GLACIAL GEOLOGY OF THE NORTHERN CHENANGO RIVER VALLEY

Regional Setting

The field trip area (Fig. 1) is located in the northern reaches of the Chenango River, a tributary of the Susquehanna River drainage system. The region is covered by parts of the Munnsville, Morrisville, Hamilton, Earlville, Norwich, Sherburne, and Holmesville 7½ minute U.S.G.S. topographic quadrangles. The area has a total relief of 980 ft (1000 to 1980 ft). The bedrock is predominantly Devonian shale, siltstone, and sandstone (Broughton, et.al., 1962).

Glacial Geologic Setting

Brigham (1897) recognized the extent of the glacial sediments within the Chenango River valley from Binghamton north to the Mohawk Valley.

Tarr (1905) described the characteristics of the glacial deposits near the Finger Lakes.

Fairchild (1932) named the thick drift units in the Finger Lake region the Valley Heads moraine. He delineated two other areas of drift deposits: the Olean at the terminal moraine in Pennsylvania, and the Susquehanna Valley kames.

MacClintock and Apfel (1944) used the term "Binghamton moraine" to describe the Susquehanna Valley kames of Fairchild, indicating that this drift was deposited during a separate advance. They suggested that the Olean was

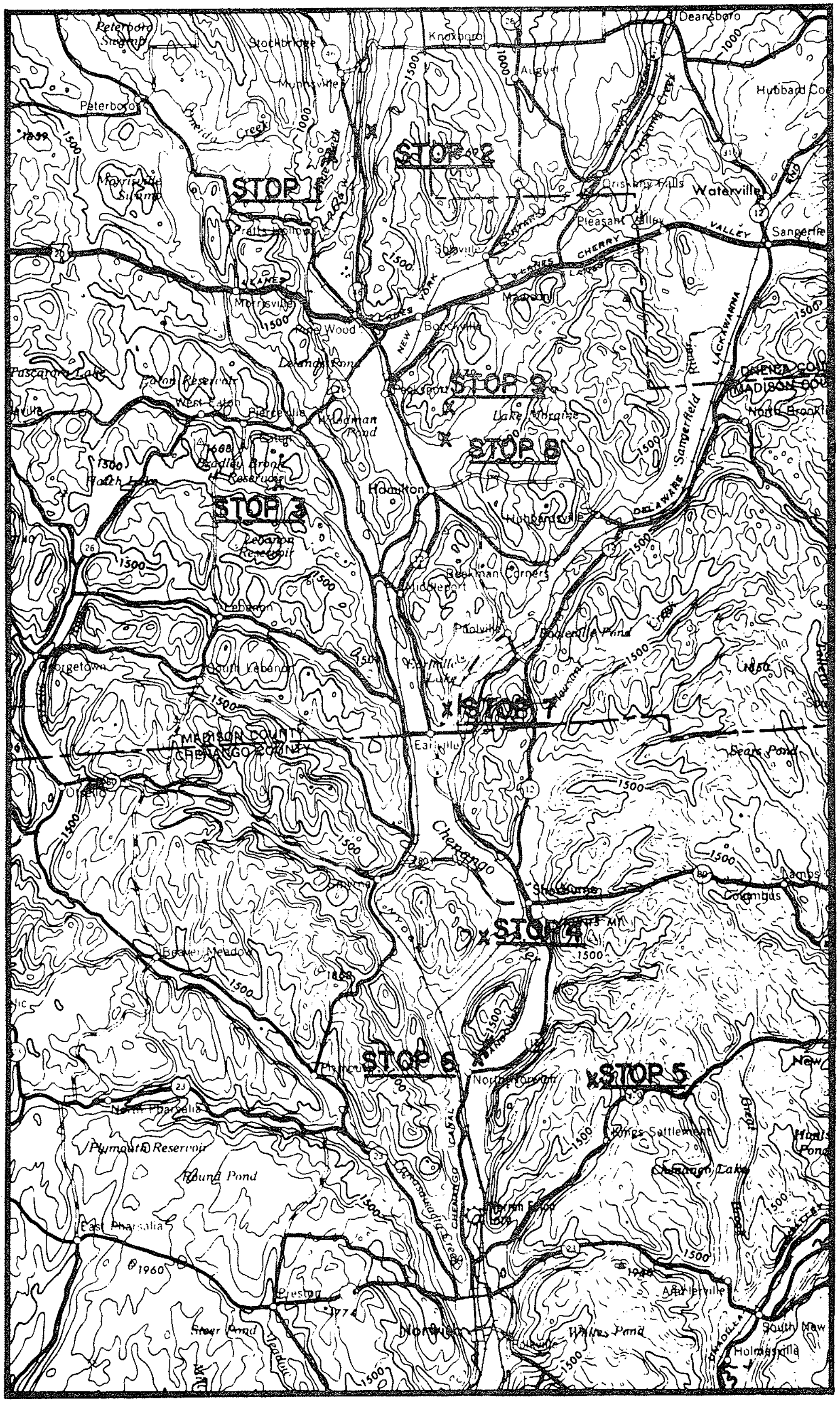

Figure 1. General field trip area (part of a Binghamton 1/250,000 map).

oldest Wisconsin; Binghamton-middle Wisconsin; and Valley Heads-youngest Wisconsin.

