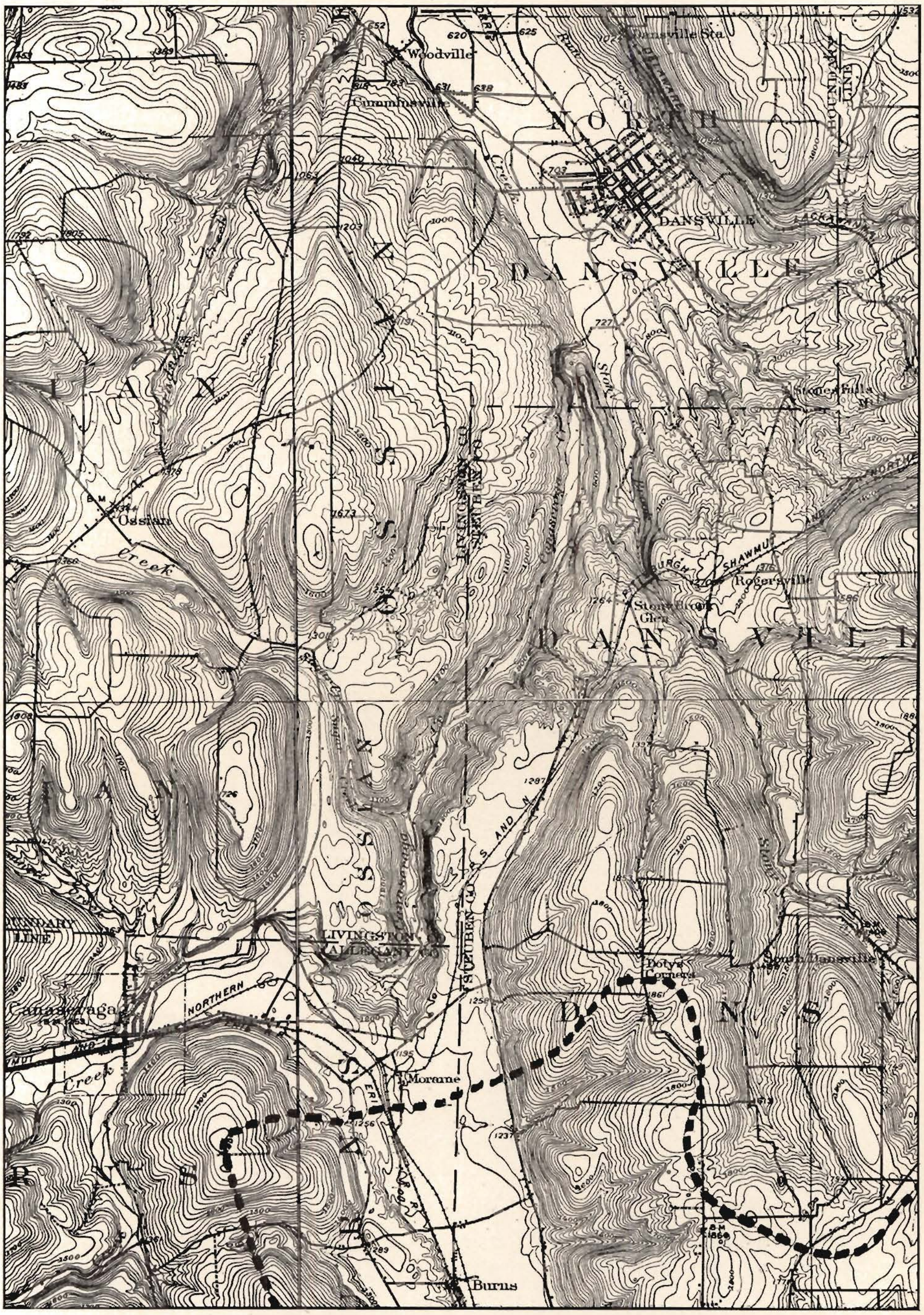
sides indicate that the lake had an elevation of toward 1,200 feet. Above Hornell the indolent stream has had slight effect in erosion of the lake-bottom plain, and above Arkport no effect at all.

