Glacial Geology of the Troy, N. Y. Quadrangle

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Contents

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by Robert G. LaFleur*

ABSTRACT

Glacial deposits of probable Cary age exposed within the Troy, N.Y., 15 minute quadrangle are mapped in detail at a scale of 1:48000. Successive phases of ice margin withdrawal northward across the area are described and diagramed. Phases of development of glacial Lake Albany are recognized by shore features which include early-phase ice-contact terraces and kame deltas, a beach representing a middle-phase ice-free lake, and late-phase terraces and minor beaches associated with falling water levels. Correlations between late Lake Albany phases and early Lake Vermont phases are proposed.

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Introduction

For sixty years, the glacial geology of the Hudson-Champlain Lowland has been the subject of voluminous literature, devoted largely to discussion of relationships between glacial landforms and the receding ice. Demonstration of crustal rebound in eastern North America was facilitated by the north-south trend of a 350-mile-long lowland with abundant beaches, terraces, and deltas which indicate glacial water levels.

The works of Peet (1904), Woodworth (1905), and Fairchild (1918) are early classics in regional analysis. Chadwick (1928) discussed the deglaciation of the Hudson Valley from Schuylerville to Glens Falls and his work, particularly the illustrations, should be referred to as an adjunct to the present paper. The glacial geology of more localized areas within the Hudson Valley was described by Cook in chapters included in New York State Museum and Science Service Bulletins on the bedrock geology of several quadrangles southwest of Troy. The manner of deglaciation, the nature of the glacial lakes, the presence of a sea-level strait connecting the Atlantic Ocean at New York City with the St. Lawrence Valley, and the character of crustal rebound all became subjects of heated controversy. Only Stoller mapped local surficial deposits in sufficient detail to provide a sound basis for many of the conclusions which were drawn. Stoller's mapping of the Schenectady (1911), Saratoga (1916), and Cohoes (1918) quadrangles bordering the Troy quadrangle on the north and northwest was largely physiographic, but his work served to focus attention upon the classical area where the Mohawk joins the Hudson Valley. Although he was guided by the hypotheses of Woodworth, Stoller attempted to maintain a position of neutrality between the diverging schools of thought of Woodworth (1905) and Fairchild (1914), until Fairchild (1918) unequivocally postulated the existence of a sea-level strait expanding from New York to Canada as the ice margin receded. Stoller (1919) promptly rejected this concept because it could not be applied to features he had mapped on the Cohoes quadrangle. Interest in the glacial history of eastern New York by then was established and was to continue for the next 30 years through the efforts, in widely separated areas, of Cook, Chadwick, Brigham, Rich, and Chapman. Much of this work was concerned with an evaluation of lacustrine conditions, summarized in a later section of this paper.

Flint (1953) assigned Tazewell age to drift south of the Hudson Highlands, Cary age to deposits between the Hudson Highlands and Glens Falls, and Mankato age to deposits north of Glens Falls. MacClintock (1954) on the basis of depth of leaching also assigned Cary age to the central Hudson Valley drift and to the younger Catskill drift of Rich (1935). Radiocarbon dates have not been obtained for the central Hudson Valley. In the Troy area only one glacial advance and recession are recorded, and a Cary age for the drift remains satisfactory.

Revisions in age of the drifts of eastern New York have negated the presumption by earlier workers that one continuous withdrawal of ice from the Long Island terminal moraines was responsible for the Hudson Valley deposits. However, many local details of interpretation of the glacial geology are still valid. Some of the present problems in eastern New York concern the relationship of Lake Vermont to Lake Albany with attendant nomenclatural difficulties, and the glacial history of the Mohawk River as indicated both by depositional and erosional features.

Field mapping of the Troy 15 minute quadrangle was carried out from 1957 to 1960 and plotted on the 7½ minute Troy South, Averill Park, Nassau, and East Greenbush topographic base maps which subdivide the area. The New York State Museum and Science Service supported a portion of the work with an honorarium which is gratefully acknowledged. The writer is also indebted to Professor Shepard W. Lowman and the late Richard Hopkins for their guidance and encouragement, and to Professor Ernest H. Muller who critically read the manuscript and offered many helpful suggestions.

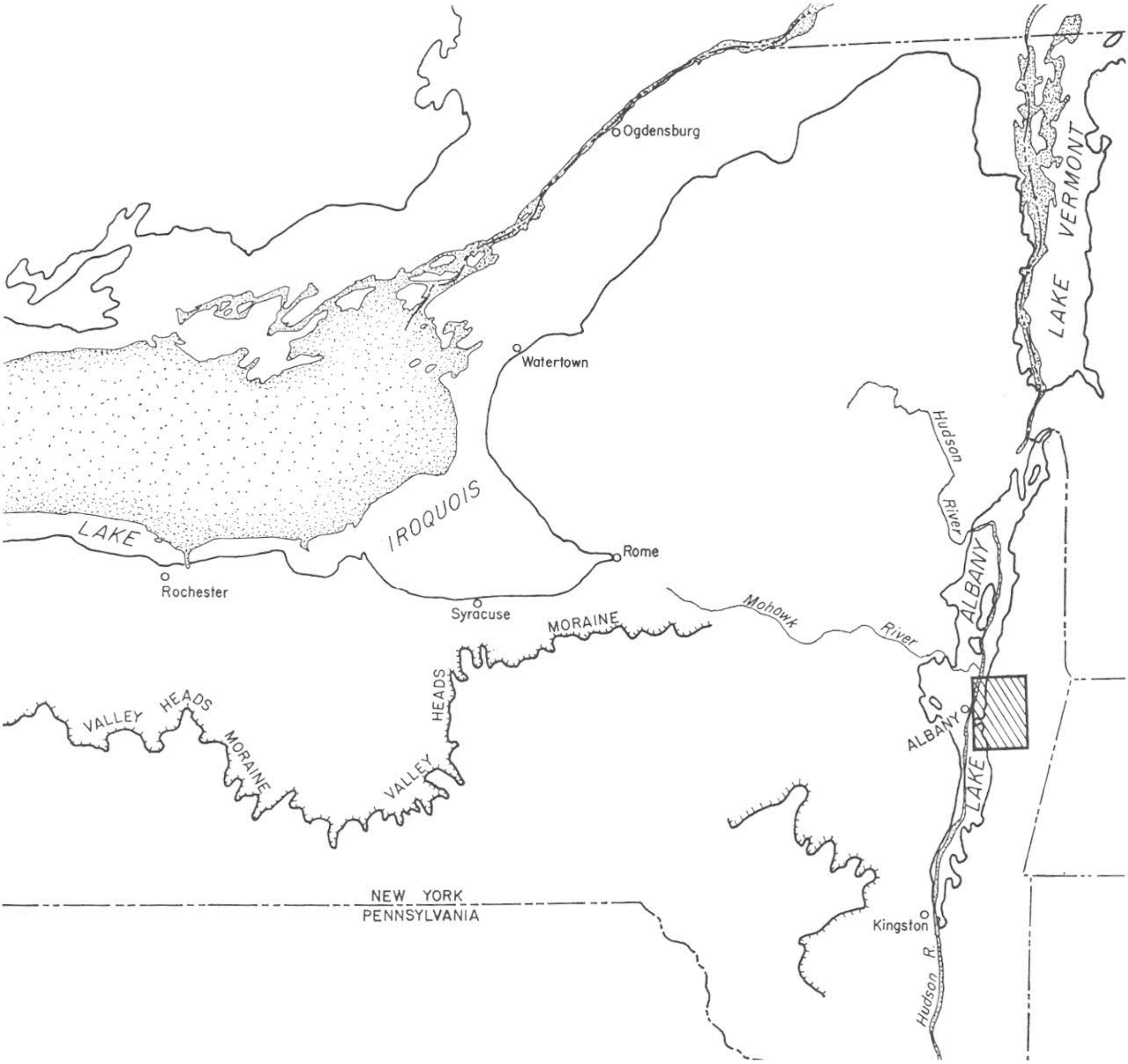

FIGURE 1. Location of the Troy (N.Y.) Quadrangle plotted on the Glacial Map of Eastern United States.
Courtesy of Geological Society of America.

Geomorphic Setting

The Troy quadrangle embraces 225 square miles in southwestern Rensselaer County near the confluence of the Hudson-Champlain Lowland with the Mohawk Valley, and displays the record of a single late Wisconsin glacial advance and stagnation of probable Cary age. See Figure 1. The surficial deposits are underlain by sharply folded Cambrian and Ordovician rocks of the Taconic sequence. Bedrock geology of the entire quadrangle was mapped by Ruedemann (1930), and more recently by Elam (1960) (Troy South and East Greenbush 7½ minute quadrangles), and by Bird (1962) (Nassau 7½ minute quadrangle).

