SYRACUSE CHANNELS: EVIDENCE OF A CATASTROPHIC FLOOD

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Introduction

Uniformitarianism triumphed over Catastrophism in the days of Hutton and Werner, but skirmishing between modified catastrophist and uniformitarian views has been sporadically renewed down to the present time. Such has been the controversy over the channeled scablands of the Columbia Plateau. Similarly, divergent views have entered into conjecture regarding the meltwater channels south and east of Syracuse -- conjecture as to duration of drainage diversion which they record, and as to the relative roles of channel scour and plungepool migration in their development.

This field trip is planned to present evidence of a limnic hlaup, and episode of truly catastrophic stream erosion and canyon cutting resulting from precipitate down-cutting of a drift dam in Rock Cut Channel. The objective is to present arguments supporting a new look at the Syracuse channels (Muller and Hand, 1972). Very candidly, where the evidence permits alternative interpretations, we shall blandly espouse that interpretation which best fits the view that exceptional catastrophic events as well as normal processes have shaped the channels south and east of Syracuse.

Although the channel system in question was certainly initiated prior to the last major episode of Wisconsin glaciation (Sissons, 1960; Muller, 1964), the focus of this excursion is upon development during recession of the Wisconsin ice sheet and the story begins as the ice margin receded from the Valley Heads Moraine along the southern limits of the field trip route.

Early Development of Meltwater Lakes

The northern margin of the Appalachian Plateau in the Syracuse area is deeply cut by glacially-modified through valleys that extend south from the Ontario Lake Plain and well across the divide into Susquehanna and Allegheny River drainage. The actual divide between northward and southward drainage in these valleys is the Valley Heads Moraine, one loop of which (the Tully Moraine of von Engeln, 1921), crosses Onondaga Trough 12 miles south of Syracuse. As the ice front retreated from the Valley Heads position, the steep north slope of the moraine served as a dam to impond meltwater in Onondaga Trough and other through valleys. Initial drainage was southward over the moraine, whose crest today stands at an elevation of 1200 ft. Immediately north of Tully Moraine, the lake in Onondaga Trough was more than 600 ft. deep.

Continued recession of the ice front exposed saddles in the highlands between troughs and resulted in lateral connections between the lakes. One by one, the southward outlets were abandoned and lakes occupying Butternut and Onondaga Troughs drained westward into Otisco Trough (Lake Cardiff Stage).

Eventually, ice recession freed still lower outlets east of Butternut Trough, allowing discharge from Onondaga and Butternut Troughs to escape eastward toward the Mohawk Valley. Also, at this time, water began to discharge into the Cedarvale branch of Onondaga Trough from other lakes still farther west. One result of this was the building of deltas whose remnants still record major lake level stands in Onondaga Trough.

Smoky Hollow Channel

The cross channels by which meltwater drained from Onondaga Trough eastward into Butternut Trough are shown in fig. 1. Southernmost of these channels is Smoky Hollow, a gorge 100 feet deep, with steep walls and flat floor, incised into Hamilton Shale. The eastern half of this gorge includes a distinctive ingrown meander loop with neck cutoff isolating an umlaufberg. The complex history of this part of the channel is demonstrated by inset deposits of till, lake sediments, and fluvial gravels. Evidently, Smoky Hollow was created during one or more episodes of meltwater escape that occurred prior to final Wisconsin glaciation. It became filled with till and related sediments during ice advance, and subsequently re-excavated by meltwater drainage during the most recent deglaciation. We suppose that most, if not all, of the Syracuse cross channels have had similarly complex histories.

Clark Reservation Channel

Smoky Hollow was abandoned once the ice margin had retreated enough to allow water to escape from Onondaga Trough by a more northerly route whose elevation was below the 790-foot threshold of Smoky Hollow. The newly diverted flow produced no well-defined channel throughout the western part of its course, though it scoured a broad area essentially free of drift. At Clark Reservation State Park (STOP 4), the flow dropped rapidly from 760 feet to 720 feet, then spilled over a waterfall to a plunge pool 100 feet below. The resulting amphitheater-like basin is now occupied by Green Lake, 57 feet deep, and the channel carved by the migrating falls extends approximately 3/4 mile to Butternut Trough. Just west of the lip of the falls (and within the access channel) is a depression 300 feet across and about 60 feet deep that may be a sinkhole produced or enlarged by intense ground water activity while the falls was active. The local hydraulic gradient at that time would have involved a drop of 120 feet within a horizontal distance of 800 feet.

Rock Cut & Nottingham Channels

The next two channels farther north are Rock Cut and Nottingham Channels. It is clear that in their present form they post-date Clark Reservation Channel, but their relationship to one another is more problematic. Free drainage through Rock Cut (threshold at 555 ft.) would have precluded later activation of Nottingham Channel (accessible only across a sill at 700 ft.). On the other hand, assigning Rock Cut a younger age than Nottingham violates the simple south-to-north activation sequence that has been favored by most previous workers. One tactic has been to ignore Nottingham Channel altogether, if necessary by relagating it entirely to an earlier interglacial epoch, but this is unacceptable in view of the fresh, well-developed plunge basin found at the head of this channel (STOP 5). Alternatively, Nottingham Channel may have been carved not by through drainage, such as accounts for the other cross channels, but by off-ice or even sub-ice drainage unrelated to the lake in Onondaga Trough. Sissons (1960) has shown that certain of the smaller channelways in the Syracuse area were cut by waters flowing into or off of the ice itself. Such an explanation seems unlikely in the present situation, however, inasmuch as the shape of Nottingham Channel suggests inflow from the south, the channel is similar in size to other adjacent cross channels, the channel below the plunge pool is graded to the same 600-foot level as is Clark Reservation Channel, and the 700-foot access route is underlain by bedrock