The lower slopes of the valley walls have very interesting features. The last ice occupation of the valley was by a slender lobe or tongue of the glacier. Above and below North Hornell the east valley wall has very clear stream-cut terraces or shelves made by the flow of escaping water along the side of the ice lobe. The water was partly from the melting ice but was largely the flow of Carrington and Big creeks. On the face of the hill, a mile north of North

Figure 6. **RIVER BANK**
Two miles east of Canaseraga. Looking south

Hornell, at least four distinct terraces may be counted, ranging in altitude from 1,240 to 1,380 feet. These benches are suggested by the map contours. Before these terraces were made the water of Carrington Creek, and the glacial water, found higher escape behind (east of) the hill. During this phase the fine delta plain north of the hill, and south of Burden School, was built in a local glacial lake, held in by the ice lobe. As the ice barrier weakened the outflow cut the terraces on the hillslope facing the valley. Lower terraces along the valley walls, at and below 1,200 feet, were made in the open lake.

On the west side of the valley at Burns, and for three miles northward, is a pronounced kame-moraine and delta, with elevation up



TOPOGRAPHY OF THE DANSVILLE DISTRICT

Broken line is water-parting between the present north and south flow to 1,300 feet. This deposit was piled against the ice lobe by a river pouring into Lake Hornell from the west through the Canaseraga Valley. The river was the outflow of the Portage-Nunda Lake, one of the many stages of the Genesee Valley glacial waters (paper 2, pages 438–446).

East of Canaseraga village is a splendid pitted plain, or kettled plain, toward two miles long, at 1,260 feet elevation. This was built in Lake Hornell along with the Burns filling. The pits or bowls in the plain are true kettles, from buried ice blocks, which did not melt until the lake was drained away. Probably the deposit is mainly

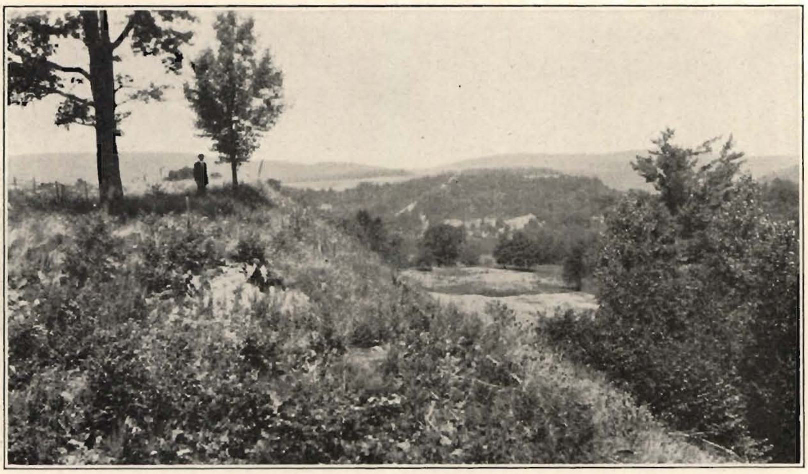


Figure 7. **HEAD OF POAGSHOLE**
Looking north from highway one-fourth mile north of Moraine Station

glacial with only a veneer of lake sediments. This interesting plain (figures 4–6) appears to be only a portion of a great delta plain that filled the wide valley northeast for miles. The scenic gorge of Canaseraga Creek, known locally as Poagshole (figure 7), has been excavated out of the plain. But a good remnant of the wide filling is the plain on the east side of the valley from Moraine Station north for three miles. This is traversed by the railroad and the Dansville-Hornell highway, with elevation rising from 1,200 to 1,300 feet.

With erosion of the outlet channel at Adrian the Hornell waters were gradually lowered, and at some stage, with unknown time relation to the Hornell lake, the glacial waters spread over the Dansville district. Eventually the Dansville lake became one of the long series of glacial lakes which occupied the drainage basin of the Genesee River, as noted above.