Peltier (1949) correlated terraces along the Susquehanna River in Pennsylvania with pre-Wisconsin, Olean, Binghamton, Valley Heads, and Mankato advances in New York.

Denny (1956) questioned the presence of the Binghamton advance in the Elmira region. He theorized that (1) the Binghamton border may be north of the Valley Heads border and therefore concealed, (2) the Binghamton border is incorporated within the Valley Heads border, and (3) there is a complete change in the character of the Binghamton materials between the type locality (Binghamton) and Elmira.

Connally (1960, 1964) indicated that the Binghamton is related to the Valley Heads advance, on the basis of heavy mineral analyses.

Moss and Ritter (1962) suggested that the Binghamton was not a separate advance, but a phase of the Olean.

Coates (1963) suggested that a single ice sheet deposited the drift with the Olean as the upland facies and the Binghamton as valley facies.

Hollyday (1969)suggested thicknesses of aquifers within the valleys in the Susqueharna River basin. This data suggests the drift in the valleys in the vicinity of the field trip ranges between 50 and 250 ft thick.

Cadwell (1972) formulated the idea of a single retreating Woodfordian ice sheet that deposited the Olean and Binghamton deposits, with a minimum age of 16,650 ± 1800 radiocarbon years B.P.

The Valley Ice Tongue

The model I have developed is one of ice protuberances, which may become stranded upon retreat of the ice sheet. These ice masses left in the valleys are called valley ice tongues. The ice tongue may extend down valley up to several miles beyond the upland ice margin (Fig. 2). Meltwater flowing from the upland margin is forced to flow between the ice and the bedrock walls creating unique and diagnostic deposits.

With continued retreat of the ice tongue, the high level glacio-fluvial deposits remain against the valley walls. The upper surface of these features are flat to subhorizontal, commonly areally extensive and are termed planar surfaces. Features that may commonly be associated with the retreating ice tongue include kames, kame terraces, kame deltas, valley plugs, valley train, ice channel fillings, kamefields, and eskers.

The Problem of Ice Retreat

In central New York the problem of delineating the number of glaciations has been a problem. Denny and Lyford (1962) indicated that the earlier Wisconsin (Olean) ice did not build a prominent moraine at the drift border, or construct any significant moraine south of the Valley Heads