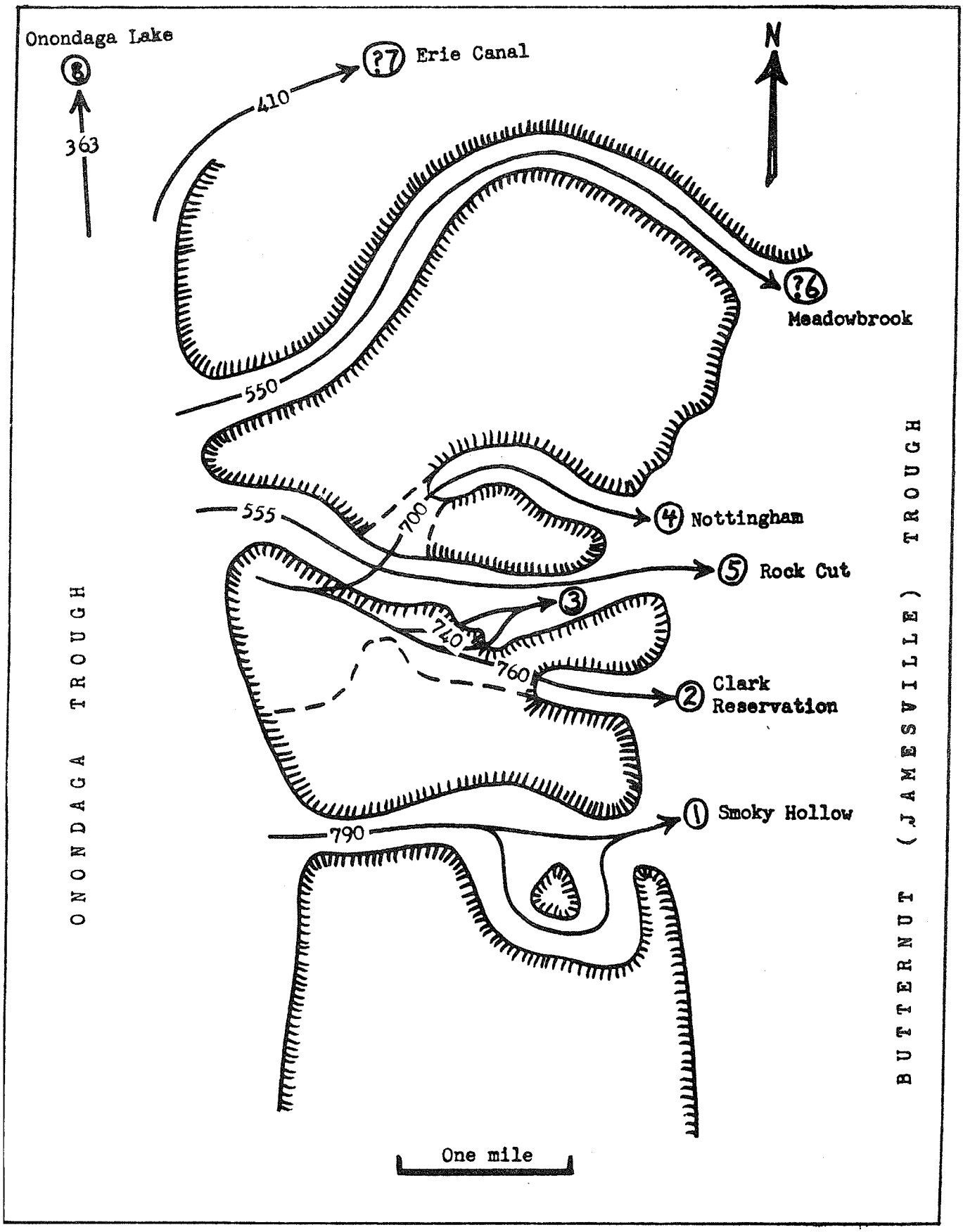

Figure 1. Cross channels connecting Onondaga Trough with Butternut Trough. Circled numbers indicate sequence of activation and abandonment. Typed numbers indicate present threshold elevations.

apparently scoured free of till.

We will argue that there is a better explanation which entails ice-marginal and near-ice drainage, exclusively.

Evidence for Catastrophic Diversion

The south wall of Rock Cut, at a position midway along its length, displays two small plunge basins that were active for a brief time in carrying water from Onondaga Trough over the south rim of Rock Cut and into the main gorge. The presence of these fresh plunge basins implies that Rock Cut already existed prior to the most recent deglaciation and that it had subsequently became filled with drift. Flow from the plunge basins flushed most of this drift from the eastern end of the channel, but base level control farther east (at about 600 ft.) prevented scouring to the full depth of the present channel (550 msl). There remained approximately 50 feet of fill in the re-excavated part of the gorge. In fig. 2A these conditions are designated the Early Rock Cut phase.

