Geomorphology of the Southeastern Tug Hill Plateau

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INTRODUCTION

Few areas of comparable size in New York State are less accessible or less well known than the heart of the Tug Hill Plateau. The heaviest snowfalls in the eastern states make for brief growing seasons. Extensive tracts cleared and farmed in the past century have returned to second growth. The road net involves only jeep trails between a few broadly spaced transverse highways.

Although isolated by peripheral lowlands -- the Black River Lowlands on the north and east, the Ontario Lowlands on the west and the Oneida-Mohawk Lowlands on the south -- the Tug Hill is a crudely triangular outlier of the Southern New York Section of the Appalachian Plateaus Province. Rough accordance of summit elevations (e.g. 1960 ft at Gomer Hill, 1920 ft at Mohawk Hill) led Newell (1940) to relate physiographic history of the Tug Hill to that of the adjacent Appalachian Plateaus to the south, ascribing a major role to Tertiary peneplanation. Regional dip southwesterly away from the Adirondack Massif led Hanefeld (1960) to stress the cuestaform nature of the Tug Hill. The scarped east-facing border of the plateau contrasts with the gradual southerly and westerly dip slopes. Indeed both peneplanation and cuestaform development convey true, but incomplete impressions of the regional character of the Tug Hill subprovince. Each is incomplete in failing to emphasize the role of prolonged and repeated Pleistocene glaciation in isolating the plateau, in reducing summits and in shaping present topography. Perhaps because of the erodibility of underlying rocks, these effects are maximized in the southeastern portion of the plateau.

Rocks of Ordovician and Silurian age underlie the Tug Hill Plateau. At the base of the sedimentary section are carbonate rocks of the Trenton and Black River Groups which lie unconformably upon Precambrian metasediments of the Adirondack terrane. From Forestville north to Carthage, the contact between sedimentary and metamorphic rocks lies roughly along the course of the Black River and presumably exerted structural control upon development of the Black River Lowlands. Trenton, Utica, and Frankfort Formations of Ordovician age comprise the stepped and cuestaform eastern margin of the plateau. They also underlie the narrow, southeastern extension of the subprovince where regional dip approximates regional slope from the Black River to the Oneida-Mohawk Lowlands. As a result, Utica Shale underlies both northern and southern margins of this southeastern portion of the subprovince. The youngest Paleozoic strata of the plateau are the red and green sandstones and shales of the Medina Group which lie unconformably upon Queenston, Oswego and Lorraine rocks in the southwestern portion of the Tug Hill.

Knowledge of the geology of the Tug Hill has long been based chiefly on inference from studies in the peripheral lowlands. Surficial geology, for instance, was inferred from studies such as those of Taylor (1924), Stewart (1958) and MacClintock and Stewart (1963) in the St. Lawrence Lowlands; of Miller (1909a, 1909b), Fairchild (1912), Buddington (1934), Tyler (1938) and Force, Lipin, and Smith (1975) in the Black River Lowlands. Kaiser (1962) showed the responsiveness of glacial drift to immediate bedrock provenance and inferred prevailingly southeasterly glacial flow across the Tug Hill. Street (1966) on lithologic criteria delineated the interlobate area of rapid transition from characteristic eastern (Black River Lobe) to western (Ontario Lobe) till in the area west of Ava. Jordan (1977, 1978) studied glacial deposits in the heart of the Tug Hill with a view to distinguishing relationships of wetland types to glacial geology. More specifically, published geologic information relating to the southeastern portion of the Tug Hill subprovince involves geologic mapping of the Remsen (Miller, 1909a), Oriskany (Dale, 1953) and Utica (Kay, 1953) quadrangles, surficial mapping by Wright (1972) and regional correlation by Fullerton (1971, in press).

DRIFT LITHOLOGY

Drift characteristics reflect primarily the mode of emplacement and the nature of the source terrane from which the materials were derived. Mode of emplacement usually can be inferred on the basis of structural characteristics within the drift. Firm, compact, impermeable lodgment till is distinguishable from relatively loose, coarse, ablation drift. The former indicates deposition by plastering down beneath the base of an actively moving wet-soled glacier. The latter results from the melting out of debris-laden ice, letting down the formerly superglacial drift with variable washing and sorting. Under favorable circumstances, more specific interpretation of the depositional environment and process can be inferred from such characteristics as platy structure (fissility), shear surfaces, silt caps associated with embedded clasts, etc. Except for weathering and soil-profile development, these characteristics are not age dependent and therefore cannot be used directly in inferring age relationships. Factors affecting profile development are sufficiently complex that pedologic criteria likewise are difficult to apply except where great differences in age are to be distinguished. Such is not the situation in the Tug Hill Plateau.