The earlier phase of the Dansville lake was independent of the Genesee valley waters. Its level was somewhat below that of Lake Hornell, its predecessor. Judging by the kettle-plain at Canaseraga village, and the levels either side of Poagshole, the Hornell waters lay there at about 1,260 feet, present altitude. Lake Dansville came into existence when the Hornell waters fell toward 1,200 feet. A portion of the floor of the outlet channel of Lake Dansville is well preserved southeast of Moraine station. For a mile north and

Figure 8. **STONY BROOK GLEN**
Lower fall

south, and with width of one-half mile, the ground is coarse gravel, swampy and uncultivated. The surface has a fluted, or washboard form, a characteristic effect of river flow over sand and gravel. This is the record of the latest outflow, and determines the later lake level at 1,200 feet, plus the depth of the river. The earliest outflow was somewhat higher, and the channel farther north, where Canaseraga Creek has excavated the great delta, producing Poagshole ravine (figure 7).

The glacial Genesee waters became tributary to Lake Dansville when the glacier front weakened and declined on the steep hillside a mile southeast of Union Corners (Town of West Sparta), to about 1,340 feet. Then the Portage-Nunda lake began to abandon its channel at Rosses, in the upper Canaseraga valley (Nunda sheet) and the waters sneaked around the north face of the Union Corners hill, between the ice front and the rock slope. The notches cut in the hillside are weak but distinct.

When the ice against the hill at Union Corners yielded sufficiently to let the Portage-Nunda lake blend with the water in the Dansville valley, then Lake Dansville became a full-fledged member of the Genesee lake series. And Lake Dansville existed for a long time, until the receding ice front uncovered lower escape on the ground

Figure 9. STONY BROOK GLEN
Upper fall

south of Batavia and permitted the water to escape westward to Mississippi drainage. (Papers 6, 9.)

Shore phenomena as evidence of the Dansville lake must correlate with the level of the outlet north of Burns, which is 1,200 feet. We may add five to ten feet for depth of the river, and about 29 feet more for the differential uplift of the land; and then look for the latest shore features at Dansville at about 1,225 or 1,230 feet. The terraces south of the village much higher than this figure belong to the Hornell lake, for example, the plain at Rogersville, 1,300 feet, and the Stony Brook delta.