The fact that the waterfall responsible for these two plunge basins did not continue to shift westward and clear out the entire length of Rock Cut can be explained by invoking a drift barrier between the Rock Cut plunge basins and the access route to Nottingham Channel and at the same time freeing Nottingham Channel of ice. The flow which previously had spilled into Rock Cut now was diverted northward to Nottingham Channel, gaining 40 feet of vertical advantage in the bargain. (The 760-foot threshold in fig. 2A refers to the more easterly of the two plunge basins, now occupied by a trailer park. This elevation is very nearly the same as for the threshold at Clark Reservation. The plunge basin that was abandoned in favor of Nottingham Channel lies partially buried beneath drift in fig. 2A. Its threshold elevation is 740 ft, as indicated in fig. 1.

While Nottingham Channel was active (fig. 2B) the postulated drift barrier must have been exceedingly vulnerable to headward sapping by gullies. (These gullies may have been fed in part by seepage through the barrier.) In time, the barrier was breached, releasing catastrophic flow through the entire length of Rock Cut. Immediately after this diversion from Nottingham Channel, the main discharge through Rock Cut flowed for 2000 feet over unconsolidated drift with a gradient of at least 6 or 7 percent. Behind this flow was Onondaga Trough Lake, with an area of 24 square miles, whose surface fell 100 feet as Rock Cut was flushed. For every foot of downcutting in Rock Cut, an additional 15,000 acre-feet of reservoir volume was tapped. In short order, the rate of channel cutting across the drift barrier must have exceeded the rate of drawdown of Onondaga Trough Lake, establishing a condition of rapidly increasing discharge which could only be retarded as channel efficiency began to match diminished discharge from the shrinking reservoir.

In the terminology of Thorarinsson, a limnic hlaup had occurred.

Augmenting the normal flow through the cross channel system, the abrupt drawdown of some 50 billion cubic feet of water involved in lowering the level of Onondaga Trough Lake from 710 feet elevation to 600 feet created sufficient discharge to maintain flow 60 to 80 feet deep through Rock Cut. Evidence for this includes the presence of a boulder spit constructed across the mouth of the more westerly plunge pool high on the south wall of Rock Cut (elev. 640 ft.), and the occurrence of boulder gravels in a levee-like deposit sealing the east end of Nottingham Channel (figs. 2C and 3).

At the eastern end of Rock Cut Channel are remnants of a large (1 x 2 mi) delta consisting of boulder gravels deposited where the catastrophic flow from Rock Cut expanded into the northern end of