Petrologic and mineralogic characteristics of tills depend primarily upon source terranes. Ordinarily drift lithologies are dominated by local bedrock. The probability of representation of farther traveled constituents depends upon distance from source, relative attrition rates and dilution. Dominance by local rock types is apt to be particularly strong in areas of thin drift and up-hill flow on moderate slopes and in moderate relief. Conversely, far-traveled components tend to be represented for longer distances in through valleys and areas of thick drift. Gradual transition in till characteristics is more usual than sharply defined borders, but patterns of lateral change may be used to reconstruct past glacial flow trajectories and by inference, to correlate or distinguish different till units.

On the basis of till constitution, three rather readily distinguishable tills, derived from contrasting source terranes are recognized in the Tug Hill.

Till of the Ontario Lobe in the western and particularly the southwestern part of the Tug Hill is represented by characteristically red till, moderately stony, with sand to silt matrix. Clasts of red sandstone (Grimsby) and pale green sandstone (Oswego) are dominant in the coarse component with only 1-2 percent of metamorphic rocks. Carbonate content diminishes southeastward.

Till of the Black River Lobe is represented by dark-gray to black, sparsely to moderately stony till with silty clay to clay loam matrix. Clasts of dark siltstone and gray limestone dominate. The source terrane involves the fine clastics and carbonates of the Ordovician Trenton, Utica, and Frankfort Formations. Carbonate content is apt to be moderately high. Together with the relative impermeability of these tills this results in disproportionally shallow leaching and profile development as compared with tills of the same age in the area dominated by the Ontario Lobe.

Till of Adirondack provenance is typically gray to yellow brown, moderately to very stony and with sandy matrix. It is apt to be relatively loose and permeable so that the distinction between lodgment and ablation drift may be obscure. Components derived from metamorphic rocks dominate in all size fractions. Distribution of very large metamorphic boulders on the landscape may be an indicator that obviates the need for clean exposures to distinguish it from either the Ontario Lobe or Black River Lobe tills.

Recognition of the three till types distinguished by provenance usually is clearcut, and made the more so by contouring of lateral variation (Street, 1966) or application of statistical techniques (Jordan, 1978). Nevertheless, transitional and intermediate characteristics are to be expected in interlobate areas, or in exposures of reworked or mixed till components.

DEGLACIATION OF THE SOUTHEASTERN TUG HILL PLATEAU

For present purposes, the southeastern Tug Hill Plateau is that portion of the subprovince drained by the Mohawk River and its tributaries. As such, it lies in Oneida County and largely in the area dominated during glaciation by the Black River Lobe of the continental ice sheet. It is an area of broadly rounded hills separated by open basins and reduced well below the inferred Appalachian summit accordance. Boonville Gorge, the overfit valley inherited by Lansing Kill (Muller, 1964, p. 32) transects this portion of the plateau in a north-south direction from Boonville to Rome. West of Boonville Gorge, the upper course of the Mohawk River separates Quaker Hill from the higher summits of Webster and Clark Hills to the north. East of Boonville Gorge, the Steuben Basin, drained by Wells and Steuben Creeks, similarly separates South Mountain from the more rugged upland area that ranges east-west through Penn Mountain (1813 ft above sealevel).

The parallel alignment of elongate ridges in the central Tug Hill gives evidence of a time of dominantly south-southeastward glacier movement across the entire plateau with flowlines essentially unaffected by

PROGLACIAL IMPONDMENT

Fairchild (1912) outlined the succession of proglacial meltwater lake stages in the Black and Mohawk Valleys, a sequence modified slightly by subsequent work (Wright, 1972).

In the Black River Valley, meltwaters imponded in front of the ice at positions south of and including the Alder Creek Moraine escaped southward past Remsen into the watershed of West Canada Creek. This lake stage corresponds generally to Fairchild's Forestport Lake, although Fairchild considered the lake to have been imponded outside Ontario Lobe moraine.

Northward withdrawal of ice in the Black River Valley to the position marked by kame moraine remnants south of Boonville opened the Boonville Gorge, lowering the imponded waters nearly 100 ft to a threshold on the Trenton Limestone. Although the threshold resisted erosion, downvalley incision into glacial drift and Utica Shale was relatively rapid. This lake stage, referred to as Port Leyden Lake by Fairchild (1912) persisted until northward glacial recession uncovered lower outlets around the north margin of the Tug Hill. The resulting Glenfield Lake occupied only the northern portion of the Black River Valley.