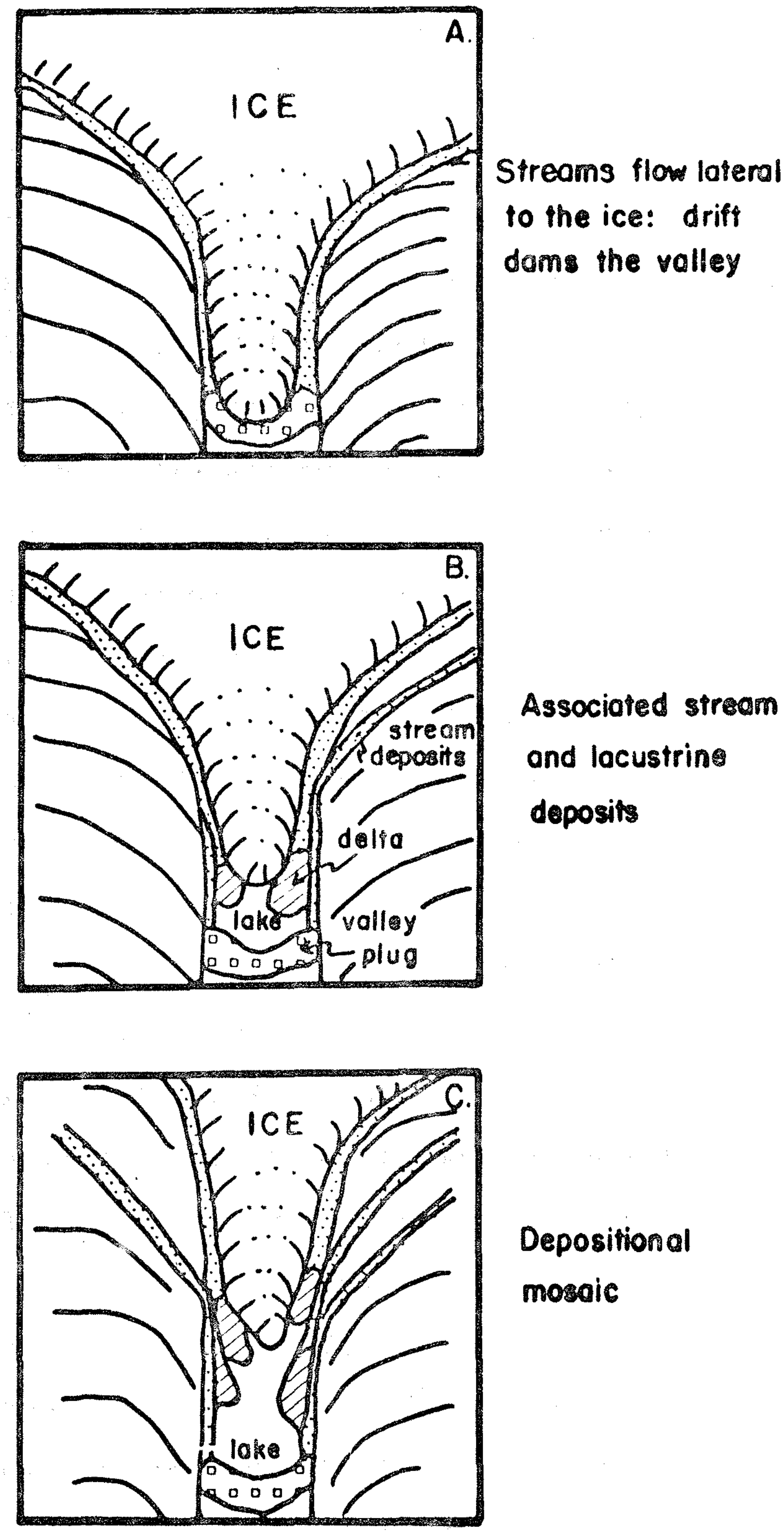

Figure 2. Valley ice tongue mosaic. Diagram of a retreating ice tongue margin and the depositional mosaic associated with the retreat.

moraine. Hence, the problem of the manner of retreat of the Woodfordian ice sheet.

A distinction is made between the manner of retreat in the valleys and uplands. The valley margins are characterized by large accumulations of drift plugging the valley, thus providing a limit for the toe of the valley ice tongue. Kames, kame terraces, kame deltas, and valley trains may be associated with the valley ice tongue. Upland margins are characterized by marked asymmetry; stratified drift along the north-facing slope, and a surficial mantle of thin ablation till on the south-facing slope. Bradley Brook, STOP 3 on the field trip, illustrates this configuration of deposits. Figures 3 and 4 suggest a mode of formation as the ice retreats in the uplands. Plate 1 is a low angle air photograph of Bradley Brook.

Criteria for the Location of Retreatal Ice Margins

The criteria which led to the identification of the ice margin positions in the northern Chenango River valley include the following: (1) the surface morphology or shape of the upland hills, (2) the location of outflow channels in the uplands, (3) the association of upland meltwater deposits, (4) the configuration of stratified drift around umlaufbergs, and (5) the sequence of valley meltwater deposits.