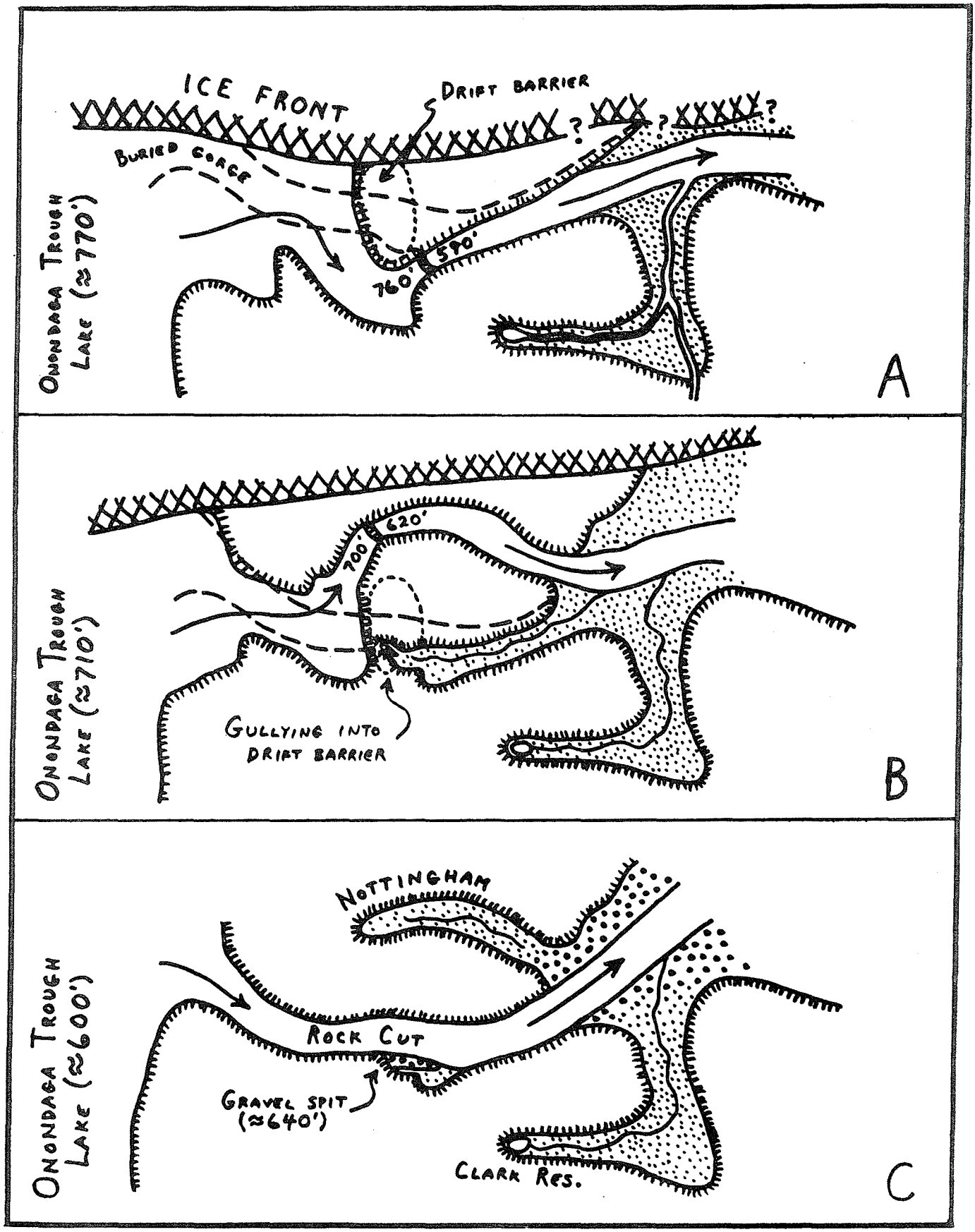

Figure 2. Evolution of drainage routes leading to the (re-)excavation of Rock Cut and Nottingham channels. A. Early Rock Cut phase. B. Nottingham phase. C. Late Rock Cut phase.

Butternut Trough. The levee across the end of Nottingham Channel is in fact part of a sizeable remnant of Rock Cut Delta preserved on the west side of Butternut Trough (fig. 3). The 1- to 3-foot boulders characteristic of this deposit will be seen in a gravel quarry at STOP 3. Still larger boulders (occasionally 5 to 6 feet in diameter) were swept across Butternut Trough to form the delta remnant preserved at the western end of High Bridge (White Lake) Channel. Some examples of these "pebbles" will be seen displayed in the front yards of homes along Cedar Heights Drive.

At the time of these events, it was High Bridge (White Lake) Channel that carried the flood waters eastward from Butternut Trough. Thus, the flow discharging across most of the Rock Cut Delta margin was constrained to change direction by nearly 90° upon crossing the lip of the delta. The redirected flow then followed the southeastwardly-expanding scourway along the delta margin into High Bridge Channel (fig. 4). Flow separation in the lee of the delta, combined with the required redirection of flow, must have maintained an active vortex that prevented the delta front from building all the way across to the bedrock slope on the northeast flank of this scourway.

The collected floodwaters again became confined upon entering High Bridge Channel, where the flow must have been at least 60 feet deep (the difference in elevation between White Lake and the lip of Rock Cut Delta). At the eastern end of this channel is High Bridge Delta (fig. 4), a feature resulting from expansion of flow similar to that which occurred in the northern end of Jamesville Trough. Foreset and topset beds will be observed in a gravel pit at STOP 2, where pebbles are mostly smaller than 2 inches, and rarely as large as 18 inches in diameter. These gravels are distinctly finer-grained than those of the Rock Cut Delta.

Except for minor erosion by Limestone Creek, we interpret the morphology of High Bridge Delta as primary. Dividing the delta into two unequal parts is a channel 1000 ft wide and 70 ft deep which apparently carried most of the discharge in the brief period during which the delta was constructed. The delta and scour levels near 600 ft elevation appear to have been adjusted to the same flow that deepened the floors of Rock Cut and High Bridge Channels to 530 or 550 feet, requiring water depths of 70 to 80 feet in the more restricted portions. Such flow could have been sustained only by catastrophic discharge from the Onondaga Trough Lake, an event whose duration was probably best measured in hours.

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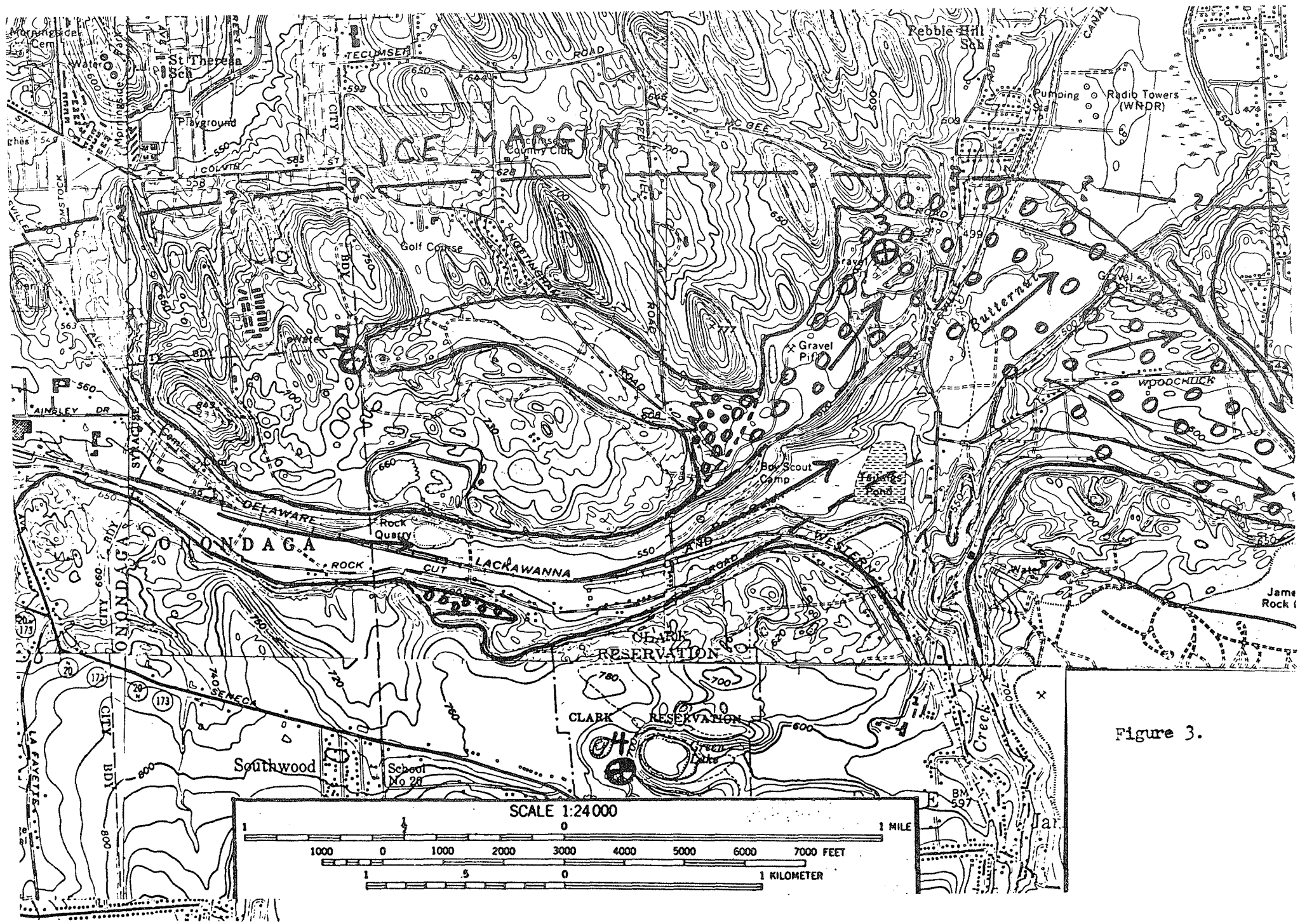
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AINSLEY DR
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Figure 3.