Total relief is more than 1500 feet from the tidewater Hudson River eastward to the rugged plateau upheld by the Lower Cambrian Rensselaer Graywacke. Preglacial erosion developed a topography with local relief of generally less than 200 feet upon north-south trending structures in the less resistant shales and sandstones west of the Rensselaer plateau. Drumlins are very abundant throughout this area and their elevations rise toward the east from 450 feet near the Hudson River to 950 feet at the base of the Rensselaer escarpment. Some drumloid masses of thick till occur between massive rock outcrops on the Rensselaer plateau, but typical drumlins are restricted to lower elevations. Most of the upland valleys are partly occupied by kames and other ice-contact deposits. A particularly extensive kame and esker complex about 2 miles wide and 9 miles long extends northwestward from Burden Lake to Albia. Much of the western quarter of the quadrangle is underlain by thick lacustrine clay and silt beds, heretofore assigned to Lake Albany, and by sandy deltas and gravelly kame terraces. Beaches of Lake Albany have extensively altered granular deposits from North Greenbush south to the edge of the quadrangle. Postglacial gullying of lake clays has dissected the westward-sloping plain bordering the Hudson River on the east.

Two distinct topographic trends are developed. Cary (?) ice flow from N20W is indicated by drumlin axes and bedrock striations. Where drift is thin the Taconic structural grain is evident, striking N-S to N15E.

SURFICIAL DEPOSITS

Till. Nearly all of the till (mapped as Ct) has been concentrated into clusters of drumlins. Where the till is thin (mapped as Ctt) it has been eroded by flowing meltwaters, in close proximity to later receding ice margins, so as to permit the topographic trend of the bedrock to be shown.

Composition of the till closely reflects underlying bedrock. The trend of major Taconic lithologies nearly coincides with the direction of ice advance, making difficult the evaluation of distance of transport of bedrock fragments by moving ice. Generally the till is very firm, rich in clay matrix, with cobbles and boulders of shale and siltstone, but poor in carbonate lithologies. Near the base of the Rensselaer plateau the till has a brownish or reddish color from the high content of Cambrian Nassau and Mettawee red slate. On top of the plateau, the till is generally thin and contains huge boulders of Rensselaer Graywacke. Some of the drift there is sandy, suggesting an ablation origin where running meltwater has effected a slight sorting of the finer matrix. Where the till is at all calcareous, it has been leached to a depth of about 5 feet (Latimer 1937). Although limestone content of the drift is low and irregular, and correlation of the till by depth of leaching alone has limitations, a Cary age as proposed by Flint (1953) and MacClintock (1954) seems reasonable.

Ice-contact and outwash deposits. Several varieties of ice-contact features occur in the Troy area, the most prominent of which are the Schodack terrace, the Albia-Burden Lake complex, and the kame deltas at Rensselaer and at Hampton Park north of East Greenbush. These deposits were formed along a progressively northward-receding ice margin. Direction of sediment transport is generally from north to south. Spatial relationships among these features confirm the concept of an expanding glacial lake defended on the north by a stagnating ice block.

The gravel and sand of these major features and of other smaller deposits are mapped on the basis of landform, internal structure, and texture, as eskers (Eg), kames (Kg, Ks), and kame deltas (Hg, Hs). Outwash gravels (Og) are common beneath flatter surfaces downstream from ice-contact deposits in the Albia-Burden Lake complex. Outwash surfaces there frequently represent summits of esker deltas which occupy topographically inferior levels among earlier eskers and kames.

On the Schodack terrace, outwash (Og) overlies ice-contact gravels (Kg) and represents a deltaic facies of the kame terrace which collected after the ice withdrew slightly from the western edge of the terrace into open lake waters. Bottomset equivalents to this delta phase are mapped as lacustrine deposits.

Younger outwash gravels and sands (Ogr) occupy the lowest portion of valley bottoms where they collected during the dissection of earlier ice-contact and outwash deposits. Some of these outwash deposits, particularly those along the Wynants Kill, date at least from the time of the 330 foot phase of Lake Albany, as evidenced by their topographic continuity with summits of lake deltas. This outwash is mapped separately to distinguish it from those outwash gravels which are proximal to ice margins.

Schodack Terrace

The Schodack kame terrace, named for its prominent development through the Town of Schodack, embraces a 6 square-mile area of gravel and sand. It is characterized on the north by an esker-fed morainal complex near the village of East Greenbush. Eight miles to the south it merges with the similar but larger Kinderhook terrace. The Schodack terrace was first recognized by Peet (1904) and Woodworth (1905) as a kame terrace with an ice contact along its western edge. This designation was also followed by Fairchild (1918), and Cook (1930). In 1946, Cook attributed the rounded and smoothed western edge to contact with ice which overhung the terrace toward the east. Jahns and Willard (1942) noted similar ice-margin terraces in the Connecticut River Valley and pictured them as forming by stages beginning with sedimentation along ice margins, but ending in delta foreset deposition into glacial lakes standing in front of the ice margin. The Schodack terrace appears to duplicate this sequence (LaFleur, 1963, p. 10). In several pits in the terrace, collapsed superglacial gravel is overlain by delta topset and foreset beds. West of the terrace edge, interbedded clay and sandy gravel encountered in water wells appear to represent the bottomset equivalents to the deltaic stage.

The western edge of the terrace rises about 100 feet from a gullied clay plain and much of this edge (where mapped as Asp) has been altered to a prominent beach by waters assigned to the ice-free phase of Lake Albany (LaFleur, 1961 b). Beach ridges (mapped as Agt) occur where the terrace edge faces due westward or slightly north of west. Where the border faces southwest, beaches are not so well developed. The western terrace edge does not, in most places, reflect contacting ice, either overhanging or buried, and the sediments beneath the beach, exposed in several pits, are mainly westward-dipping delta foresets, particularly at the widest part of the terrace near Brookview.

The terrace surface is gently rolling and frequently pitted by unfilled kettle holes. Its maximum elevation is 350 feet near the eastern edge where it is bordered by drumlins, and it slopes to about 320 feet near the wave-worked edge. Esker segments are exposed within the terrace along the Moordener and Vlockie Kills and attain summits of 350 feet.

Southeast of Brookview, between the Moordener and Vlockie Kills, the western edge of the terrace is indented by reentrants, the sides of which are aligned parallel to eskers exposed elsewhere on the terrace. Beaching in this area is slight and the reentrants could represent unaltered ice contacts.

South of the Vlockie Kill, the western edge is straight and capped by beach ridges. The part of the terrace south of the Moordener Kill is older than that part to the north, as evidenced by eskers which feed the terrace at an ice contact along which this creek now flows. This suggests that the Kinderhook terrace to the south, with a similar form, was deposited at least in part before the Schodack terrace, while a south-and-east-facing ice margin in the Hudson Valley was progressively wasting northward.

Albia-Burden Lake Complex

Isolated kames, kame complexes, eskers, and esker deltas are well developed throughout a continuous gravelly moraine which extends for 9 miles from Burden Lake north and west to Poestenkill and Albia.

Within this complex, summit elevations of eskers and esker deltas systematically drop from a maximum of 750 feet to 400 feet above sea level from SE to NW, indicating a decrease in age of the deposits from south to north. Sequential pauses in the recession of the ice margin are indicated by ice contacts at the following locations: one mile NW of Maple Grove; one mile WNW of Crystal Cliff; at West Sand Lake; one mile NW of Racquet (Reicherts) Lake; at Coopers Pond-Pine Bowl Speedway; and at Pawling Sanitarium-Moules Lake. The ice margin at Moules Lake can be traced into the Poesten Kill Valley along Route 354 and thence southeast along the Newfoundland Creek valley. This particular margin has been selected as the basis of Figure 5.

As evidenced by the maximum length of eskers which feed ice-margin outwash within the Albia-Burden Lake complex, the ablation zone in which sediment accumulated extended upstream no more than 2 miles from any given margin. Sediment deposited within this zone was chiefly cobble gravel and was preserved only in crevasses. On the south side of any given ice margin, the outwash is usually confined within one-half mile of the margin by slightly higher, earlier, kamey or eskerine ridges. Meltwater outlets from areas of sedimentation were provided by channels along the edges of the complex where till and gravel were stripped, frequently exposing the bedrock. This material in turn provided the source for the accumulations of outwash in deglaciated valleys to the south, such as those of the Moordener Kill and Valatie Kill which flowed into the expanding glacial lake occupying the Hudson Valley.

Figure 4 indicates an episode when the glacial Poesten Kill combined with ice-derived, crevasse-directed streams to construct outwash and ice-contact deposits of the Albia-Burden Lake complex. The construction of ice-contact deposits by the glacial Poesten Kill elsewhere is evidenced by kame terraces near the village of Poestenkill at several elevations slightly higher than esker deltas found in the complex. Some of the other ice margins cited above can also be traced into areas adjacent to the complex through kames and kame terraces which are in near topographic agreement to outwash surfaces of the complex.