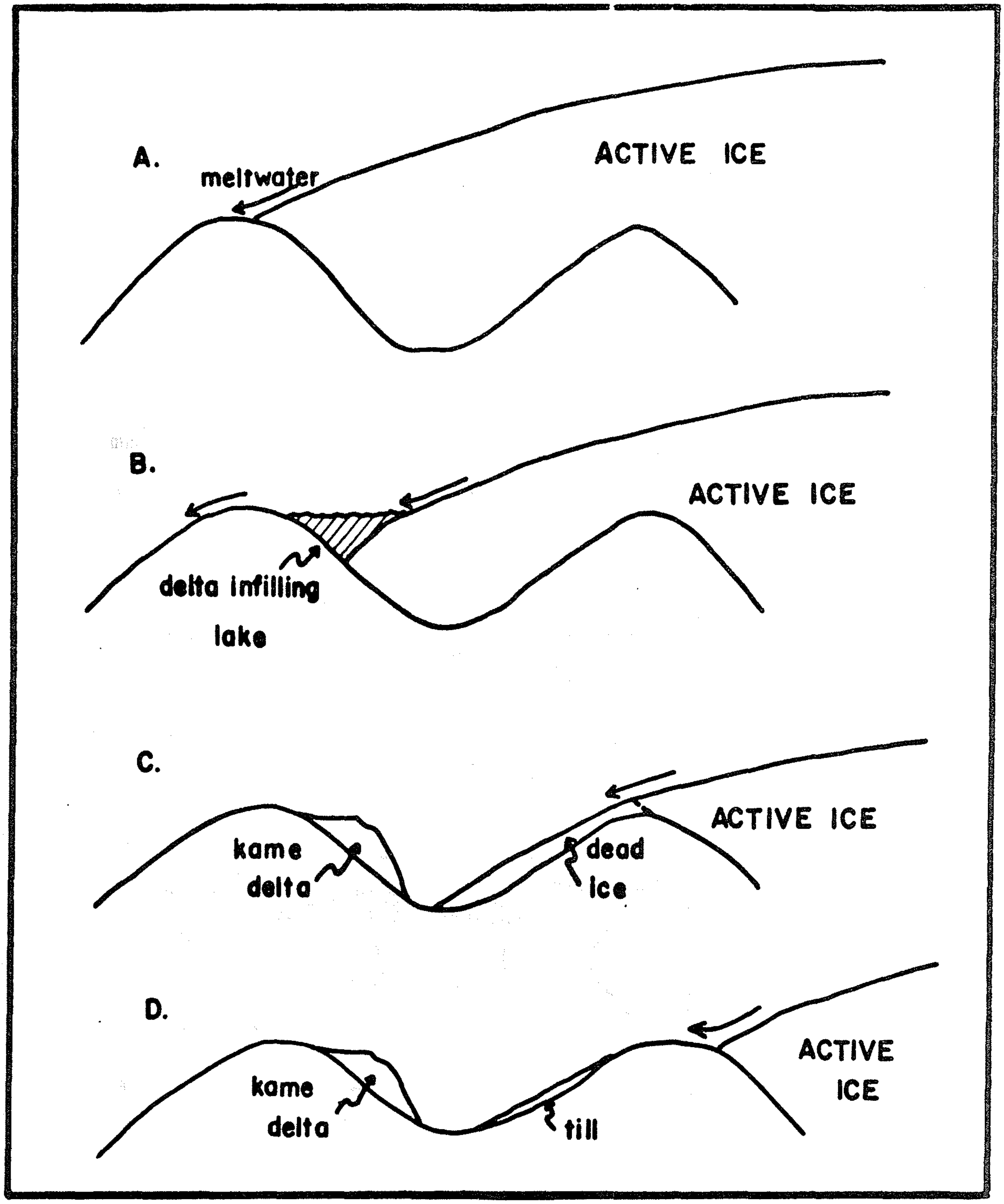

Figure 3. Diagram of the profile of upland ice retreat, as Bradley Brook. Margin locations and associated upland deposits are governed by topography which preceded the ice.

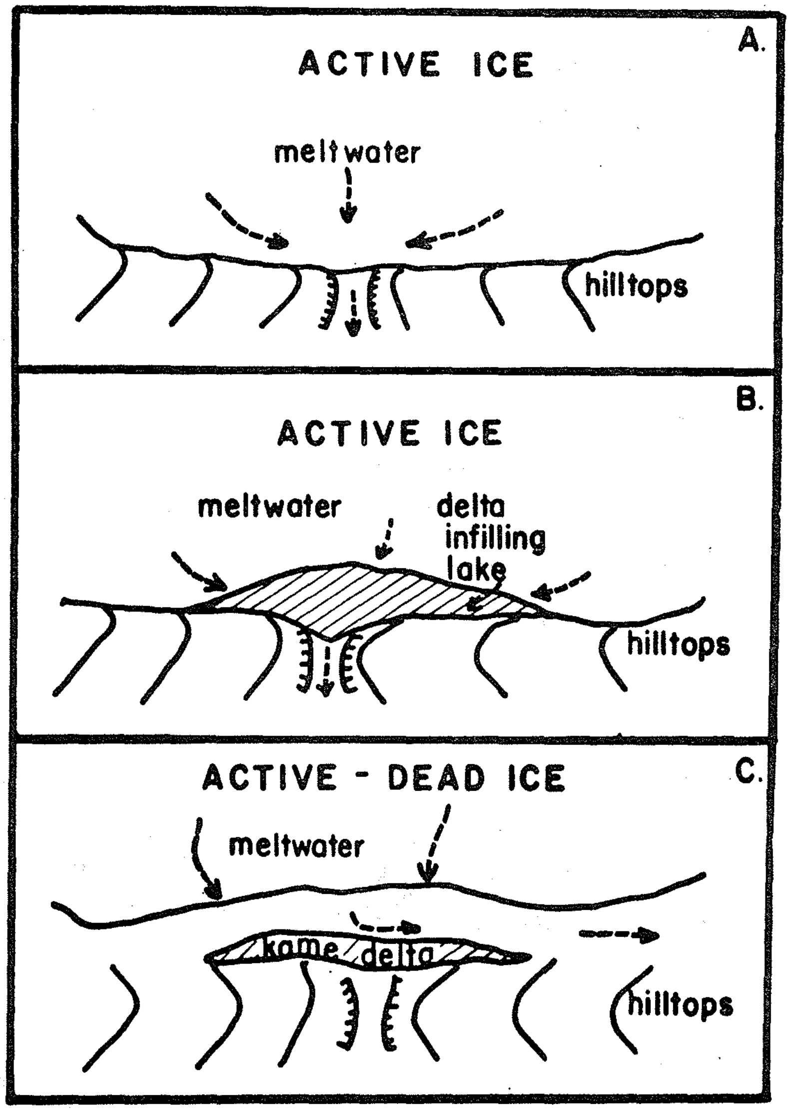

Figure 4. Plan diagram of upland ice retreat, as Bradley Brook.

A. Ice against mountain with meltwater flowing through outflow channel.

B. Shaded area represents deglaciated part with proglacial lake and delta. Meltwater flows through outflow channel.

C. Continuing ice margin retreat with lake draining; outflow channel abandoned, and incisement of lateral channel.

Deglaciation Chronology

The Woodfordian ice sheet retreated primarily by backwasting in the uplands. There are no massive stagnant ice areas continuous from one valley to another across a divide. This suggests there were no large areas of ice detached from the main ice sheet. The size of the ice tongues remaining in the valleys during retreat was governed by such factors as the rate of upland retreat and the rate of valley ice melting. In areas of rapid upland ice retreat long tongues of ice could have remained in the valleys behaving in some ways similar to a valley glacier. The valley tongue retreated by both backwasting and downwasting.