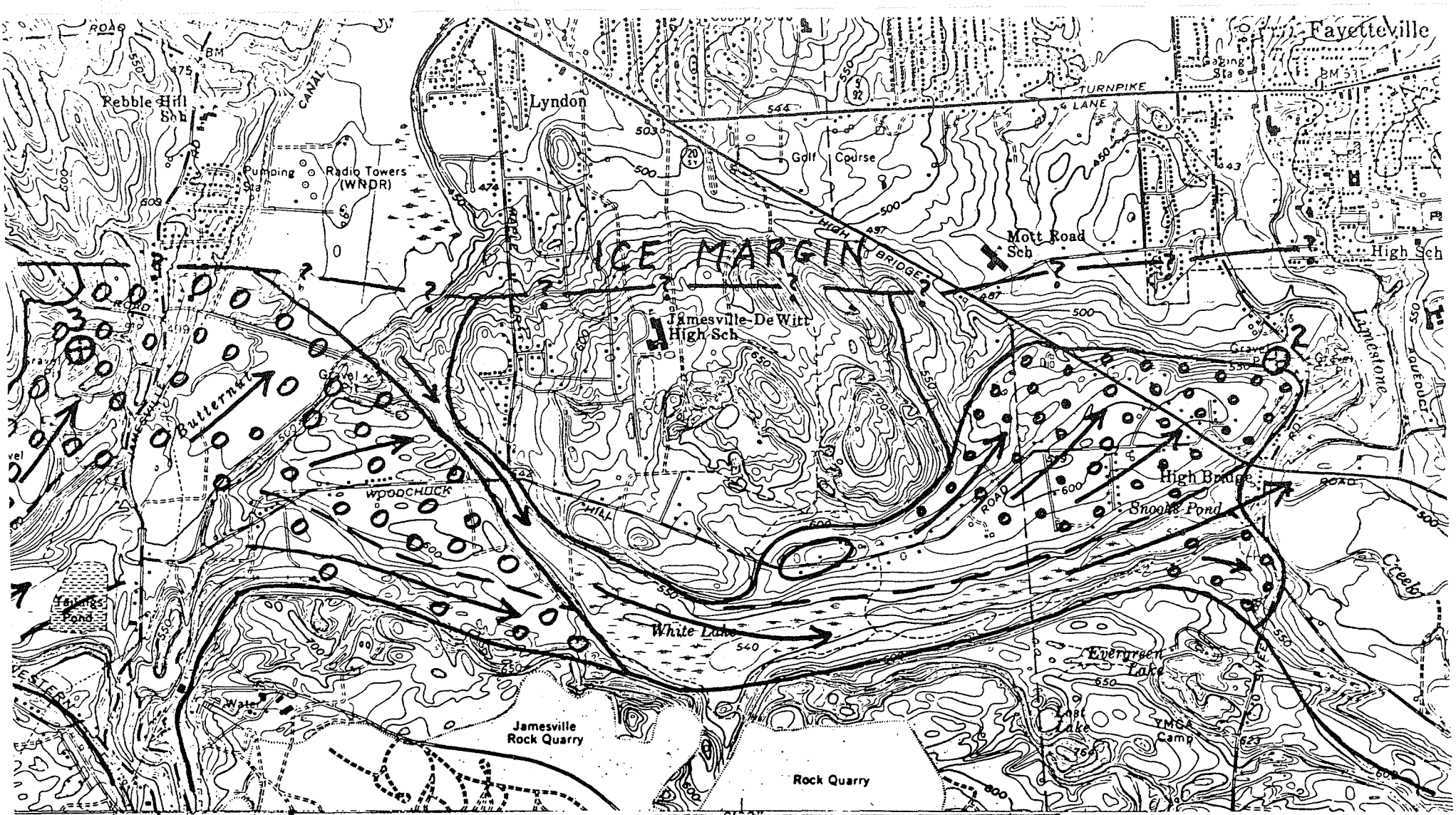
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Figure 4.