If allowance be made for reasonable stream gradients, then it may be presumed that deposits of groundlaid outwash with similar elevations are built under the same temporary local base levels, and are approximately correlatable. This hypothesis appears to work well in systematizing the sequence of formation of glaciofluial upland deposits where topography is favorable to the movement of meltwater streams free from long episodes of ponding.

In the topographically lowest portion of the Hudson Valley, the receding ice-margin served to progressively unblock side valleys marginal to expanding Lake Albany. Meltwater streams occupied these valleys as they became available, and served to supply outwash and lacustrine sediment to the lake in a recognizable sequence, as evidenced by the late delta phases of kame terrace formation of the Schodack and Defreestville terraces. (Figs. 5, 6, 7).

Clearly, the stagnating ice block frequently presented a discernable south-facing margin on the uplands under glaciofluvial conditions and, as is further demonstrated by the kame deltas at Hampton Park and at Rensselaer, this tendency was maintained under lacustrine conditions also. This would seem to refute Cook's (1924) preference for a detached ice block occupying the middle Hudson Valley, apparently unrelated in its melting to any general northward withdrawal of the ice margin.

Lacustrine deposits. Lacustrine sediments are confined to the areas west of the 330 foot beach of Lake Albany, where at least 3 episodes of deposition are recorded. The most extensive deposits are rhythmites of clay and fine sand with numerous interbedded pebble gravels (mapped as Ac, As, Ag). These beds exceed 100 feet in thickness in many places. Water well logs (Hall and Company, personal communication) from the area west of the Schodack terrace and field observations in the gullies of Mill Creek south of the Rensselaer kame delta indicate that these rhythmites comprise a bottomset facies of ice-margin deltas and kame terraces. Textural variations in the rhythmites are frequently great with the sand dominating the clay nearer the deltas. In exposures at distance from kame deltas, as at Castleton, for example, the rhythmites are almost completely clay. At the toe of the kame delta at Rensselaer, about 25 feet of graded sand and silt units with load- and groove-cast sole markings is exposed in a large pit. The turbidity current origin of these units is very probable, suggesting a related origin for the finer-grained rhythmites to the south. Superglacial drift, concentrated by downwasting ice, can be expected to slump or fall directly into lake waters or into crevasse-confined rivers along the calving ice margin, and thereby contribute sporadic overloads of sediment. Whether or not they were deposited by such a mechanism, the thick clays and silts are clearly the oldest lacustrine deposits and spatially related to nearby ice margins.

Overlying the clay rhythmites are fine sands and pebble gravels. These are mapped as Ast where the thickness exceeds 4 feet, Asc where less than 4 feet, and Asd where later wind action has reworked the sand into dunes. Some of these sediments were derived from the 330 foot beach and spread westward for several hundred yards. Along the Schodack terrace and south of Troy, sands as much as 25 feet in thickness represent the contribution of land-derived streams such as the Moordener Kill and Wynants Kill when they flowed across and through the earlier kame terraces into Lake Albany. These deposits are now largely left as erosional remnants between deep gullies, but appear to have been continuous with the widespread sands found in Albany County.

As Albany lake level lowered from 330 feet, terraces and weak beaches formed at 230 feet and 180 feet. The lake, by then confined to the topographically lowest portion of the lake bottom, collected mainly fine sand. These terrace sand deposits were not distinguished in mapping from the deltaic sands because of the very limited occurrence of the former, but on the Cohoes quadrangle the terrace sands can be isolated, particularly on the 240 foot terrace, from other deposits, and mapped separately (Schock 1963).

Stratigraphically, the lacustrine sequence can be generalized with decreasing age, into 1) thick rhythmically-bedded clay and silt derived from wasting ice, 2) land-derived deltaic sand, and, 3) sand confined to erosional terraces inset into earlier rhythmite as lake levels lowered.

Glacial History

Ice-Stagnation and Lacustrine Episodes

Figures 2-7 show positions of the ice margin as it receded northwestward through the quadrangle. The episodes defined by each plate are based upon conditions of drainage most compatible with the spatial relationships of ice-contact, outwash, and lacustrine deposits, but are not necessarily of equal duration.

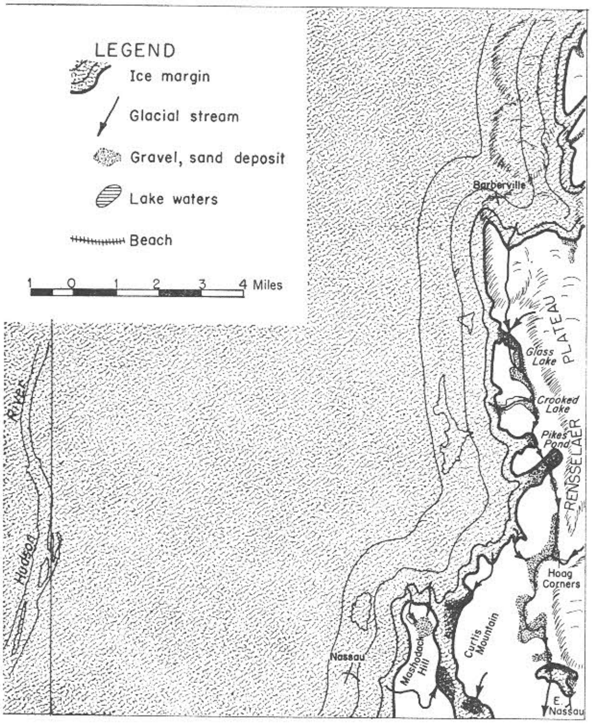

FIGURE 2

Figure 2. A well-defined series of outlet channels, kame terraces, and outwash constitute evidence of a meltwater system with outflow south along the base of the Rensselaer plateau. When ice plugged the Poesten Kill east of Barberville and small tongues blocked the north end of Glass Lake, the west end of Crooked Lake, and the valley now headed by Pikes Pond, a channel now followed by Route 66 distributed extensive outwash gravels into the valley of Alder Brook and Tackawasick (Tsatsawassa) Creek near Hoag Corners. This drainage escaped into the Kinderhook after flowing over a detached ice block at East Nassau. Small kames were deposited over ice in the Pine Swamp-Jacks Corners valley where streams entered the valley from Mashodack Hill to the west and from Curtis Mountain on the east.

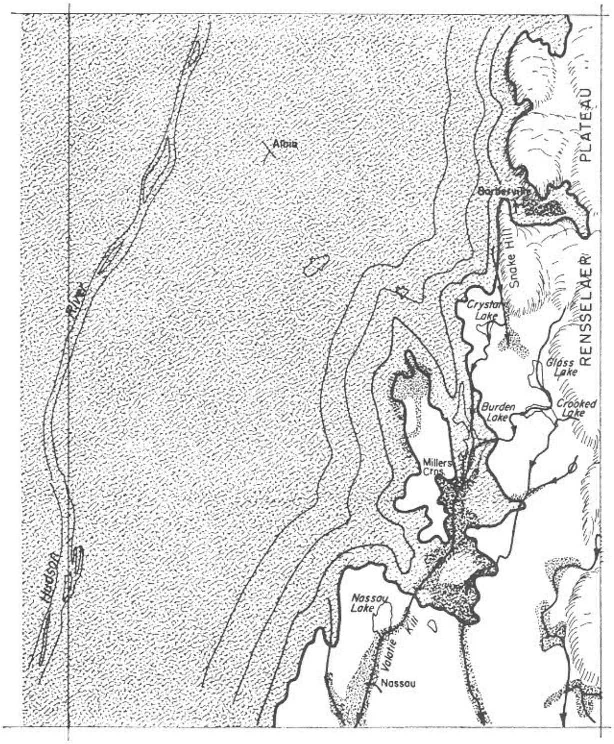

FIGURE 3

Figure 3. The unblocking of the basins of Crystal and Crooked Lakes and the withdrawal of the ice to the west side of Snake Hill permitted diversion of drainage into the lower area now occupied by Burden Lake. The glacial Valatie Kill deposited extensive gravels over ice south of Millers Corners, occupied the channel east of Nassau Lake, and contributed some of the outwash which now fills the valley south of Nassau. Till was stripped from channels in front of the ice west of Nassau Lake by a stream issuing from the ice and was redeposited as the stream joined the main outwash system immediately southwest of Nassau. Esker deltas with summits at 700 to 800 feet west of Burden Lake are considered to be early elements of the Albia-Burden Lake complex related to this ice margin position. Near Barberville in the upper Poesten Kill valley, kames at 900 feet were probably deposited during this episode.