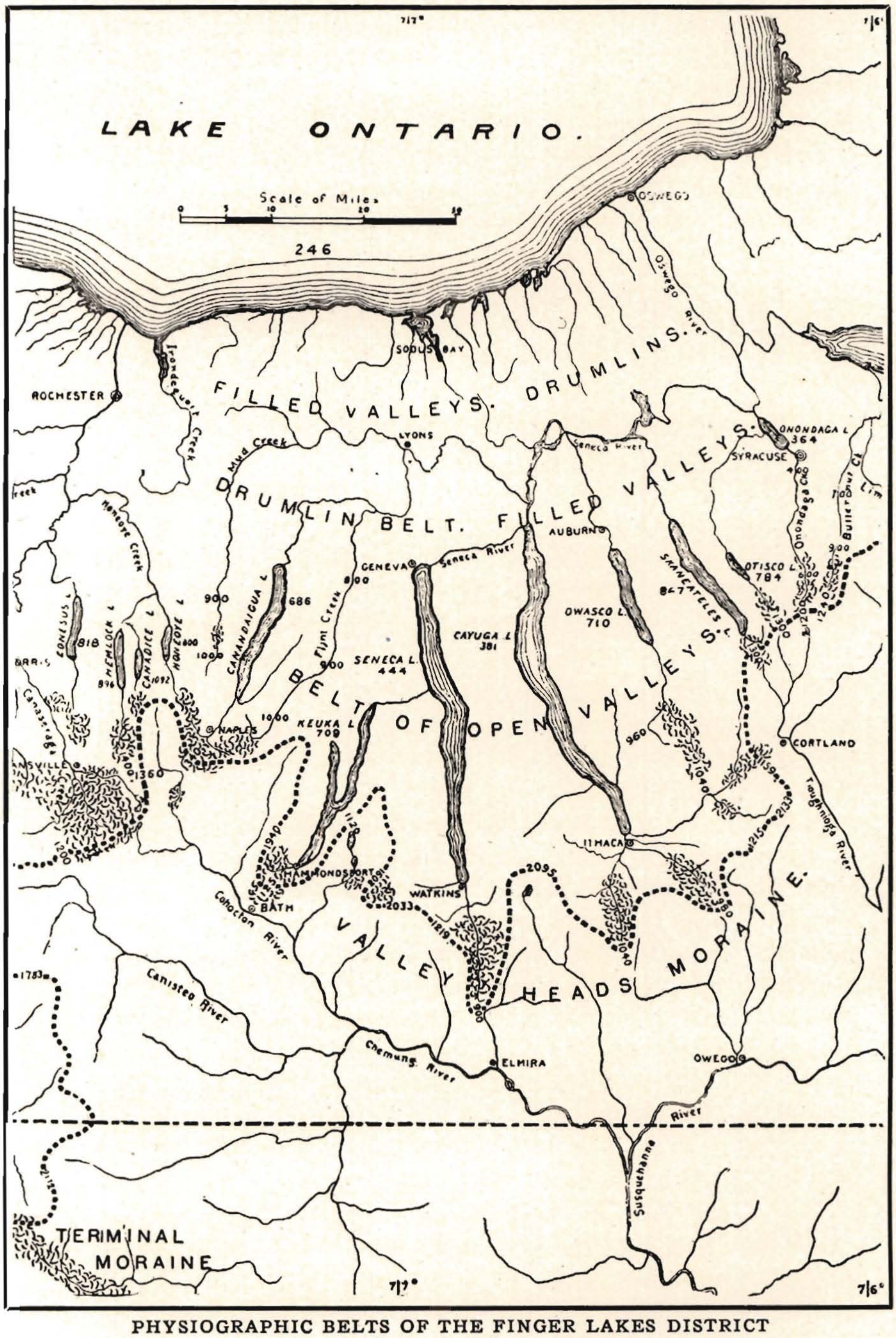
On the heavy moraine filling between Dansville and Rogersville the terracing is found at levels from 1,300 down to 700 feet, representing the lowering of the waters to much below the Dansville lake level. To find Lake Dansville shore features as the highest record we must go north some miles, to where the valley ice lobe had covered the land slopes until Lake Dansville was in existence. Such shore terraces are found northwest of Reeds Corners at about 1,220–1,230 feet.

Succeeding Lake Dansville was a long succession of glacial lakes in the Genesee valley, with changing levels, up and down. The story has been told in papers 2, 4, 9, 10, and it is too long and involved to be here repeated. The Genesee waters with elevation above 600 feet flooded the Dansville valley, and the lower terraces on the valley walls, the deltas of creeks and brooks, were made in the inferior waters. Two of the later and important lakes were Warren and Dana, the former tributary to the Mississippi and the latter to the Mohawk-Hudson. Between Dansville and Mount Morris the Warren plane is figured at about 820 feet; and the Dana level is always 180 feet lower than the Warren. It may be difficult, but interesting, to discriminate these levels from among the delta terraces on the walls of the valley. Well developed deltas occur east and north of Groveland Station, and west of Groveland, on the streams flowing down the east wall of the valley.

There are other interesting features in the Dansville region. One is the shut-in plain at Ossian, at 1,340 feet. This appears to be a filling of a small local lake which was held in the triangular hollow between the hills for a brief time. The Ossian valley collected a large volume of the glacial drainage, and this found escape southeastward by the valley now occupied by Sugar Creek. The outflow helped to build the extensive delta plain extending for three miles northeast of Canaseraga village. This plain is part of the great delta filling described above.