In the Steuben Basin, impondment began as the Black River and Oneida Lobes separated. Although the earliest lake stage may have been above 1000 ft as part of a more widespread lake in the Mohawk Valley, the main or "Steuben Stage" of Wright (1972) persisted later as a local lake draining east past Merrick Corners and Steuben Valley. Paired terraces in the Lansing Kill Valley downstream from the confluence of the Mohawk River record changing base level in this system down to about 830 ft. Below this level, local impondment was restricted to the Lansing Kill Valley (Wright's "Frenchville Stage") during the Stanwix Glaciation. Progressive capture of remaining impondment in the Steuben Basin by westward draining Wells Creek has resulted in subsequent incision of the Wells Creek Gorge east of Frenchtown.

Glacial withdrawal from the Stanwix Moraine exposed the eastern portion of the Oneida plain bringing into existence a series of short lived lake levels collectively referred to as "Hyper-Iroquois" (Fairchild, 1902). The following main Iroquois lake stage, controlled by the threshold near Rome, persisted until initiation of drainage north of the Adirondacks.

POSTGLACIAL MODIFICATION

Landscapes of the southeastern Tug Hill Plateau have a dominantly glacial imprint. They are a legacy of the Pleistocene, but this is not to deny that postglacial modification has taken place.

The draining of Lake Iroquois exposed broad sandy flats to eolian modification. Notable in this regard is that portion of the bed of Lake Iroquois into which streams flowed from the southern slopes of the Tug Hill. Wind erosion and deposition of an extensive area northwest of Rome produced characteristic dune and blowout topography, evidence of dominant west-northwesterly winds during the interval before stabilization by vegetation cover.

underlying topography. This condition is inferred to have persisted as late as Valley Heads time, that is roughly 13,800 years ago.

As a result of subsequent thinning of the ice sheet, irregularity of the glacier margin began to reflect the interference of overridden obstructions. Even while the highest parts of the Tug Hill were ice-covered, lobation of the ice margin began to develop in response to relative ease of glacier flow in the Black River and Oneida-Mohawk Lowlands. Late Wisconsinan retreat from the Valley Heads Moraine was neither continuous nor uniform. In the valley of West Canada Creek between Newport and Poland till overlies laminated lake sediments marking glacial readvance (Kay,1953, p. 97). Numerous lines of independent evidence (for instance, see Andrews, and Jordan, 1978) indicate that more than once in post-Valley Heads time, meltwater drained freely from central New York east to the Mohawk Valley. Three stops in the accompanying guide record oscillations of a fluctuating ice margin and ultimate stagnation. At STOP 1, for instance, the intercalation of lodgment tills and intervening lake beds records oscillation of an ice margin fronting on waters ponded in the Mohawk Valley. Deformation of the intercalated lake beds may have resulted either from static loading of dilatant, water-saturated sediments beneath thickening ice, or from shear beneath actively flowing ice.

A marked change of conditions is recorded during construction of the Oriskany-Whitestown Sand Plain adjacent to STOP 1. This feature described by Dale, (1953, p. 160) is, properly, a <u>dalsandur</u>, a remnant of valley train with surface elevation about 550 ft above sealevel. As exposed in several large pits between Oriskany and Whitestown, the terrace is underlain by 50 to 100 ft of essentially horizontal, ripple-bedded coarse sand and gravel, capped by 25 ft or so of coarse cobble gravel. Clearly, the gravel cap records a distinct change in depositional conditions, as for example might result from approach of the contributing ice margin or the opening of free drainage. Prominent kames mark a portion of the southwestern or proximal margin of the plain. The Whitestown Esker, a 1.25-mi long serpentine ridge develops into a reticulate of minor ridges as it approaches the edge of the plain indicating subglacial drainage through fractures in a stagnant and decaying ice mass.