The field trip route passes across U.S. Geological Survey 7½-minute quadrangles in the following sequence:

Hamilton	Canastota	Syracuse West
Munnsville	Manlius	South Onondaga
Morrisville	Syracuse East	Otisco Valley
Cazenovia	Jamesville	Tully

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ROAD LOG

Mileage Cum.	Int.	
		Hamilton 7½-min. quadrangle
0.0	0.0	Leave Hamilton, driving north on NY 46 and 12B across Valley Heads outwash plain. Enter Munnsville 7½-minute quadrangle.
1.0	1.0	NY 12B forks NE; stay North on 12B.
5.0	4.0	Turn left(west) onto US 20 at Pine Woods. Proceed west across Valley Heads outwash plain. Kames and kettles of early ("advance") phase of Valley Heads Moraine are south of US 20, but the massive, divide-forming moraine ridges are 1.5 miles north. Leave Chenango-Stockbridge trough. Road cuts expose Skaneateles shale members. Enter Morrisville 7½-minute quadrangle.
8.4	3.4	Continue west through Morrisville. In 6 miles enter Cazenovia 7½-minute quadrangle.
15.6	7.2	Enter village of Nelson. In 0.2 mi. turn right (north) at Nelson Inn onto two-lane, blacktop road.
18.3	2.7	Coty Corners. Stop sign and cross road. Continue straight.
19.6	1.3	Cross East Road. Continue straight.
19.6	1.6	Christainson Corners. Intersection with Peterboro Road and Canastota-Fenner Road. Main road curves left. Continue nearly straight on Canastota-Fenner Road. In half mile, enter Canastota 7½-minute quadrangle.
22.7	1.5	STOP 1. Park on shoulder at crest of hill for overview of regional relationships and introduction to meltwater drainage conditions at margin of ice sheet during wastage at the edge of the Appalachian Plateau. Evidence of subglacial and englacial meltwater flow.
		Continue north on Nelson Road.
23.1	0.4	Turn sharp left (west) at intersection with Bosworth Road.
24.4	1.3	Turn right (north) at "T-intersection" onto Quarry Road. Descend steadily northward, passing exposures of Onondaga, Helderberg and Cobleskill Formations. Old Lehigh Valley RR alignment follows meltwater channel east to Cottons.

26.2	1.8	Cross Osborne Road. Continue north on Quarry Road. Constructional topography and thick drift at left ahead fill the former valley of Canaseraga Creek, forcing the creek to cut a narrow rock-walled postglacial gorge through Syracuse Formation and Vernon Shale along Creek Road.
27.9	1.7	Intersection with NY 5. Turn left (west) onto NY 5. Roadside exposures of red and green Vernon Shale and red shale-crammed lodgment till.
30.3	2.4	At flashing amber caution signal in outskirts of Chittenango, proceed straight, temporarily leaving NY 5 and continuing on Tuscarora Road.
32.7	2.4	Turn right, rejoining NY 5.
33.9	1.2	Enter Mycenae. For approximately the next 3 miles, from Mycenae to Fayetteville, NY 5 follows the well-defined Pools Brook glacial meltwater channel. Inset lodgment till shows a complex history of channel development.
36.1	2.2	Entrance to Green Lakes State Park, location of Green and Round Lakes, both of which are meromictic and have been the object of intense and diverse limnologic studies. Both are situated in the Green Lake glacial meltwater channel.
36.9	0.8	Enter Fayetteville
38.1	1.2	Cross NY 257. Proceed west on NY 5.
38.6	0.5	Cross Limestone Creek, then turn left (south) at traffic light onto High Bridge Road which becomes Sweet Road.
39.4	0.8	STOP 2 Gravel pit on right (west) side of High Bridge Road.
		Character and structure of High Bridge Delta built where the High Bridge (White Lake) Channel entered Limestone Trough Lake. Note clast size and dominance of carbonate rocks.
		Continue south from gravel pit on Sweet (High Bridge) Road.
39.7	0.3	Turn right just before reaching NY 92 highway overpass.
39.9	0.2	Stop sign. Cross NY 92, following Woodchuck Road westward.
		For about 0.5 mile from this intersection, the road crosses the constructional upper surface of the High Bridge Delta. During flushing of Rock Cut Channel, the catastrophic discharge escaped eastward through High Bridge Channel. At peak discharge the whole delta may have been covered with water. The main channel is south of the road. Its floor is at about 530 feet above sea level, whereas the top of the delta stands at 600 feet. From this we infer that the water in High Bridge Channel was at least 80 feet deep during delta development.

The road continues along the north side of the main channel, occupied by White Lake. Toward the west, the road is located on bedrock.

41.8 1.9 Descend into scour channel maintained by vortex in lee of Rock Cut Delta. The near (northeast) wall of this scour channel is bedrock while part at least of the far (southwest) side is the depositional front of the Rock Cut Delta. Delta foreset beds are parallel to the present slope. The material is sand and gravel with boulders several feet in diameter.

42.0 0.2 Maple Drive enters from right. Bedrock exposed in roadcut along Maple Drive just north of intersection. Continue straight (west) on Woodchuck Hill Road.