The Pokamoonshine Gulf, four miles northeast of Dansville, is a singular deep cut across a high ridge. Its explanation can be found only in the glacial history. Probably a notch in the ridge existed there before glacial time. The elevation at the head of the Gulf is 1,520 feet. The probable explanation is, that when the waning ice lobe in the Dansville district was pressing against the hill west of Wayland the notch became the outlet for the waters in Carney Hollow, which in their eastward flow deepened the notch and produced the present gulf.

The wide valley east from Perkinsville to North Cohocton, and then south as the Cohocton Valley, has its own complex and inter-



PHYSIOGRAPHIC BELTS OF THE FINGER LAKES DISTRICT esting history. That it was occupied by standing waters is proven not only by the smooth plains of sand and clay, but also by the beds of marl. The marl is an accumulation of lime by the work of lime-secreting plants (Chara) in quiet calcareous waters.

The lake history in the Wayland valley is tied in with that of the glacial waters in the Cohocton valley. The plain west of Atlanta and North Cohocton was partly contributed by the stream which carried the overflow of the highest glacial waters in the Canandaigua Valley, the Naples Lake. (1, pages 361–364.)

The very handsome Cohocton Valley contains many very interesting features and deserves special study. Especially notable are the deep and strong channels on the west wall of the valley, a mile west of Cohocton village, which were cut by glacial waters.

Buried Dansville Valley. The deep filling of glacier and lake deposits in the stretch of the ancient valley from Dansville to Naples has so changed the appearance of the country that the river history and valley topography might not be recognized. But a glance at the Wayland and Naples topographic maps will show that the deposits occupy only the bottom, or deeper section, of the old valley. The valley walls of rock strata rise as hills 500 feet above the filling, and the outline of the great valley is in general very clear.

The morainal stuff left in the valley by the ice sheet has been smoothed and covered by the subsequent glacial lake waters, as proved by the sands, clays and marl. These are described below.

Without many deep boring to reveal the buried rock topography, we cannot be sure of the depths of drift in the old valleys. A crude guess is made by using the supposed slope of the rock bottom of the valley. By comparing the known surfaces of the land along the course of the Dansville river with the supposed line of the river bottom, from the bed of Canandaigua lake to that of Lake Ontario, some suggestion of the depth of filling is obtained.

The bed of the ancient river probably was not uniform in slope, because the river cut across the edges of two heavy limestone formations, the Onondaga, somewhere south of Avon, and the Lockport (Niagara), somewhere in the Upper Irondequoit valley (plate 85). With some allowance for this the depths of drift figure as follows: The greatest depth is at the divide near Perkinsville where the surface elevation is 1,380 feet. The old river bed is theoretically about 300, which gives 1,080 feet of drift. At Wayland it is about 1,000 feet, and at the divide north of North Cohocton about the same. Under Dansville village the drift is estimated at about 400 feet,[5] and under Mt. Morris about 370. Under the swamp plain at the head of Irondequoit Bay the filling is between 500 and 600 feet. Sometime, somewhere these rough theoretic estimates may be checked by the drill and the true depths found. The drillers should not mistake heavy glacial bowlders for the bed rock.

Stage 4. Present Diverted Drainage

Any geographic map of New York State will show, when compared with plate 84, the Preglacial drainage, the remarkable changes produced in river-flow by the obtrusive interference of the Quebec ice sheet.

The dominating physiographic feature of ancient time was the great Ontario Valley, with its Ontarian River, and today the valley with its lake remains as the greatest controlling factor, although it has lost a large part of the contribution by the southern tributaries.

The only one of the ancient rivers which has successfully resisted the destructive efforts of the glacier is the Genesee. Although it has been diverted into new channels, for most of its course below Portageville, it has retained its northward direction.

The present varied and irrevelant directions of stream-flow are due to glacial interference, first by compelling new flow, and later by the drift blockades.