Closely related to the Oriskany-Whitestown Sand Plain is the plain of Ninemile Creek southwest of Holland Patent. Rather than a simple delta as suggested by Brigham (1898, p. 196), it is a complex surface composed of lake sediments, and outwash. Between Stittville and Floyd, the arcuate pattern of swell and swale is indicative of receding ice margin positions. At Floyd, a well-defined ice-marginal channel incised into Utica Shale opens eastward onto the plain. Southwest of Floyd an east-southeasterly alignment of alternating kame ridges and shallow channels gives way to kettle-pocked outwash plain. The surface of the plain, though remarkably consistent at about 525 ft seemingly is graded to a lower surface than the Oriskany-Whitestown Plain. Northwestward tracing of the ice-marginal alignments represented by these channels and ridges indicates their continuity with and relationship to similar channels and ridges northwest of Rome. Together these features mark the Stanwix Glaciation, a readvance of the Oneida Lobe into the Mohawk Valley at a time when free eastward drainage was well established.

Other areas of former lake bottom, particularly those in which drainage remained impeded either by high-water table or relatively impermeable substrate passed gradually through a cycle of sedimentation, eutrophication and fen development accounting for extensive swampy areas.

Notable as representing the transition from glacial to fluvial landscapes has been the process of gorge incision in upland areas, and flood plain development on valley floors. The Utica Shale, in particular, because of its erodibility and jointing has been particularly susceptible to gorge incision, as is well illustrated in the Wells Creek Gorge, the "Palisade" where Delta Reservoir is imponded, and in parts of the Boonville Gorge.

Nevertheless, landscape adjustment to postglacial environmental conditions had only begun to make a good start when new and traumatic change was set in motion by the arrival of Man and the stresses imposed on natural systems by modern technology.

Topographic maps involved in Field Trip A-4 include: Boonville, Clinton, Forestport, North Western, Oriskany, Remsen, Rome, Westernville, and West Leyden quadrangles of the U.S. Geological Survey 1:24,000 map series.

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FIELD TRIP GUIDE FOR GEOMORPHOLOGY OF THE SOUTHEAST TUG HILL PLATEAU