Upland ice margin positions are identified in the area of the field trip (Fig. 5). During the development of margins A and B an ice tongue remained in the main river valley to about Sherburne. Kame terraces and deltas were deposited lateral to the ice tongue. At margin B the ice tongue may have retreated to about Earlville, permitting lake sediments to accumulate in the valley north of Sherburne. The dam for the lake was perhaps a shallow bedrock riegel in conjunction with alluvial fans which blocked the valley to the south of Sherburne.

Margin C is located along Bradley Brook. During the time when the ice entirely filled this valley, meltwater flowed through the outflow channel and to the south into the Lebanon Reservoir valley. Figures 3 and 4 illustrate the sequence of retreat away from the hilltops, with the

Figure 5. Retreatal ice margins in the northern Chenango River valley and vicinity, New York.

deposition of the kame delta and the ablation till.

During the retreat from margin C to D the hilltop to the west of Hamilton became exposed through the ice as a nunatak, and meltwater carved the meltwater channel to the north of the hill. Ice tongues remained in both the main Chenango Valley and the Hamilton-Madison Valley. A large mass of ice remained in the Moraine Lake valley while the ice was retreating and the hilltops east of Hamilton became exposed. This ice retreated northeastward, away from the Hamilton Valley ice tongue, and a large lake was formed between the retreating Moraine Lake ice and the Hamilton Valley ice. Much of this lake was filled with a large delta, and the foresets are exposed southwest of the lake (STOP 6 of the field trip).

Backwasting of the ice sheet continued through margins E and F with the deposition of kame terraces lateral to the ice tongue. The ice sheet then retreated north outside of the field trip area, and perhaps to the north of the Mohawk Valley, permitting some of the lakes to the northwest to drain via the Mohawk and Husdon Rivers.

Margin G is the terminal moraine of the Valley Heads advance, and represents a readvance of the Late Wisconsinan (Woodfordian) ice sheet. This moraine contains a series of margin positions associated with the readvance instead of a single stand. Associated with this margin are the massive valley train deposits infilling the Chenango and Hamilton-Madison Valleys, especially in the vicinity of Pratts Hollow. The valley train is traced semi-continuously to Sherburne, 19 mi south of the terminal moraine.

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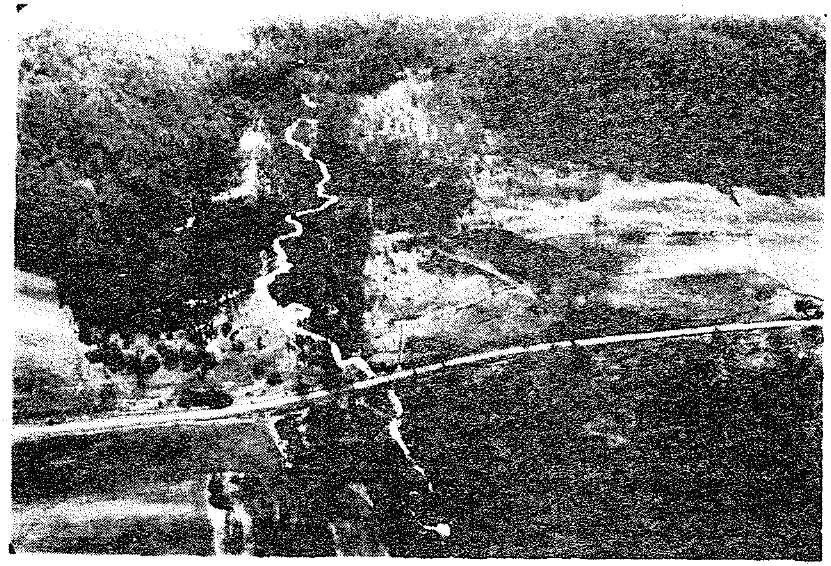

Plate 1. Bradley Brook. Low angle air photograph of Bradley Brook illustrating the location of sand and gravel in the uplands. View is to the east.