The chief effect of the moraine fillings and drift blockade was the turning of northward drainage into southward. The Preglacial drainage headed in northern Pennsylvania. The construction of the Valley Heads moraine (plate 88) turned the upper or southern portions of the northflowing streams back to southward. In other words, the principal drainage divide was shifted from northern Pennsylvania into central New York, as shown by the broken line in plate 88.

Local diversion due to moraine dams have compelled streams to find new courses, thus producing the young and steep-walled channels, like Niagara, Portage, Rochester and Oswego canyons, and the numerous ravines or glens in the smaller streams. Stony Brook Glen is a fine example (figures 8, 9).

The filling of considerable stretches of the old valleys by drift accumulation has been more effective where the valley lay athwart

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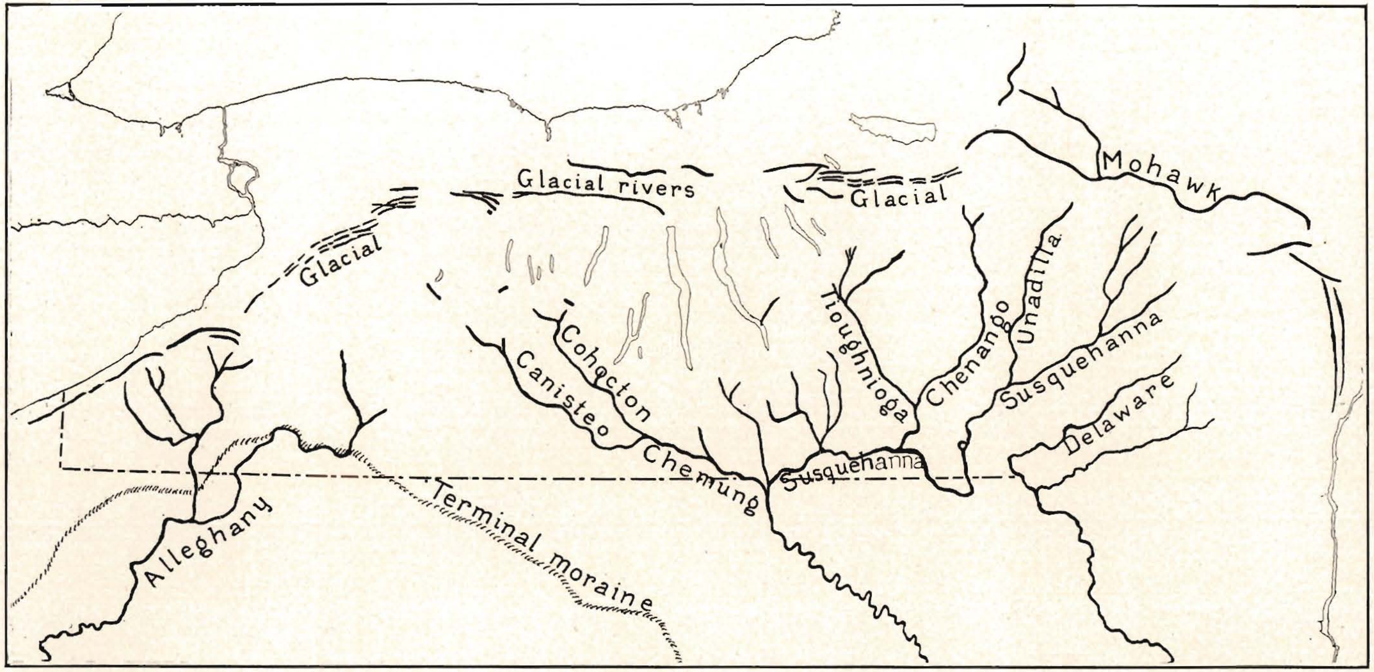
[5] Since this paper was written it is learned that a well, three miles below Dansville, was sunk 450 feet without reaching rock.



GLACIAL DRAINAGE

the direction of ice movement. Examples in the Dansville and Genesee have been described above.