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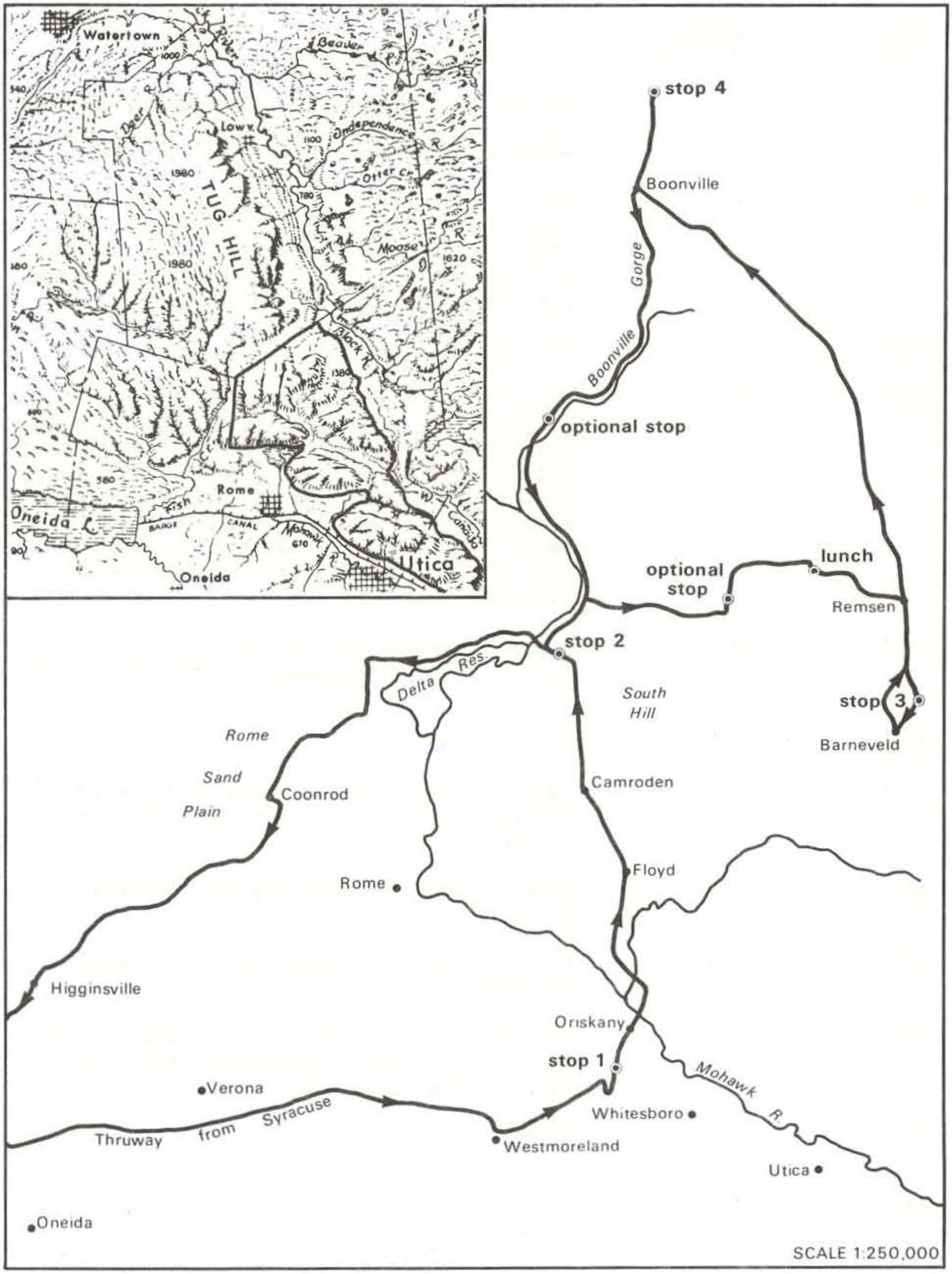
Total Miles	Miles from last point	Route Description
0.0	0.0	Assemble in parking lot at Manley Field House, corner of Colvin St. and Comstock Ave. Proceed west on Colvin across Comstock to railroad overpass.
0.6	0.6	Turn right, north, to enter Interstate Route I81, northbound, immediately beyond railroad overpass and before Route I81 overpass.
		Beyond Adams Street (Exit 18), stay in right lane to be ready for ramp to Route I690.
2.2	1.6	Stay right, east, on ramp to Route I690, eastbound.
		Continue east past Teall, Midler, and Thompson Road (Exits 8, 9 and 10-11) on Route I690. This route follows the lowest of the Syracuse Channels by which proglacial meltwater drained from Onondaga Trough east toward the Mohawk Valley. Exposures of Syracuse Formation in its type area are visible south of Erie Boulevard on right.
4.8	2.6	Pass Thompson Road, Exit 10-11 and move toward left lane to be ready for ramp to Route I481.
6.6	1.8	Stay left on ramp to Route I481, northbound, following signs for New York Thruway. Beyond Kirkwood Road exit all traffic bears right to New York Thruway.
11.2	4.6	New York Thruway Toll Gate 34-A, Follow left lane as it curves right across Thruway to eastbound lane toward Utica.
		Travel east across plainlands, the floor of proglacial Lake Iroquois. This area underlain by nonresistant Vernon Shale accounting for basin. Bedrock topography with local relief of 150 ft in next few miles is concealed by postglacial lake sediments.
16.7	5.5	Sandy, stone-free soil in fields on left. Ephemeral strand line of low lake phase that succeeded Lake Iroquois in the Canastota mucklands is in trees at left. Dune modification



Route for field trip on Geomorphology of Southeastern Tug Hill Plateau

Total Miles	Miles from last point	Route Description
		of the backshore sands is visible briefly and better developed along Chestnut Ridge Road which parallels the Thruway to the north.
22.0	5.3	Vernon Shale exposed in low roadside cut on right (south) side of eastbound lane, opposite Chittenango Service Area. For next several miles the strand of Lake Iroquois trends parallel to Thruway on the South.
26.8	4.8	Pass Canastota Exit 34.
30.5	3.7	One mile south of the Thruway, not readily visible is Wampsville, site of Madison County Courthouse. A well on the property of Hubbard Industries located near a Lake Iroquois spit, taps an artesian system at 90 ft and flows a reported 700 gallons per minute. Gravel pits south of Route NY 5 in Wampsville expose two impermeable lodgment tils with intervening permeable cobble gravel.
33.7	3.2	Iroquois barrier bar on right about 0.2 mi before railroad underpass. Leave bed of Lake Iroquois.
34.7	1.0	Pass Verona Exit 33.
39.3	4.6	Herkimer Sandstone of uppermost Clinton Group exposed south of eastbound lane discontinuously for 0.25 mi.
44.9	5.6	Enter offramp to leave New York Thruway at Westmoreland, Exit 32.
45.4	0.5	Shortly beyond tollgate, turn left toward Oriskany.
45.9	0.5	Stay left at fork, passing over New York Thruway on Cider Road. Immediately turn right on Humphrey Road toward Oriskany.
48.2	2.3	At fork in Colemans Mills, stay left, continuing parallel to Oriskany Creek on its north.
48.8	0.6	At STOP sign, turn right onto Judd Road. Descend and cross Oriskany Creek. Roadcuts expose stratified drift indurated at base, overlying firm, dark-gray, silty clay till.