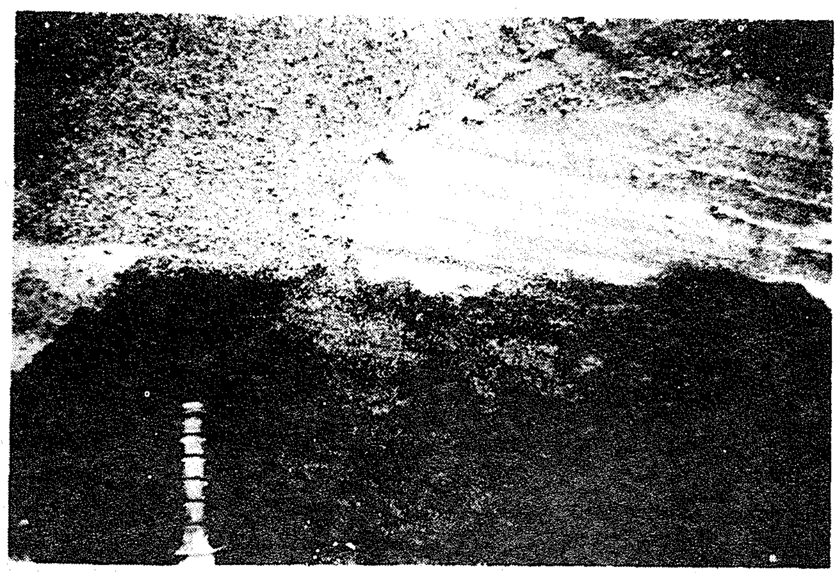

Plate 2. Chenango County Sand Pit. Block of stratified drift in unstratified drift. Note the apparent lack of horizontal stratification above the knife.

Plate 3. Chenango County Sand Pit. Block of stratified drift. Note vertical stratification parallel to orientation of knife.

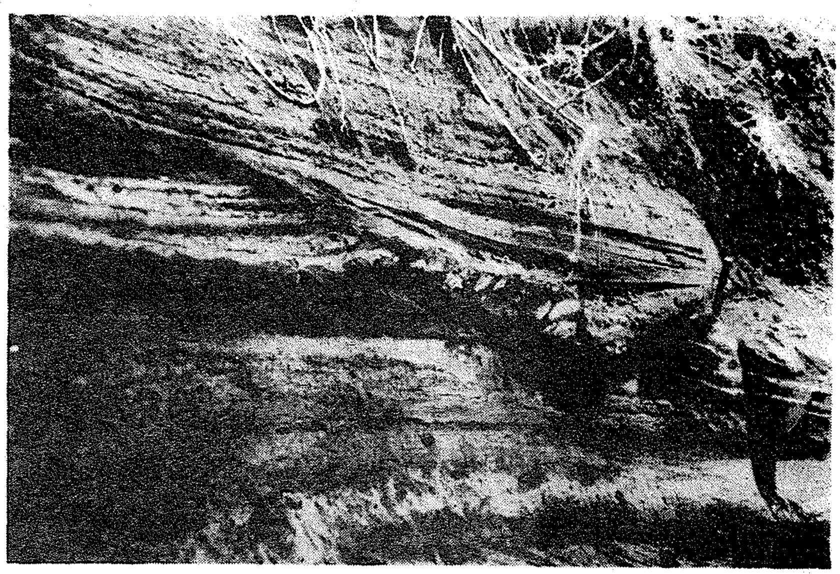

Plate 4. Chenango County Sand Pit. Contorted silts and clays. Note the light (clay) layer with ripples to the left, segmented nodules of clay in the middle, and thrusting near the knife.

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TRIP 4: ROAD LOG AND ROUTE DESCRIPTION

GLACIAL GEOLOGY OF THE NORTHERN CHENANGO RIVER VALLEY

Donald H. Cadwell

Total miles	miles	
		This trip leaves from Utica, but the road log will begin at the Colgate University entrance. To get to STOP 1 from Utica, proceed west on Rt. 5 about 20 mi to Oneida. Turn south on Rt 46, through Munnsville. STOP 1 is on a side road 1½ mi south of Munnsville.
0.0	0.0	Colgate University entrance. Proceed north on Rt 12B.
3.4	3.4	Junction with Rt 46: stay on Rt 46 through the junction of routes 26 and 20.
5.3	1.9	Turn left onto unnamed road 0.2 mi north of the jct with Rt 20. This road crosses the valley train of the Valley Heads moraine. Note the many kettles. There is an intersection in Pratts Hollow, continue straight through. The crest of the Valley Heads moraine is immediately south of town; all drainage in this area is north into the Mohawk Valley. The clay beds 1 mi north of Pratts Hollow are ponded lacustrine deposits formed during the retreat of the ice from the Valley Heads moraine.
10.0	4.7	STOP 1. VALLEY HEADS MORAINE EXPOSURE This is an exposure of glaciofluviatile and glaciolacustrine sediments in an ice contact zone. These materials, therefore, were deposits adjacent to large blocks of ice. In this pit there are examples of several depositional environments: horizontally stratified sands and gravels, cross-bedded sands and gravels with 10 ft of relief, finely cross-bedded sands, and clays dipping northward at the north side of the exposure.

The lithologies in this pit are of typical Valley Heads composition. The provenance of the exotics indicates a source from the Adirondacks and Canada.

Percentage composition:

9%	red sandstone
26%	limestone and chert
39%	locals
26%	exotics

Return to the bus and proceed north.