42.2 0.2 Turn right onto Cedar Heights Drive and follow its winding course until you encounter Will-O-Wind Drive for the second time. You are now on top of the Rock Cut Delta. The favored lawn ornaments in this housing development are boulders 4 to 6 feet in dimension. These boulders occur here in delta topset beds at an elevation of 600 feet about 50 feet above the floor of Rock Cut Channel from which they were derived.

42.7 0.5 Turn left onto Will-O- Wind Drive.

42.8 0.1 Turn right and then right again onto Woodchuck Hill Road, heading west.

Immediately after turning onto Woodchuck Hill Road, note the broad channel-like depression to the left (south) on the grounds of the Dewitt Fish and Game Club. This channel is 700 to 1000 feet wide; its axis lies about 35 feet below the adjacent delta surface and slopes gently westward, i.e. up-current. We conclude that this channel developed during catastrophic discharge from Rock Cut Channel, at a time when water level stood near 600 feet in elevation.

Presumably, most, if not all, of the delta surface was under water at one time, but channels accomodated a disproportionate part of the flow. The situation is similar to, but with less pronounced channelization than in the High Bridge Delta.

43.2 0.4 Fluvial boulder gravels in road cut on left. The valley into which we are now descending was cut subsequent to formation of Rock Cut Delta and so transects the delta, isolating the remnant we have just crossed from other remnants west of Butternut Creek.

43.4 0.2 Turn right onto Jamesville Road. Continue north, crossing Butternut Creek. Do not turn right onto I-481!

43.9 0.5 Turn left into large gravel pit.

STOP 3 Heavily worked pit exposing remnants of deltaic structure, part of the delta built by Rock Cut Channel into Butternut Trough Lake. Note boulder size, northeastward-dipping foreset beds and irregular surface upon which the delta was built. The delta surface is more than 60-feet above the floor of Rock Cut Channel.

In contrast to the material in the delta at Stop 1, black shale is a constituent in the gravel here, though black shale is not present as bedrock north of Rock Cut Channel. We conclude that a) Rock Cut Channel had been carved into bedrock prior to the most recent glaciation; b) Black Marcellus Shale had not yet been stripped from the area north of Rock Cut Gorge at the onset of the most recent glaciation; c) Marcellus Shale as well as 80 feet of Onondaga Limestone was stripped from the plateau margin north of Rock Cut Channel by late glacial erosion; d) some of the glacially eroded debris rich in black shale and Onondaga Limestone was deposited as drift fill within Rock Cut Gorge; and e) catastrophic erosion of the drift-fill dam in Rock Cut Channel delivered this material for deposition in the delta built into Butternut Trough Lake.

Leave gravel pit, turning right (south) onto Jamesville Road.

44.9	1.0	I-481 enters from left. Continue straight, south, on Jamesville Road.
45.2	0.3	Boulder gravel at top of the exposure on the right across Butternut Creek is part of a small remnant of the Rock Cut Delta with its surface at about 610 feet above sea level. The gravel displays crude foreset bedding dipping southeast (to the left, out of the exposure face) and graded bedding. The boulder gravel rests upon finer sediments including both lacustrine silt and sand and lodgment till.
45.5	0.3	Bear left, following sign to Jamesville.
46.4	0.9	Turn right (west) onto NY 173 in Jamesville.
47.3	0.9	Till in roadside exposure on left contains little or no black shale fragments in spite of its location south of Rock Cut Channel from which shale-bearing drift was eroded to build the delta at Stop 3. We hypothesize therefore that during the last glaciation, all black shale north of this position had been removed by the time the glacier had changed from an erosional to a depositional regime.
47.6	0.3	Turn right into Clark Reservation State Park and proceed 0.2 mi. to parking area.

STOP 4 and LUNCH

North of the parking lot is the steep-walled basin of Green Lake (Jamesville Lake). At the west end, twin

channels lead to a lip 175 feet above lake floor. The lake is about 55 feet deep, with unknown thickness of marl and detritus infilling. Eastward a broad channel leads to Butternut trough. About 100 yards west of Green Lake is the smaller basin of Dry Lake, which also bears the appearance of a plunge basin, occupied for a shorter interval and cut perhaps by smaller discharge. The surrounding rock bench at 710 to 720 feet above sea level is relatively bare of either drift or alluvium. North and northeast of Green Lake are several much smaller basins. All have eastward-opening channels leading to Butternut Trough and all are presently controlled by subterranean outflow. The features of Clark Reservation reflect the work of subglacial and glaciomarginal drainage controlled in part of previously developed and subsequently modified solution features.

48.1 0.5 Leave Clark Reservation. Turn left (east) onto NY 173.

48.7 0.6 Enter Jamesville. In another 0.6 mile, cross railroad tracks and immediately turn left onto Jamesville Road. Do not cross creek.

50.2 1.5 Bear left (nearly straight) at "Yield" sign. Continue on Rock Cut Road (Jamesville Toll Road). In 0.1 mile the road turns sharply for railroad overpass. Caution: Single-lane bridge on double curve.

50.7 0.5 Excellent view of Rock Cut Channel. The view is west, i.e. upstream. The gorge is 2000 feet across from rim to rim. Farther west the gorge narrows slightly, but is never less than 1300 feet across. The flat valley floor, averaging about 130 feet below the rim, is 1000 feet wide. Floor and walls are composed of Upper Silurian and Lower Devonian carbonate rocks. The floor, on Fiddlers Green Dolostone is at 555 feet above sea level.

51.0 0.3 Turn right (north) onto Nottingham Road. Cross Rock Cut Channel.

51.5 0.5 Cross axis of Nottingham Channel at oblique angle.