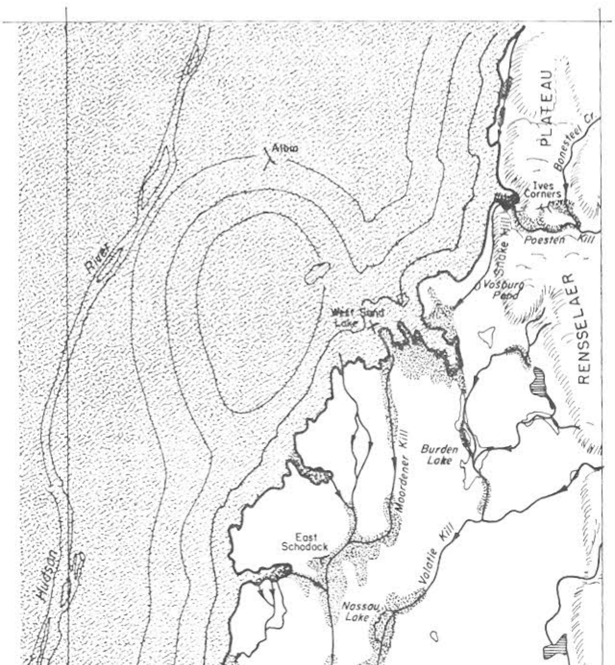

FIGURE 4

Figure 4. In the Albia-Burden Lake complex south of West Sand Lake, outwash surfaces at 650 feet fed by eskers from the northwest agree in summit elevation with an outwash fan supplied by the glacial Poesten Kill as it escaped around the north end of Snake Hill and occupied the valley of Vosburg Pond. Kames at 750 to 800 feet at the Barberville cemetery were formed where the latter stream flowed over the ice. The upper Poesten Kill valley terraces at 900 feet were formed at Ives Corners by Bonesteel Creek. The glacial Moordener Kill carried outwash waters south from the margin at West Sand Lake, depositing extensive gravels near East Schodack. Ice plugged the valley west of East Schodack, maintaining a 440 foot base level.

The Moordener Kill drained southward through channels previously established west of Nassau, where it joined the Valatie Kill. The Valatie Kill eroded through some of the kames at the south end of Burden Lake while ice still occupied the Burden Lake basin, and this stream then initiated the present exit from the basin along China Hill Road.

Outwash continued to collect at Nassau Lake as the eroded kame gravels were redeposited. The 310 foot terrace of the Kinderhook probably correlates with this episode as its presence is necessary to maintain the temporary base levels for the Valatie Kill-Moordener Kill in the Nassau valley. The Schodack terrace continued to expand northward to the vicinity of the Vlockie Kill.

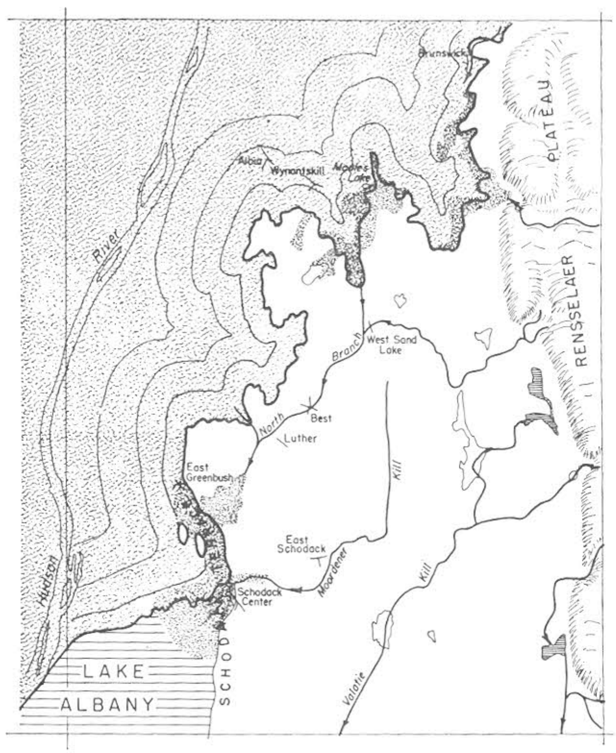

FIGURE 5

Figure 5. Lacustrine conditions spread northward into the quadrangle shortly after the Moordener Kill became unblocked at Schodack Center (intersection of Routes U.S. 9 and 20 and N.Y. 150) The westward diversion of the outwash plain drainage at East Schodack permitted the dissection of a kame complex east of Schodack Center, and upon the heavy influx of gravel a delta was built to near 350 feet where the Moordener Kill emptied into lake waters. This ice margin is now followed by the Moordener Kill west of Schodack Center where the meanders are in part confined by the sides of exhumed eskers containing boulder gravel. The valley of the north branch of the Moordener Kill also became unblocked during this episode, receiving waters from an ice tongue which lay in the valley of the Wynants Kill north of West Sand Lake. Further downstream these waters eroded a kame complex plugging the valley between Best and Luther. A large outwash and kame terrace system was constructed south of East Greenbush at levels of 390-350 feet where the Moordener Kill debouched over the ice.

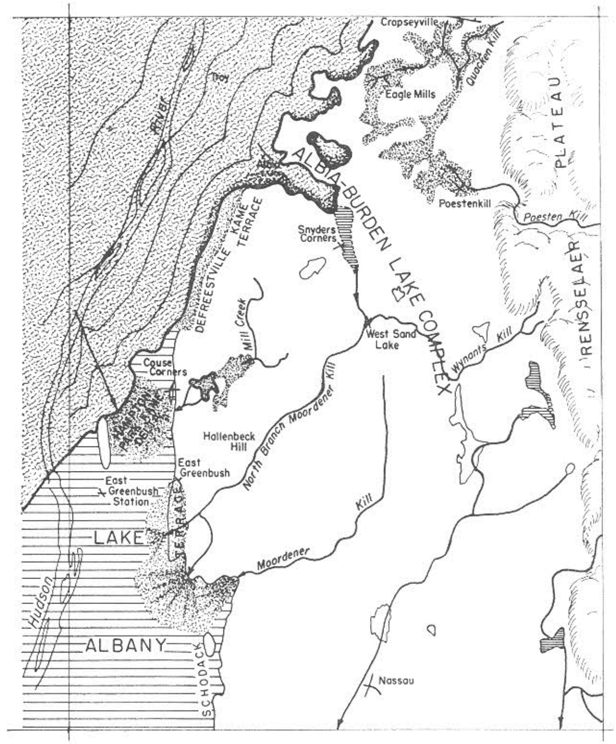

FIGURE 6

Esker deltas were built to 550 feet in the Albia-Burden Lake complex as the margin lay at Moules Lake and along Route 154 east of Wynantskill. In the Poesten Kill valley, kame terraces at similar elevations were formed at the contact of the ice with the base of the Rensselaer plateau. Dissection of a drumlin cluster at Brunswick by the glacial Quacken Kill began late in this stage of recession. *Figure 6.* The kame delta at Hampton Park and the kame terrace north of Defreestville mark the edge of the ice which in the Hudson Valley defended lake waters standing near 350 feet. Bottomset lacustrine sands of the Hampton Park kame delta abut the northernmost kame gravels of the Schodack terrace between Sherwood Park and East Greenbush, and overlie and interfinger with rhythmic clay west of Couse. A long esker extending west from East Greenbush served to confine these sandy delta bottomsets to the north, as indicated by water well logs of the Sherwood Park-East Greenbush Station area. South of the esker barrier the clays contain no sand. Mill Creek was plugged by an ice block, indicated by kame gravels east of Couse and a terrace which developed at 360 feet on the upstream side of the block. The valley of the present Wynants Kill remained ice-plugged and the Albia-Burden Lake complex was completed. The kame complex filling this valley south of Snyders Corners prevented the Wynants Kill from turning northward at West Sand Lake. Hence the Moordener Kill continued to receive the full discharge and began to erode the earlier 380 foot terrace between the Hallenbeck Hill gorge and Routes 9 and 20. Some detached ice blocks probably lingered in the valley northwest of Poestenkill but this area was deglaciated sufficiently to permit the Poesten Kill to deposit outwash and lacustrine sediments.

The glacial Quacken Kill joined this system through the Brunswick channel as it further eroded the cluster of drumlins south of Cropseyville. These waters were isolated from the Hudson Valley by a tongue of ice which filled the Poesten Kill valley west of Eagle Mills. The kamey edge deposits of this tongue are prominent near the 500 foot level northwest of Eagle Mills. This system was defended on the north by a tongue of ice plugging the Tomhannock valley to near Tamarack on the Cohoes quadrangle, and continued as an outwash and lacustrine complex until finally drained by the deglaciation of the Poesten Kill valley to the vicinity of Troy and by the erosion of the kame terraces just west of Eagle Mills.