Total Miles	Miles from last point	Route Description
49.1	0.3	Turn left at high tension power line, toward Whitesboro. Small gravel pit beneath power line was opened in the Whitestown Esker which parallels route on the right.
49.6	0.5	Left at fork. Cross Oriskany Creek and park on right.
49.9	0.3	STOP ONE. Streamcut bluff of Oriskany Creek, exposing intercalated lodgment tills and deformed lake sediments overlain by firmly cemented fluvioglacial gravel. The section records multiple oscillations of the Late Wisconsinan ice margin into proglacially imponded waters.
		Proceed north toward Oriskany. A few exposures of stratified drift across Oriskany Creek on the right. Out of sight to the south, the Whitestown Esker leads to the kame moraine south of Oriskany which fronts on the Oriskany-Whitestown Sand Plain at approximately 550 ft above sealevel. Numerous exposures in bluffs facing the Mohawk River show the Sand Plain to be underlain by 80+ ft of horizontally bedded sand and gravel, capped by 10 to 20 ft of coarse cobble gravel, in part firmly cemented with calcium carbonate.
50.9	1.0	At traffic light, cross River Street in Oriskany. Continue north across Oriskany Boulevard and Mohawk floodplain. Cross Mohawk River and Barge Canal. Continue north following signs to Stittville. Do not turn onto Route NY49.
52.4	1.5	Stay left onto River Road. Shale exposed in roadside ditches and gully at right. Follow River Road northwest.
52.9	0.5	Cross Ninemile Creek
54.9	2.0	Turn right, north onto Stearns Road. Rise onto pitted outwash plain. Irregular closed depressions due to melting of buried stagnant ice masses on both sides of road. Surface of undissected plain is about 525 ft above sea level, graded below the Oriskany-Whitestown Sand Plain. This surface is a <u>sandur</u>

Total Miles	Miles from last point	Route Description
		built where meltwater streams flowing along the margin of a progressively receding ice front spread onto the open valley floor.
56.3	1.4	The extensive sand mantle gives way to cobble gravel in a few low knolls. East of the road, weak channel development trends ESE.
56.9	0.6	Turn left on Koenig Road toward Floyd
57.2	0.3	In Floyd, cross Route NY365 and continue north toward Camroden. A well-developed, flat-floored marginal meltwater channel 250-300 ft wide, and cut into Utica Shale opens onto the sandur west of Floyd. North of Floyd, rise on drift mantled slope which in places shows low constructional topography.
59.7	2.5	Continue north through Camroden, crossing west end of South Hill.
63.1	3.4	Turn left, west, on Gifford Hill Road (South Hill Road). Cross Gifford Creek.
63.3	0.2	STOP TWO. GIFFORD HILL ROADCUTS
		Exposure of multiple tills, intercalated with partially indurated intraglacial stratified drift units.
		Continue west on Gifford Hill Road. Note indurated, eastward dipping foreset cobble to boulder gravel in road cut on right.
63.8	0.5	Turn right, north, on Route NY 46 toward Boonville.
65.7	1.9	In Frenchville, cross Wells Creek and immediately turn right, east, onto Wells Creek Road (Route NY 274).
		Eastward from Frenchville, Route NY 274 occupies the floor of a narrow, steep-walled defile incised by Wells Creek. Cut 200-ft deep in postglacial time, the gorge owes its character to rapid incision and the erosivity and vertical jointing of the Utica Shale. The gorge is incised into a fluvioglacial terrace at 800 ft above sea level built eastward into the Steuben Basin.