51.9 0.4 Bear left at "Y" with Tecumseh Elementary School on right.

52.1 0.2 Turn left into "Drumlins", Nottingham Knolls Country Club.

STOP 5. Nottingham Channel leads from a plunge pool near the southwest edge of the golf course and drained into Butternut Trough Lake. At its outlet it appears to be sealed off by boulder gravels of Rock Cut Delta, presenting the anomaly that though located north of Rock Cut Channel, it seems to have ceased to exist prior to final cutting of the Rock Cut Channel.

Leave "Drumlins", turning right (east) onto Nottingham Road.

52.4 0.3 Bear right at Tecumseh Elementary School.

52.6 0.2 Cross Rock Cut Channel

52.8 0.2 Turn right (west) onto Jamesville Toll Road (Rock Cut Road).

53.2 0.4 The plunge basin behind the trailer park on the left (south) was carved by a waterfall during an early stage of drainage through the east end of Rock Cut Channel. By that time Clark Reservation Channel had been abandoned, its sill having been some 30 feet higher than the top of the south wall of Rock Cut Channel at this location. Drainage therefore spilled into Rock Cut Gorge from the south wall and flowed eastward within the gorge to Butternut Trough.

For this to occur, Rock Cut must have been incised essentially to its present level during an earlier episode of channel cutting. Most, if not all of the drift that had been deposited in the eastern half of Rock Cut Channel during the prior ice advance was flushed out down to the 600-foot level or lower.

Another less well-developed plunge basin was carved as a scallop in the south wall of Rock Cut 700 feet or so farther west, but is not readily seen from the road.

53.4 0.2 Boulder gravel exposed behind trailers on left. These gravels include clasts more than 2 feet in diameter and form a gravel spit built across the plunge pools on the south side of Rock Cut. Large scale cross-bedding has a southward component into the plunge basins.

This spit is interpreted as being a product of the limnic hlaup which introduced the late phase of Rock Cut drainage. The top to the spit is 640 feet above sea level, 90 feet above the floor of Rock Cut Channel at this point, thus placing an upper limit of about 90 feet on the depth of water during catastrophic discharge through Rock Cut Channel.

53.8 0.4 This is the inferred location of the drift barrier which diverted meltwater northward during the active life of Nottingham Channel. Breaching of this barrier released the waters of the lake impounded in Onondaga Trough and produced the catastrophic flood responsible for many of the features we have seen today.

The barrier is presumed to have consisted of drift, which must have been thoroughly saturated and may well have been quite permeable. If the drift was permeable, springs discharging on its east flank may well have contributed to erosion and subsequent failure of the dam.

The Onondaga Trough Lake stood at 700 feet and extended to the west flank of the drift barrier. The barrier could not have been much more than 2000 feet wide, separating the lake waters from a potential discharge route 100 feet lower.

54.9 1.1 Leave Rock Cut Channel at its west end, entering Onondaga Trough.

55.1	0.2	Turn left (south) onto East Brighton Avenue.
55.6	0.5	Turn half-right onto Lafayette Road (Not onto NY 173).
56.7	1.1	View of Onondaga Trough on right (west). Note the broadly rounded, u-shaped cross profile, the result of glacial modification of a pre-existing stream valley. The road here would have been under about 20 feet of water at the time that Clark Reservation waterfall was active. With the shift of discharge to the plunge pools along the south side of Rock Cut Channel, this became the temporary shoreline. Activation of Nottingham Channel dropped lake level about 40 feet below the road. Breaching of the drift barrier in Rock Cut Gorge let the lake drop another 100 feet. Each foot of lowering of lake level during removal of the drift barrier meant an additional 15,000 acre-feet of water to escape through Rock Cut and High Bridge Channels.
56.9	0.2	West end of Smoky Hollow Channel on left (east). This is the highest, and the first of the several channels to have been activated by post-Valley Heads glacial recession. When the floor of Smoky Hollow controlled the level of Onondaga Trough Lake, the water must have been about 380 feet deep.
57.1	0.2	Turn right onto Graham Road.
57.3	0.2	Excellent view of Onondaga Trough. Looking southward, one can see the juncture of Onondaga and Cedarvale Troughs (arms of a y-shaped, glaciated valley system) and Tully Trough (stem of the "y"). Terraces visible along the flanks of Onondaga Trough and across Cedarvale Trough are remnants of deltas which record changing lake level in Onondaga Trough.
57.8	0.5	Turn right (west) on Sentinel Heights Road
58.0	0.2	Turn left (south) onto Kennedy Road
59.0	1.0	Turn right toward I-81.
59.1	0.1	Turn right at "Yield" sign onto US 11, North. Immediately on passing through overpass, turn left (south) onto I-81.
59.7	0.6	Terrace gravels on near (east) side of Onondaga Trough below road.
66.6	6.9	STOP 6 in REST AREA for overview, resume and final discussion
		Continue south on I-81.
68.8	2.2	Tully (Valley Heads) Moraine. Crest of the moraine stands at 1200 feet, but the valley floor drops 600 feet within a half mile to the north. South of the moraine crest the outwash plain spreads for many miles toward Cortland. This is the moraine that separates southward drainage from the formerly ponded northward drainage.

70.0	1.2	Crest of the Tully Moraine. Outwash plain to south ahead.
70.6	0.6	Leave I-81 at Tully Exit (Interchange 14). Junction with NY 80.

END OF ROAD LOG