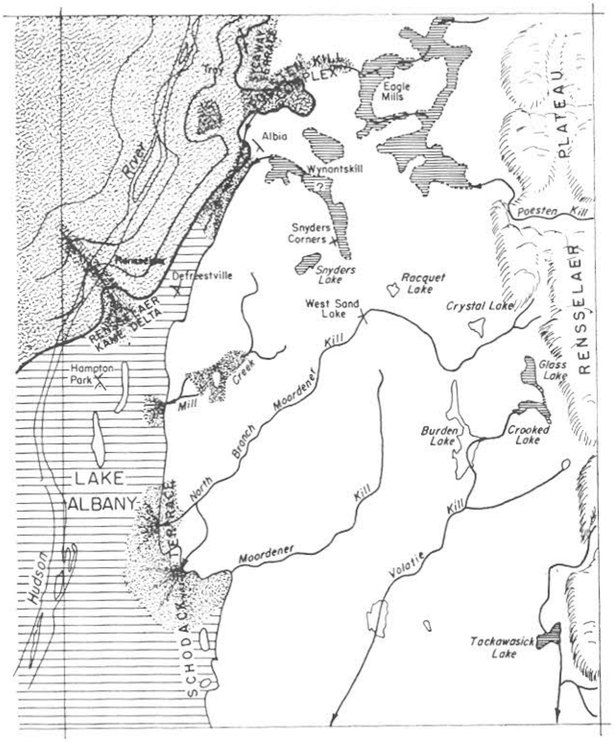

FIGURE 7

Figure 7. A large kame delta on the eastern limits of the city of Rensselaer marks the edge of the ice after it receded about one mile from the Hampton Park area. A superglacial river entering lake water deposited both the Hampton Park and Rensselaer kame deltas, as indicated by their size, simple lobate form of sediment distribution, and by the absence of significant ice-margin deposits elsewhere in the vicinity. Extensive ice-contact gravel found beneath the Rensselaer delta on the northwest side appears to have been continuous across the present Hudson River with the Loudonville kame complex (Woodworth, 1905) on the Albany quadrangle.

The position of the ice margin northeast of the kame delta at Rensselaer is difficult to determine. Part of the kame terrace north of Defreestville may date from this episode but beach alteration of this deposit by later Lake Albany waters at 330 feet has destroyed any evidence of an ice contact along the edge. The Poesten Kill had a temporary base level at 440 feet, defended by ice which blocked that valley east of Troy and which lay beneath the kamey area now occupied by Troy Country Club ("Golf Course" of topographic map). The Sycaway kame terrace at 400 feet is esker-fed northwest of Lady of Victory School and merges with the Poesten Kill kame complex and 400 foot terrace along Route 2 east of Troy. The glacial Poesten Kill and Quacken Kill, confined earlier to the valleys east of Eagle Mills, maintained outflow there during this episode and contributed gravel to the highest Poesten Kill terrace. Northwest of Albia, bedrock exposed at 400 feet suggests a southward outlet toward lake waters. The Wynants Kill valley continued to enlarge southward under lacustrine conditions toward Snyder's Corners as detached and buried ice blocks melted, but because the capture of the Moordener Kill at West Sand Lake required considerable erosion and draining of the west edge of the Albia-Burden Lake complex, the capture is assigned to a later episode. The 370 foot terrace of the Wynants Kill west of Albia formed after withdrawal of ice, to the site of Emma Willard School, permitting the initial overflow and erosion of the kame barrier west of the village of Wynantskill.

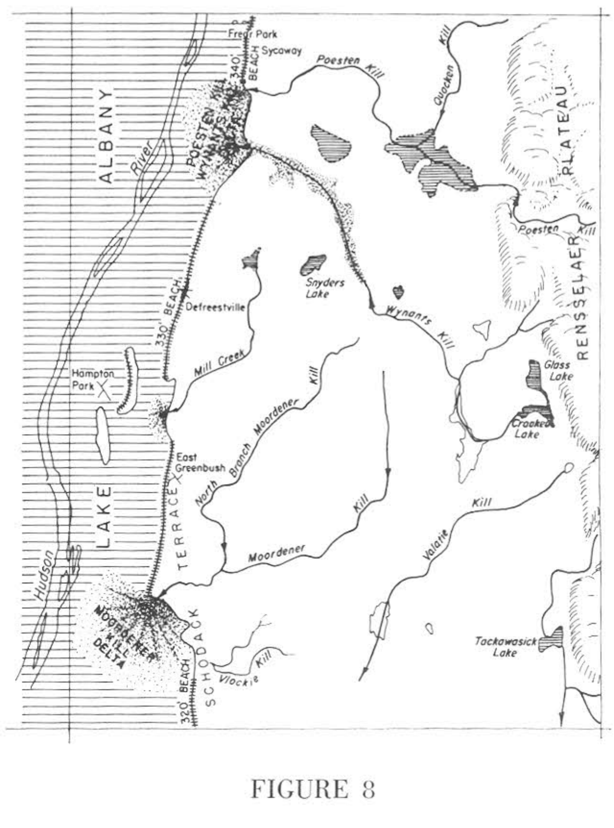

FIGURE 8

Figure 8. Lake Albany, 330 foot level. A prominent beach marks the eastern shore of Lake Albany throughout the length of the Troy quadrangle. From an elevation of 320 feet, south of the present Vlockie Kill, the beach rises to 330 feet at Defreestville and to 340 feet at Frear Park at Troy as a result of

glacial rebound. All kame terraces and kame deltas at elevations of 350 to 400 feet have had their western edges altered by wave action, particularly the Schodack terrace south of East Greenbush, the Hampton Park kame delta, the Defreestville kame terrace through the town of North Greenbush, and the Sycaway terrace at Troy. The Poesten Kill, Wynants Kill, and Moordener Kill built deltas into the lake, covering earlier clay and ice-margin gravel with 25 to 40 feet of sand and fine gravel.

Beach ridges of fine gravel, built 5 to 10 feet above normal lake level, are conspicuous along the edge of the Schodack terrace and in North Greenbush, and require for their formation a wide fetch of open lake water, unencumbered by ice. Thin layers of sand and clay accumulated in ponds behind the beach ridge. Small ice blocks buried in the earlier kame terraces thawed during and after the formation of the beach, as evidenced by abnormal thickness of down-faulted beach gravels along the Schodack terrace, and by occasional unfilled kettles in the beach at Defreestville and North Greenbush.

Sand covers rhythmically bedded silt and clay west of the best-formed beach segments and, prior to more recent gullying, this sand probably combined with later lacustrine sands to form a deposit continuous with the thick sand west of the present Hudson. Rafted boulders are frequently found in this deposit east of Rensselaer.

The deposition of sandy deltas by streams entering this phase of Lake Albany is in contrast with the thick clay deposits frequently associated with earlier, ice-margin kame deltas in bottomset relationship. Dissection of upland kame complexes and terraces which are originally poor in clay, provided reworked silt, sand, and fine gravel for deposits of such streams as the Wynants Kill and Poesten Kill. The stratigraphic relationship of late delta sand over earlier clay is demonstrated elsewhere in the Hudson Valley, especially by the deltas of the Mohawk and Batten Kill (Woodworth 1905) and the southern edge of the Hoosic delta (Schock 1963).

Lower Albany Phases

Lowering of Lake Albany to 240 feet. Only two Albany levels lower than the 330 foot beach are recorded in the Troy area. A 240 foot level is indicated by a small beach west of Route 4 south of the mouth of the Wynants Kill. Sand deposits associated with this level are common in the Cohoes quadrangle on both sides of the Hudson (Schock 1963) but have been largely eroded in the Troy area.

Partial dissection of the Schodack terrace by the Moordener Kill permitted the deposition of about 10 feet of pebbly sand near Castleton. The Wynants Kill similarly eroded through the 340 foot delta along its present course, forming first the 315 foot terrace west of Albia, when bedrock became exposed south of Smarts Pond. After the partial excavation of the Burden Pond basin, the Wynants Kill joined the 240 foot Lake Albany north of the Immaculate Conception Monastery and probably contributed the pebbly sand found west of the beach along Route 4.

During the lowering of lake level to 240 feet, the Poesten Kill dissected its earlier 340 foot delta and formed terraces at 325 feet, 310 feet, and 280 feet. At 240 feet the shore of Lake Albany stood at the present head of the Poesten Kill gorge. Pebble gravel presently capping the 240 foot hill at Prospect Park in Troy probably dates from this phase. West of Watervliet remnants of fine sand below 240 feet cap a now-dissected clay terrace and are traceable northward into the Cohoes quadrangle (Schock 1963).