The broad east and west depression on the outcrop of the Salina shales (plate 85) which had been effective in Preglacial time in turning the flow of all central and western New York into the two trunk streams, the Genesee and Susqueseneca, has retained its influence. Today the flow is mostly concentrated in the Genesee and Oswego rivers. The east-flowing glacial rivers produced channels which the present secondary streams partially follow. The principal west-flowing streams in the Salina belt are the lower portions of the Tonawanda and Honeoye creeks. The eastflowing streams are the Black and Oatka creeks west of the Genesee River, and the Ganargua Creek and Seneca River in central New York.

The most striking glacial effect on the drainage has been the production of new rivers. Plate 89 shows the forced glacial drainage and the newly created rivers. The chief examples of the latter are the Canisteo, Cohocton and Tioughnioga rivers. The Cayuta Creek, joining the Susquehanna River at Waverly, is an example of the smaller new streams.

The new, or Postglacial, rivers were produced by the piecing together of old and previously independent stream courses. The glacial waters being forced into some southward escape took possession of available valleys, and by cutting down the minor divides produced extended streams, some of which have survived, as named above.

In résumé of the drainage history:—all the drainage of western-central New York was originally southward. Then, under rock control and the development of the Ontario basin it was all turned northward. The invading ice sheet turned it again southward, and then entirely extinguished it. The removal of the ice sheet has left the older flow divided, part northward and part southward, with tributary in various directions.

Post-Glacial Erosion; Scenic Features

The elevation of the continent is so much lower that it was in Tertiary or Preglacial time that the stream gradients are reduced. Postglacial time has been too brief to permit important adjustment of the drainage by rock control. The newness of our present drainage is proven by the many canyons of large rivers, as Niagara, Rochester, Portage, Mount Morris and Oswego, and the innumerable ravines, as Stony Brook, Watkins, Montour, Taughannock, Ithaca and scores of other beautiful glens.

Much of the existing drainage is yet in the infantile stage of drainage evolution. Some of the larger streams have attained the youthful stage in their new courses, illustrated in the canyons and cataracts named above. It will be understood that any stream channel with steep walls is young, and indicates some recent change in flow, either in place or in volume. Given time and the walls crumble under atmospheric decay, and the valley widens, especially in weak shales and sandstone like those of all the streams of central and western New York.

The multitude of lakes and lakelets in the northern country prove interference with the drainage, for bodies of standing water are not normal to free-flowing streams. Before the Ice Age probably there were no lakes in all of eastern America.

For all of our peculiar and romantic scenic features we are indebted to glaciation. We may add this to our soil fertility as credit against having been for ages, like present Greenland, under the relentless ice sheet. Without glaciation we should have had only the valley and mountain forms, like southern Pennsylvania.

Glacial geology has a romantic interest that appeals to the lovers of the out-of-doors. And its educational value is not surpassed, though not appreciated, among the many subjects of the schools.

Future Changes

With a far look ahead, for some millions of years, and in attempt to forecast geologic future of our drainage, we can judge only by the long past. If northeastern America should again be lifted by the interior geophysical forces, perhaps one or two thousand feet higher, all the streams would be greatly enlivened. The Great Lakes, and all the lesser lakes, would probably disappear by downcutting of their outlets. The drift fillings in the valleys would be largely removed. The mature drainage would largely restore that of Tertiary time, plate 84. But probably Niagara, Genesee, and Oswego rivers would retain their courses, developing very deep and wide valleys. Perhaps the Irondequoit and Sodus valleys would again carry heavy streams. The fate of the Dansville Valley is not evident. From Naples to Dansville the drift filling is massive, lying high at the head of divergent flow. Probably Canandaigua Valley would retain its northward flow, while either that or the Cohocton River might eat back, headward, and possess the Wayland-Perkinsville district. The Dansville Valley proper would probably remain tributary to the downcutting Genesee.