Total miles	Miles from last point	Route Description
66.9	1.2	Continue eastward on Route NY 274, following Big Brook. Prior to incision of the Wells Creek Gorge, this part of the basin of Big Brook was imponded. As long as the ice margin blocked westward drainage, outflow was east past Merrick Corners and down Steuben Creek. Freeing of the Mohawk Valley north of Rome initiated westward drainage, leading to incision of the gorge.
67.8	0.9	Continue on Route NY 274, climbing from flood plain of Big Brook to floor of proglacial Steuben Lake. Nearshore sands exposed in borrow pit on right. Just beyond borrow area, roadside ditch exposes oxidized calcareous lodgment till with silt-loam matrix.
69.6	1.8	Turn left, north, at Steuben Corners. Ascend sharply.
69.8	0.2	OPTIONAL STOP.
		Gully at right exposes black Utica Shale over Trenton Limestone. Roadside exposures contain dark gray till glutted with Utica Shale material near base, but with bright clast lithologies dominated by blue-gray carbonates with subordinate red sandstone and metamorphic rock types.
		Continue north
71.0	1.2	Turn right, east, toward Steuben Monument, entering Penn Mountain State Forest.
72.2	1.2	Vista southeast over Steuben Valley. Note increasing abundance of metamorphic boulders beyond this point.
72.7	0.5	Follow road as it turns south.
73.0	0.3	LUNCHEON STOP. Turn left into Baron Steuben State Memorial Park.
		Leaving park, turn left, east toward Remsen.
75.3	2.3	Pass Capel Ucha, Cemetery on site of old Welsh Church established 1804.
75.8	0.5	Turn right, south, onto Route NY12 at Remsen boundary.

Total Miles	Miles from last point	Route Description
77.6	1.8	Cross meltwater channel
78.3	0.7	Stay right onto ramp southbound to Route NY365 and Trenton (Barneveld).
78.6	0.3	STOP THREE BARNEVELD KAME COMPLEX
		Extensive gravel and sand pits expose coarse cobble gravel overlying thick stratified coarse sand section.
		Proceed south on Route NY365 toward Barneveld.
79.0	0.4	Turn right on old state road at north edge of flood plain before reaching bridge across Steuben Creek.
79.1	0.1	"Drumlin Lodge" on right; not a drumlin sensu strictu.
79.7	0.6	Minor moraine ridge cuts across road, then seen on left, south side of road.
80.4	0.7	Kettles in stagnant ice zone
81.6	1.2	Turn left, north, on Route NY12, roughly parallel to Cincinnati Creek and the course of proglacial meltwaters which drained from proglacial Lake Forestport in the south end of the Black River Valley. This region is broadly underlain by Trenton Limestone.
83.3	1.7	Swampy lowlands now drained by Cincinnati Creek comprised part of the floor of Lake Forestport.
83.6	0.3	End moraine remnants looping across valley presumed to mark minor stillstand of Black River glacial lobe.
88.8	5.2	At Alder Creek, cross dissected Alder Creek Moraine built while the Black River glacial lobe imponded the southward-draining proglacial Lake Forestport in area of present Kayuta Reservoir. Westward, Alder Creek moraine includes extensive stagnant ice deposits and the Echo Lake Esker.
95.7	6.9	Pass Boonville, continue north on Route NY12. Park Hill and Sperry Hill to right (east)

Total Miles	Miles from last point	Route Description
		of Route NY12 in southern outskirts of Boonville are massive sand and gravel mounds, interpreted as dissected remnants of kame moraine.
99.6	3.9	STOP FOUR. ALLIED CHEMICAL COMPANY, BOONVILLE LIMESTONE QUARRY. Formerly DeLia's Quarry, as access to Sugar River. We do not have permission to examine the quarry as such. Warning: beware of mosquitoes, algal slime on rocks in streambed, poison ivy, and cow patties! Objective is to examine classic solution pits in limestone and subterranean piracy in progress.
		Return south on Route NY12 toward Boonville.
		Note masonry of several locks of the old Black River Canal in roadside exposures, first on the left (east), then on the right (west) side of the road. Built in 1855 to link navigable reaches of the Black River north of Lyons Falls with the Erie Canal at Rome, the Black River Canal was only briefly economical. With a total of 109 locks in 35 mi, the canal crossed a divide 700 ft above the Erie Canal.
102.7	3.1	Turn right (W) across tracks on Schuyler Street into Boonville. At west side of triangle, turn left, south, onto Route NY46, Post Road, toward Rome.
104.2	1.5	Morainal topography on right (west). Large sand and gravel knoll on left (east), similar to Sperry and Park Hills. Descend 30 ft to valley floor.
105.2	1.0	Crossing the broad, flat-bottomed rock-floored channel across Trenton Limestone ledgerock at the head of Boonville Gorge. This ledge controlled outflow from proglacial Port Leyden Lake. Cross feeder canal for Black River Canal. Continue south parallel to an incised and constricted channelway, thence crossing diagonally back to west side of valley to parallel the old Black River Canal.
106.8	1.6	Shale bluff in roadcut on right indicates