Lowering of Lake Albany to 180 feet. A small beach at 180 feet modified earlier lake clay and a drumlin near Rosemont Park in Rensselaer, and west of Jordan Road. All streams presently fall over rock to reach this elevation and presumably these gorges were initiated during this interval. No river terraces are available to indicate falling lake levels below 240 feet. For a time the Poesten Kill may have flowed down the Congress Street valley in Troy but was largely confined to its present gorge.

The Wynants Kill was temporarily captured by the gully passing south of Troy Airport but erosion of the rock barrier at Griswold Heights caused the Wynants Kill to resume its original path. It seems likely that at some time during these drainage stages, the Spring Avenue gully in Troy should have received runoff from the Poesten Kill or Wynants Kill but there is no indication that either stream ever used this course. The gully head now lies at 310 feet and is isolated from both streams. Springline runoff on top of the clays at 230 to 250 feet probably started the headward erosion of the gully, aided by the torrential outpour through the adjacent Poesten Kill gorge.

On the Cohoes quadrangle, Schock (1963) cited cobble-strewn clay surfaces and stripped bedrock west of Waterford as evidence suggesting that the present course of the Mohawk (Alplaus to Cohoes) was initiated during the time of the 190 foot Albany level, after having earlier occupied the channel of the Anthony Kill at Mechanicville.

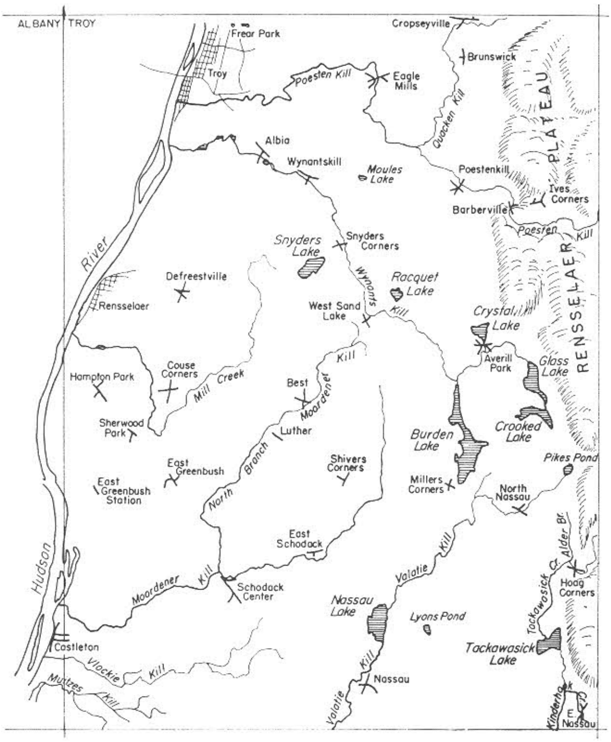

FIGURE 9. Present Drainage

Hudson Valley Lacustrine Phases

The Lake Albany Problem

The "Hudson waters" of Peet (1904) were renamed Lake Albany by Woodworth (1905). Since that time the name Albany has been variously applied to the extensive clays and sands of the Hudson Valley, to a series of falling water levels as indicated by deltas and terraces, to beaches of diverse prominence and geographic extent, and to a water body distinguishable both geographically and chronologically from Lake Vermont.

The basin holding Lake Albany waters has been variously described as ice-choked throughout the duration of the lake, and as ice-free in the late stages. Hence, the presence of a well-defined, calving ice margin defending a single, northward-expanding lake has been both denied and promoted. Fairchild's concept of a sea-level strait connecting the Atlantic Ocean at New York with the St. Lawrence Lowland was rejected first by Stoller in the Cohoes latitude on the presumption that the strait persisted after Lake Albany had begun to drain, and was thereby confined to the present strath of the Hudson. Although the clays of the Hudson Valley are clearly non-marine, the demonstration of the continuity of water bodies in which they collected through the entire Hudson-Champlain Valley and the identification of the mechanism for containing the waters at the southern end await further work.

Due to the deflections attending crustal rebound, the naming of sequential lake phases by citation of topographic levels is useful only in a local area, and such designations become unwieldy and inaccurate when extended north or south. Unfortunately the identification of all Albany phases with nameable outlets is not feasible because of the lack of evidence for spillways in the southern Hudson Valley. Finally, Lake Albany shore features include ice-contact deposits which formed in early phases, a major beach which formed during an ice-free median phase, and late-phase terraces and minor beaches which indicate several regionally traceable falling water levels.

Chadwick (1928) defined several phases in the development of Lake Albany as the ice withdrew through the Saratoga-Glens Falls area. His maps (his Figures 1-5) illustrate the interval represented in this paper between the events of Figures 7 and 8. Chadwick also recognized the deposits and channels of the falling waters of Lake Albany and implied the uninterrupted continuation of a late, draining phase of Lake Albany into the Early Coveville phase of Lake Vermont.

The time of draining and the relationships of the final Albany phases to Lake Vermont are not determinable in the Troy area alone, but spatial relationships of deltas, terraces, and outlet channels to the north pertinent to Lake Vermont have a bearing on some of the late terraces and beaches in the Troy area.

Flint (1953) proposed the hypothesis that Mankato ice advanced into the Glens Falls area following the draining of Lake Albany in Cary time and prior to the development of Lake Vermont. The disturbed clays east of Glens Falls, originally cited by Woodworth (1905), were offered as evidence of the southward limit of the Mankato advance. Contrary to Chadwick's (1928) assignment of the Glens Falls delta to Lake Albany, Flint suggested that the delta accumulated in Lake Vermont and hence might have served to bury any evidence of Mankato advance west of Glens Falls.

Relationships Between Lakes Albany and Vermont

The draining of Lake Albany in Coveville time as postulated by Chadwick (1928), and the significance of the Coveville outlet (Schuylerville

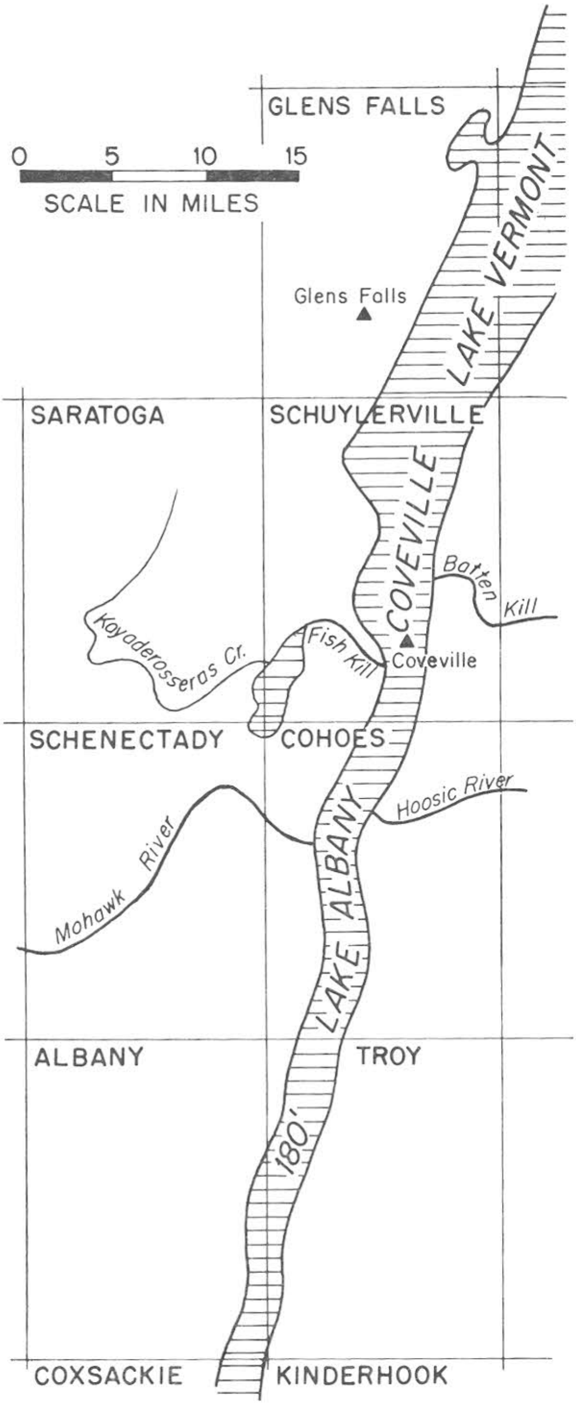

FIGURE 10
Coveville Lake Vermont, and related drainage

quadrangle) as a southern spillway for Lake Vermont are both open to question. There is evidence to suggest that Lake Albany south of Schuylerville may not have been drained so quickly as Chadwick suggested and that the Quaker Springs, Coveville, and Fort Ann phases of Lake Vermont may coincide with the late Albany phases recognized on the Cohoes and Troy quadrangles. See Figure 10.