11.3	1.3	Jct Rt 46, turn right (south).
12.7	1.4	Turn left onto Trew Hill Rd.
12.9	0.2	STOP 2. PICTURE STOP This is a view of the Valley Heads moraine area. This is the Stockbridge valley, with the towns of Stockbridge and Munnsville to the north. The stratified drift of the Valley Heads moraine is not limited to the Stockbridge valley as well data suggests there is at least 220 ft of sand and gravel in the uplands on the west valley wall. A question remains as to when and how this moraine was formed. Hypothesis 1: This moraine was formed as a recessional moraine during the retreat of the same ice sheet that deposited the glacial features to the south, between Binghamton and Earlville. Hypothesis 2: This moraine was formed during a readvance of the ice; a readvance of a Late Woodfordian ice sheet. Return to Rt 46.
13.1	0.2	Rt 46, turn left (south).
14.0	0.9	Highest level of the Valley Heads moraine. Note the large boulders in exposures along the east side of the road.
16.4	2.4	Valley train materials that grade to the south away from the Valley Heads moraine.
17.3	0.9	Jct Rt 20; Stay on Rt 46 south.
18.1	0.8	Jct Rt 26. Turn right onto Rt 26.
19.3	1.2	Kame terrace along the west valley wall. This kame terrace is 40 ft higher than the Valley Heads valley train.

Is there a relation between this kame terrace and the Valley Heads terminal moraine?

Was this terrace formed during a glacial episode previous to the Valley Heads?

20.8	1.5	Enter town of Eaton.
21.1	0.3	Turn left onto River Road.
21.2	0.1	Turn right onto dirt road (just after crossing bridge) and proceed up the steep hill.
21.4	0.2	Turn left (south) onto Lebanon Hill Road. This detour is necessary for vehicles greater than 3 tons.
22.9	1.5	STOP 3. BRADLEY BROOK ICE MARGIN

This stop illustrates the character of an upland ice margin, see also Figures 3 and 4 in the text. Bradley Brook flows to the east and stratified drift is exposed along the north-facing hillslope. Ablation till mantles the south-facing slope.

The spring near the exposed face west of the road has good drinking water. PLEASE BE CAREFUL TO KEEP IT THAT WAY as several persons still obtain their drinking water from this spring.

The stratified drift was deposited during wastage of an upland ice margin. The sediments are subhorizontally stratified, with perhaps a slight dip to the east. The materials were deposited lateral to the ice and the valley walls, as meltwater flowed to the east in the Bradley Brook valley toward the Chenango River. See also Plate 1.

With continued retreat of the ice front into the next valley to the north, a thin veneer of dead ice remained on the south-facing slope in the Bradley Brook valley. The dead ice deposited a thin ablation till on a perhaps much thicker lodgment till.

The lithologies include red sandstone, limestone, chert, igneous and metamorphic exotics, and local sandstones, siltstones and shales. The percentages are:

17% red sandstone
19% limestone
47% locals
18% **exotics**

Return to the bus and proceed south.

24.7	1.8	Turn left onto Geer Rd. Sand, gravel, and till can be seen in road cuts to the right.
25.4	0.7	Turn left, keeping the reservoir to the left. Sand, gravel, and bedrock are exposed to the right.
27.0	1.6	SHARP LEFT TURN IN ROAD. While descending this valley wall note the kame terrace and esker. This terrace is 40 ft above the valley floor. Note the kame and kame terrace on the opposite (east) valley wall. These kames and kame terraces were deposited when meltwater streams flowed between the ice and the valley walls. At this time there was an ice tongue in the valley extending at least several miles to the south. Additional diagram in the text (Fig.2).
27.4	0.4	Jct River Rd, turn right (south).
32.1	4.7	Kame delta units to the right. This is an exposure in one lobe of a delta. There is evidence for lobes in adjacent areas. At the Madison-Chenango County line continue to the south on County Rd 14.
35.7	3.6	Hummocky, stagnant ice topography behind the Sandy Acres Farm.
36.1	0.4	Jct Rt 80, turn left (east).
39.1	3.0	Turn right (south) onto County Rd 23.
40.0	0.9	STOP 4. THE BUNDY CONCRETE COMPANY This pit contains one of the most useable sand and gravel deposits in Chenango County and has been in operation for about 50 yrs. There are local zones and layers of sand and gravel that are cemented. The cemented arch is disintegrating rapidly: two years ago the pillars were twice as thick. All of the gravel is bright and exotic rich. There are, however, dull sections that result from an increase in the percentage of clays.

Percentage composition:

bright

19%	red sandstone
26%	limestone
34%	locals
21%	exotics

duller

10%	red sandstone
31%	limestone
32%	locals
27%	exotics

Problem 1: What is the origin of the cemented zones?

Problem 2: When did cementation occur? immediately postglacially? Recent?

Return to the highway and turn left (south)

41.1	1.1	Turn left onto Blanding Road
43.3	2.2	Jct Rt 12, turn right (south).
47.3	4.0	Jct County Rd 32, bear left (south) onto Rt 32. This road is just before the bridge over the Chenango River.

The bedrock hills to the right and behind you are umlaufbergs. These are bedrock hills within the Chenango River valley and are entirely surrounded with stratified drift.

This road traverses several good examples of kame terraces. Others can be seen along the west valley wall.

51.9	4.6	Jct Rt 320. Turn left (east) onto 320.
55.0	3.1	End of Rt 320, begin County Rd 29. Stay on the main road.
56.5	1.5	Turn left onto dirt road. You are on the correct road if just after the turn you see two old railroad tank cars in the weeds to the left.