The general effect of land uplift would be the increase of topographic relief, as deepening the valleys would exceed the wastage of the hill and mountain tops. With long permanence in elevation the erosion of the uplands would reduce the relief.

If the land merely retains its present attitude for indefinite geologic time the changes in the drainage would be similar in kind to those described above, but in much less degree and very slowly.

If on the other hand the continent should sink below its present attitude all the drainage would be retarded, and in many valleys deposition would replace erosion. The uplands would be eroded away faster than the valleys deepen, and so the topographic relief would be reduced and softened, and the large region approach a near-plain or peneplane.

If the sinking should go far enough to carry the area under the sea it would merely repeat the conditions which existed when our rock strata were forming. A fall of only 700 feet would drown the Rochester plain and flood the Dansville Valley. That would be a small vertical change compared with the thousands of feet in up-and-down movement of the region in the past.

Any of these suggested changes are possible in the future, and one of them is probable if not inevitable. The reader can make a choice without fear of consequences.

List of Writings

The following list is of papers bearing more or less directly on the subject of the present writing. Titles of publications relating to the rock strata and the economic products will be found in number 19, and a more complete general list in number 18. Papers having immediate relation to the drainage history are numbers 8, 9, 15, 18.

1. H. L. Fairchild. Glacial lakes of western New York. *Geological Society of America*, Bulletin VI, 1895, 333–374.
2. ———Glacial Genesee lakes. *Geol. Soc. Amer.*, Bull. VII, 1896, 423–452.
3. ———Kettles in glacial lake deltas. *Journal of Geology*, VI, 1898, 589–596.

4. ———Glacial lake waters in the Finger Lakes region of New York. *Geol. Soc. Amer.*, Bull., X, 1899, 27–68.

5. ———Geology of Irondequoit Bay. *Rochester Academy of Science.* Proc. III. 1906, 236–239.

6. ———Glacial waters in the Lake Erie basin. *N. Y. State Museau,* Bull. 106, 1907.

7. ———Drumlins of central and western New York. *N. Y. State Museum,* Bull. 111, 1907.

8. ———Pleistocene history of the Genesee Valley in the Portage district. *N. Y. State Museum,* Bull. 118, 1907, 70–84.

9. ———Glacial waters in central New York. *N. Y. State Museum,* Bull. 127, 1909.

10. ———Pleistocene geology of New York State. *Geol. Soc. Amer.* Bull. XIV, 1913, 133–162. *Science,* XXXVII, 1913, 237–249; 290–299.

11. ———Pleistocene uplift of New York and adjacent territory. *Geol. Soc. Amer.,* Bull. XXVII, 1916, 235–262.

12. ———Post-Glacial continental uplift. *Science,* XLVII, 1918, 615–617.

13. ———Glacial depression and Post-Glacial uplift of Northeastern America. *Nat. Acad. Science,* Proc. IV, 1918, 229–232.

14. ———Post-Glacial uplift of northeastern America. *Geol. Soc. Amer.* Bull. XXIX, 1918, 187–238.

15. ———The Rochester canyon and the Genesee River base-levels. *Roch. Acad. Science,* Bull. VI, 1919, 1–55.

16. ———A nature drama. *Scientific Monthly,* X, 1920, 404–417.

17. ———The Pinnacle Hills or the Rochester Kame-Moraine. *Roch. Acad. Science,* VI. 1923, 141–194.

18. ———The Susquehanna River in New York and evolution of western New York drainage. *N. Y. State Museum,* Bull. 256, 1925.

19. ———Geologic history of the Genesee country. *The Genesee Country,* I, Chap. 1, 15–110, Chicago, 1925.

20. ———Geology of Western New York. (Republication of No. 19) 62 pages, 37 plate, Rochester, 1925.

21. ———Geologic romance of the Finger Lakes. *Scientific Monthly,* August, 1926, XXIII, 161–173.

22. ———Geologic Story of the Genesee. *Gas and Electric News,* XIV–XV, 1926–1927.