Chadwick presumed the 350 foot and 310 foot deltas of the Batten Kill plugged the Hudson Valley from Middle Falls west to Schuylerville, burying a detached block of ice. Upon lowering of Lake Albany from 310 to 270 feet in that vicinity, the deltas would have emerged as barriers and the Grangerville channel west of Schuylerville would have provided only a narrow connection between the northern and southern halves of Lake Albany. The northern half thereupon became identified as the "initial" or "Coveville" Lake Vermont in reference to the plunge pool at Coveville which presumably shared the drainage of both the glacial Mohawk and the northern lake. According to Chadwick, Lake Albany then rapidly lowered south of the Coveville outlet while the northern lake continued to grow northward, confined east of Schuylerville by the Batten Kill deltas. Chadwick made no mention of an earlier, higher phase of Lake Vermont but the severe scour near Quaker Springs at 300 feet was cited by Woodworth (1905) as evidence for this phase. This level is in near agreement with the 310 foot Batten Kill delta at Bald Mountain 5 miles to the northeast. Chadwick further suggested that Lake Albany was drained long before Lake Vermont (Fort Ann phase of Chapman) found outlet through the Fort Edward channels. Both Chadwick (1928) and Chapman (1937) assigned considerable importance to the opening of the Schuylerville gorge by erosion of the Bald Mountain delta as the mechanism for lowering the Coveville phase level to the Fort Ann outlet level.

Glacial Rebound

Flint (1953) called attention to the discrepancy between crustal rebound values of 4.2 feet per mile for the Connecticut Valley and 2.25 feet per mile for the Hudson Valley. The tilted water planes as drawn by Chapman (1937, p. 118) for Coveville- and Fort Ann-Lake Vermont in the Champlain Valley have a slope of 5 feet per mile, while in the Hudson Valley between the latitudes of the Kinderhook and Schuylerville quadrangles the tilt of the 330 foot Albany beach is 2.5 feet per mile, and the slope of both the 240 foot and 180 foot beaches is only 1.5 feet per mile. All figures are for the N-S direction. As shown on Figure 11, by connecting the rebounded water planes for the Hudson and

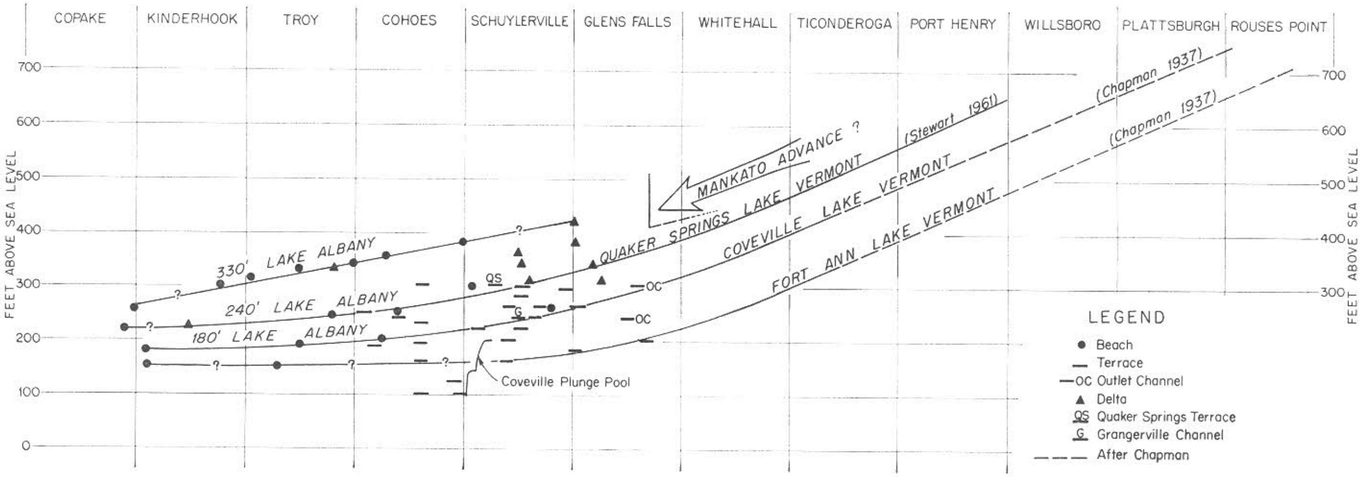

FIGURE 11. Rebounded water planes of Lakes Albany and Vermont.

Champlain valleys through what appears to be a hingeline area in the Glens Falls-Schuylerville latitude, the Coveville level as extrapolated by Chapman can be fitted nicely, through the Grangerville channel, with the 180 foot level of Lake Albany. The 180 foot Albany plane is too high for possible correlation with the Fort Ann phase, but wave-cut terraces at 150 feet on the Kinderhook quadrangle may date from this phase.

Relationships to Lake Vermont

The Coveville Outlet

The Coveville outlet could have been accessible only to northern waters which exceeded 230 feet in elevation, and which passed through the shallow valley between Grangerville and Northumberland west of Schuylerville. Although this Grangerville channel was occupied by highest Coveville waters for a time, the terraces along the Hudson extending from the mouth of the Batten Kill at Clarks Mills at 220 feet, south through Schuylerville and Coveville into the Cohoes quadrangle, reflect the erosion of the west edge of the Batten Kill delta before the rocky cap of the Coveville plunge pool at an elevation of 200 feet could serve as a lake spillway. The Coveville plunge pool has dissected this terrace on the west side of the Hudson. A 140 foot terrace has subsequently developed in the meander initiated by the plunge pool.

Correlations

The following relationships are suggested:

(1) Coveville Lake Vermont did not drain at Coveville but was concordant there with a 220 foot Lake Albany level (180 feet at Troy) with free access south through the Hudson Valley, first at Grangerville, and then east of Schuylerville.

(2) The Coveville plunge pool was active during the lowering of lake level from 220 feet to 140 feet, but served only river waters flowing through the Fish Kill valley from the west.

(3) The Quaker Springs phase of Lake Vermont in the Hudson Valley is tentatively correlated with the Bald Mountain delta of the Batten Kill at 310 feet and with the sandy terrace which represents the 240 foot Lake Albany level on the Troy and Cohoes quadrangles. To assume a higher level for a Quaker Springs phase would involve too large an elevation difference between Quaker Springs and Coveville shore features as compared with those cited by Stewart (1961) in Vermont, and would also conflict with the original definition of this phase. To assign a lower level to Quaker Springs would eliminate the Coveville phase.

(4) In the absence of evidence indicating draining of the Hudson Valley and later filling by lake waters, it is postulated that Lake Albany endured at or slightly lower than its 330 foot maximum (at Troy) while the Mankato (Fort Covington) advance was occurring. Only in this way can the Quaker Springs phase as recognized by Stewart in the Champlain Valley be accomodated in the Hudson Valley.

At present the simplest relationships indicate that during its early history Lake Vermont was controlled by late Lake Albany levels, rather than by spillways at Coveville or Schuylerville. If one presumes that Lake Vermont drained into a lake-free Hudson Valley, serious problems arise with regard to traceable terraces. The subtle but discernible northward divergence between the rebounded plane of 330-foot Lake Albany and the planes of the lower Albany phases can be interpreted to indicate an interval of crustal uplift accompanying the Cary recession through the Champlain Valley. Should these apparent relationships subsequently be proven correct, renaming of the late Albany phases would be advisable. Restriction of the Albany name to deposits no younger than the 330-foot beach, as suggested by the writer (LaFleur, 1961 b), would clarify the nomenclature.

Economic Geology

Gravel. Potentially workable gravel deposits of large volume occur throughout the quadrangle but current operations are confined to areas where quality is sufficient to justify processing and trucking to urban markets. Gravel quality is largely dependent upon the concentrations of quartzitic sandstones and Rensselaer graywacke in the pebble and cobble sizes. Sands associated with gravel in which these lithologies are abundant are similarly enriched in quartz and are also of good quality.

With the exception of an area southeast of the village of Wynantskill, the highest quality material is to be found where wasting ice has contributed washed drift rich in Rensselaer graywacke to kames, eskers, and outwash plains, or by its presence has controlled drainage from the Rensselaer plateau in such a way as to exclude the shaly lithologies commonly found in till and bedrock outcrops west of the plateau. Deposits formed during the emergence of the Rensselaer plateau as a broad nunatak, and during the episodes illustrated by Figures 2, 3, and 4, are generally of better quality than are those deposits which formed at lower elevations during the episodes shown on the remaining plates.