Entrance into the Whapanaka State Forest and the State Forest Truck Trail.

58.0	1.5	STOP 5. STATE FOREST FROST WEDGE

Walk up into the bedrock quarry. This pit is used by the State for maintenance of the truck trails. The face of the exposure is oriented N20E along one of the joint planes. The frost wedges are developed along the other joint plane N75W.

One frost wedge is well developed. A second wedge, to the north, is partially developed.

Results of digging along the upper surface of the well developed wedge indicate the feature persists with depth. It is known to persist for at least 3 ft to the east.

What is the origin of these features?

<u>Hypothesis 1</u>: That these frost wedges formed during more rigorous climatic conditions after the retreat of the last glacier.

<u>Hypothesis 2:</u> That these frost wedges resulted from several cycles of rigorous climatic conditions and perhaps from several ice advances.

<u>Hypothesis 3</u>: That these are not really frost wedges, but are frost cracks or some other periglacial phenomena.

<u>Hypothesis 4</u>: (This hypothesis was proposed by two local farmers) that these features formed as a result of a series of gas explosions, while man was drilling for oil and gas.

Return to County Road 29, and retrace path back to County Rd 32.

64.1	6.1	Jct County Rd 32, turn right (north).
68.7	4.6	Jct Rt 12, turn left and cross the Chenango River. The umlaufberg is to your right. The next stop is in the sediments deposited at the southern tip of the umlaufberg.
69.2	0.5	Bear right, onto County Rd 23A.
69.3	0.1	Bear right, leaving 23A.
69.4	0.1	Stop sign, turn right onto North Main Street.
69.7	0.3	<u>STOP 6</u>. CHENANGO COUNTY SAND PIT This is the best sand pit in Chenango County.

The upper section of this pit is composed of lake silts, sands and clays, with many ripple drift laminations. These are well stratified.

The lower section is elusive. It may not be well exposed at the time of the trip; however, it is there. In this section there are examples of strata with vertical bedding;

horizontal bedding that abruptly ceases into an unstratified zone; and cross-bedded sands with inclinations of up to 85 degrees. We may have to dig to re-expose these features. See Plates 2, 3, and 4, elusive contorted, discontinuous, vertical bedding in pit.

The lithologies present include red sandstone, limestone and chert, local sandstone, siltstone and shales, and igneous and metamorphic exotics.

Percentage composition:

18%	red sandstone
25%	limestone
43%	locals
15%	exotics

Hypothesis 1: The lower section was deposited as a kame terrace lateral to a retreating ice mass. There was an ice readvance causing the rotation of blocks and the discontinuous units. Subsequent to the ice readvance there was a lake followed by the development of the upper lake units.

Hypothesis 2: There was ice adjacent to the lower unit during sedimentation. With the melting of the ice some of the sediments were rotated, while still frozen. This could explain the rotated and discontinuous blocks, and also those with high inclinations. A lake then developed above these sediments.

Hypothesis 3: Some outrageous hypothesis.

Retrace path back to Rt 12.

70.8	1.1	Jct Rt 12. Turn left (north). Continue north through Sherburne and the intersection of Rt 80.
76.5	5.7	Jct Rts 12 and 12B. Continue straight ahead on Rt 12B.
81.9	5.4	Intersection at the center of Earlville; turn right.
82.5	0.6	Turn left onto Earlville Rd.
82.7	0.2	STOP 7. COSSITT CONCRETE PRODUCTS INC. This sand and gravel pit has the largest drag line operation in the Chenango River valley area.

Exposures in this pit illustrate the following environments of deposition: deltaic foresets; lake bottom units; braided stream deposits; and evidence of deposition near an ice margin--as faulting and slumping in an ice contact zone.

The lithologies include: red sandstones, limestone and chert, local sandstones, siltstones and shales, and igneous and metamorphic exotics.

Percentage composition:

13% red sandstone
25% limestone
47% locals
16% exotics

Return to Rt 12B in Earlville.

83.5 0.8 Jct Rt 12B, turn right (north) and proceed into Hamilton.

90.1 6.6 Light in the center of Hamilton. Leave Rt 12B and continue straight ahead onto Madison Street.

91.1 1.0 STOP 8. HITCHCOCK SAND AND GRAVEL PIT
This pit is a large delta complex of sand and gravel.

Percentage composition:

10% red sandstone
34% limestone
46% locals
10% exotics

This delta formed in a lake that existed between the ice tongue in the Hamilton valley and the ice at Moraine Lake. The Moraine Lake ice was a slowly melting remnant ice tongue whose source had been cut off.

Return to Madison Street, turn right.

91.5 0.4 Turn left onto Airport Road.

91.6 0.1 STOP 9. PICTURE STOP.
This is a view of the Hitchcock delta and the Hamilton valley.

Continue straight ahead to the intersection with Rt 12B.

92.4 0.8 Jct Rt 12B. Turn right (north) and return to Utica (about 22 mi). Turn left (south and return to Hamilton (about 1 mi).