Total Miles	Miles from Last Point	Route Description
		erosivity of rock into which the Boonville Gorge is cut. To this point the valley has become progressively narrower. The distance that minor ridges of the Alder Creek Moraine project southward down Boonville Gorge indicates prior meltwater drainage toward Rome.
		At left, across Boonville Gorge, Lansing Kill enters from the east side of the valley. Originating as a meltwater stream marginal to the Alder Creek Moraine on the flank of Potato Hill, Lansing Kill has, from this point downvalley inherited the valley of a short-lived but powerful stream, the outlet of proglacial Port Leyden Lake. Postglacial incision by Lansing Kill accounts for abrupt deepening of the narrow inner gorge at this point. Its proglacial predecessor deepened the valley some 175 ft.
109.2	2.4	OPTIONAL STOP: PIXLEY FALLS, BOONVILLE GORGE STATE PARK
		Continue south toward Rome on Route NY46.
110.2	1.0	"Five Combines" - a flight of 5 adjacent locks where the old Black River Canal crosses a limestone ledge on the side of Boonville Gorge.
114.5	4.3	Mohawk River enters Boonville Gorge from west with multiple terraces now incised by both Lansing Kill and Mohawk. The highest terrace, above 1000 ft is an ice marginal delta plain. Lower terraces have correlable equivalent remnants on the east wall, indicating they were fluvial and graded to lowering base level controls in the Mohawk Valley to the south.
115.8	1.3	Village of Northwestern. Continue south on Route NY46.
118.6	2.8	Stay right into Village of Westernville.
118.8	0.2	Turn sharply right to cross Mohawk River. Grave of William Floyd, signator of Declaration of Independence is on right. Floyd Homestead was on left.
119.8	1.0	Vista across Delta Reservoir, artificially

Total Miles	Miles from last point	Route Description
		imponded in the basin created by deposition associated with Stanwix glaciation across the mouth of Boonville Gorge. In postglacial erosion the Mohawk River failed completely to recover the bedrock valley. At the site of the Delta Reservoir Dam, it incised a steep-walled, 80-ft deep defile into Utica Shale.
124.0	4.2	Turn left onto Turin Road (Route NY26) at Stokes Corner.
		The route now crosses a gravel plain (sandur) similar in origin to the plain of Ninemile Creek crossed this morning. Marginal melt-water channels pinned against the plateau margin to the north here spread onto the basin floor.
125.0	1.0	Half a mile west of this point was the Village of Delta. Inundated by construction of the dam in 1911, it survives only in the name of the reservoir that supplanted it.
125.3	0.3	Continue south past first cross road.
125.5	0.2	Turn right on road to Lorena
127.7	2.2	Stay left at fork toward Coonrod, traveling over Rome Sand Plains.
129.4	1.7	At Coonrod, turn left, then in 100 yd turn right again. Continue southwest across Rome Sand Plains. Following demise of Lake Iroquois the sandy sediments delivered by Fish Creek and other streams draining the Tug Hill were vulnerable to wind erosion as indicated by low dune and blowout topography.
131.2	1.8	Cross Oswego Road at STOP sign, then stay right, joining Route NY46 toward New London.
133.9	2.7	Continue on Route NY46; stay left, leaving Route NY49. Cross Barge Canal at New London. Route NY46 follows the abandoned Erie Canal which has been restored as parkway, canoe, and bicycle path.
139.8	5.9	Picnic and parking area alongside Erie Canal.
140.3	0.5	Turn right, west, onto Route NY31, following signs to New York Thruway, West.

Total Miles	Miles from last point	Route Description
143.9	3.6	Turn left, north, onto Route NY13, following signs to Canastota and New York Thruway.
146.6	2.7	Turn left to enter New York Thruway at Canastota Toll Gate. Leaving Toll Gate, stay left across Thruway to enter westbound lane, following signs to Syracuse.
162.2	15.6	Stay right on ramp to Syracuse Exit 34-A and Route I481.
165.4	3.2	Stay right on ramp to Route I690, following signs to Cortland and State Fairgrounds.
168.2	2.8	Pass Teall Avenue Exit 8; work across to left lane to be ready for ramp to Route I81.
169.0	0.8	Stay left on ramp to Interstate Route I81.
170.9	1.9	Stay right onto ramp to Brighton exit, leaving Route I81.
171.2	0.3	Turn right, north, onto State St.
171.5	0.3	At first traffic light, turn right onto Colvin St. Pass under Route I81 and railway overpass.
172.2	0.7	Colvin St. at Comstock Avenue. Enter parking lot at Manley Field House.