The northern quarter of the Albia-Burden Lake complex near Wynantskill contains gravel of good quality. Pebble counts indicate a concentration of quartzite to 50 percent of the total lithologies. The high degree of rounding of the pebbles and cobbles and the presence at depth of a few cobbles of rotten limestone suggest incorporation into the ice and redeposition of older valley bottom outwash gravels.

Unfortunately, the gravel deposits closest to Albany are among the poorest in quality. Pebble counts at the kame deltas at Rensselaer and Hampton Park and in pits in the Schodack terrace indicate up to 30 percent argillaceous Normanskill subgraywacke, less than 40 percent quartzite, with the remainder largely dark shale. Where Ordovician lithologies encorporated in the ice enriched the drift, the resulting gravel is far less sound than in localities where the Cambrian lithologies dominate. As noted earlier, the direction of ice advance is not greatly different from the regional trend of the bedrock. Consequently, rock-derived drift was not laterally displaced far from the original outcrop belt and areas of gravel with similar quality are arranged more or less in a north-south direction.

Exceptions to this trend occur near the western ends of the Poesten Kill and Moordener Kill valleys in later gravel deposits in which Rensselaer graywacke was found in abnormal quantity (5 to 10 percent of the total lithologies). The reconstruction of the ice-margin in Figures 5, 6, and 7 was aided by pebble count data which suggest that these valleys were deglaciated sufficiently to permit erosion and reworking of slightly older kame complexes lying geographically closer to the Rensselaer plateau, but before the ice completely wasted from the lowest portion of the Hudson Valley.

Sand. With rare exceptions, the ice-contact deposits are gravelly and major concentrations of usable sand are to be found only in kame deltas at Rensselaer and Hampton Park, and in smaller esker deltas throughout the Albia-Burden Lake complex. Sizable accumulations of high quality sand are worked at the southeastern corner of the quadrangle and on the adjoining Stephentown Center quadrangle where kame terraces at elevations above 700 feet marginal to the Rensselaer plateau received drainage exclusively from this upland. Gravel associated with these quartz-rich sands contains as much as 85 percent graywacke and together with the sand provides the soundest surficial aggregate to be found in the Capital District.

Lacustrine sand, known as the "Colonie blow sand" in Albany County, is found overlying clay within 2 miles of the Hudson River but high silt content prohibits the processing of this sand for concrete aggregate.

Peat. Peat, in thickness up to about 3 feet is presently dug for use by florists and gardeners from a bog occupying a kettle hole one mile southeast of West Sand Lake. Many other bogs are potential peat producers but this industry has not as yet developed.

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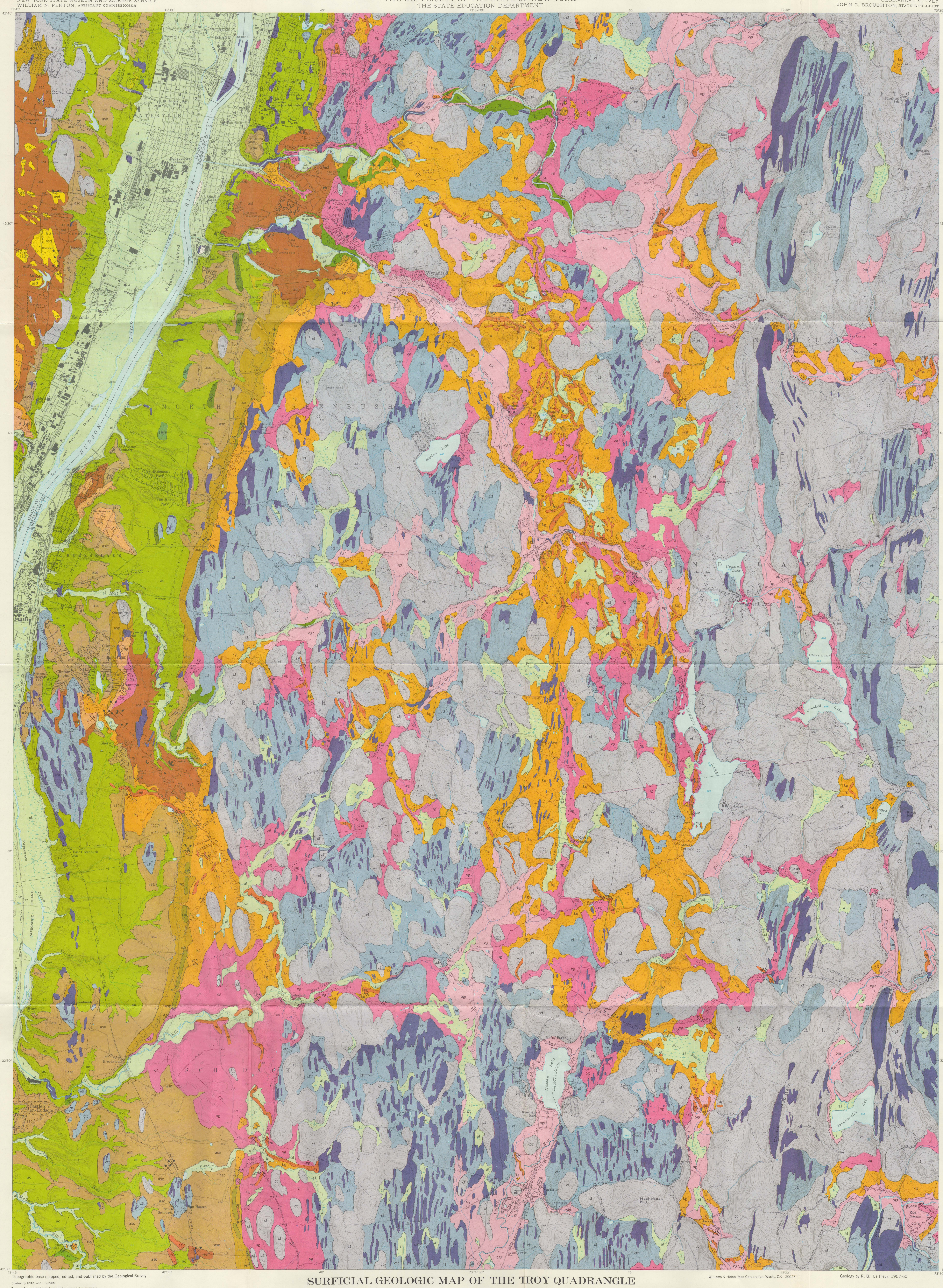


LEGEND

al — Recent alluvium. Peat, Marl bog

asd — Duned lacustrine sand. "Colonie blow-sand"

180 / 240 — Terraced clays along minor inferior Albany beaches

tg — River terraces; gravel.

LACUSTRINES

asp — Beach of 330′ Lake Albany
Thin gravels, beach pond clays.

agb — Beach ridges of 330′ Lake Albany.
Pebble gravels.

ast — Thick sand, fine gravels (> 4′) overlying clay.
Lake Albany deltas.

asc — Thin sand, pebble silts (< 4′) overlying clay.

ac — Blue-gray, chocolate, rhythmic clays and silts.
"Lake Albany clays."

as / ag — Sand, gravel interbeds in clay.

OUTWASH

ogr — Fine outwash gravels, some lacustrine silts.
River channels, temporary lakes.

og / os — Outwash gravels, sands associated with ice margins.
Esker deltas.

ICE-CONTACT DEPOSITS

hg / hs — Large kame deltas. Pebble gravels, sands.

kg / ks — Kames, kame terraces. Slumped gravel and sand.

eg — Eskers, crevasse-fillings. Slumped gravel.

TILL

ct — Thick (> 10′) Cary till. Drumlins.

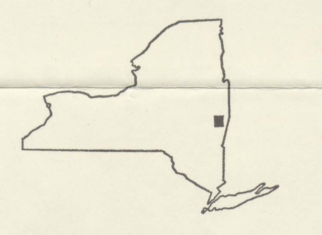
ctt — Thin (< 10′) Cary till. Frequent rock outcrop.

Bedrock outcrop. Cambrian, Ordovician sandstones, argillites.

Gravel pit

Sand pit

Contact



QUADRANGLE LOCATION

SURFICIAL GEOLOGIC MAP OF THE TROY QUADRANGLE

Topographic base mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography from aerial photographs by stereophotogrammetric methods. Aerial photographs taken 1952. Field check 1953

Polyconic projection. 1927 North American datum
10,000-foot grid based on New York coordinate system, east zone

APPROXIMATE MEAN DECLINATION, 1953

Scale 1:31680

1 ½ 0 1 2 Miles

5000 2500 0 5000 10000 Feet

Williams & Heintz Map Corporation, Wash., D.C. 20027

Geology by R. G. La Fleur: 1957-60

New York State Museum and Science Service
Geological Survey, Map and Chart Series: No. 7

M676-Ag65-2500 (1965)