GLACIAL GEOLOGY OF THE CHENANGO RIVER VALLEY
BETWEEN BINGHAMTON AND NORWICH, NEW YORK *

by

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REGIONAL SETTING

The field trip area (Fig. 1) is located in the southern part of the Chenango River valley, a tributary to the Susquehanna River drainage system. The region is included in parts of the Binghamton West, Castle Creek, Greene, Chenango Forks, Brisben, Tyner, Oxford, Norwich, and Holmesville 7½ minute U.S.G.S. topographic quadrangles. The area has a total relief of 341 m (840 to 1980 ft). The bedrock is predominantly Devonian shale, siltstone, and sandstone (Fisher et al., 1970).

GLACIAL GEOLOGIC SETTING

Brigham (1897) recognized the extent of the glacial sediments within the Chenango River valley between Binghamton and 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 Lakes region the Valley Heads moraine. He delineated 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 the drift was deposited during a separate advance. They suggested that the Olean was the oldest Wisconsin, Binghamton - middle Wisconsin, and the Valley Heads - youngest Wisconsin. Peltier (1949) correlated terraces along the Susquehanna River in Pennsylvania with pre-Wisconsin, Olean, Binghamton, Valley Heads, and Mankato ice 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) the character of the Binghamton materials is completely changed between the type locality (Binghamton) and Elmira. Connally (1960, 1964) on the basis of heavy-mineral analyses indicated that the Binghamton is related to the Valley Heads advance. 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) showed that the drift in the valleys in the vicinity of the field trip ranges

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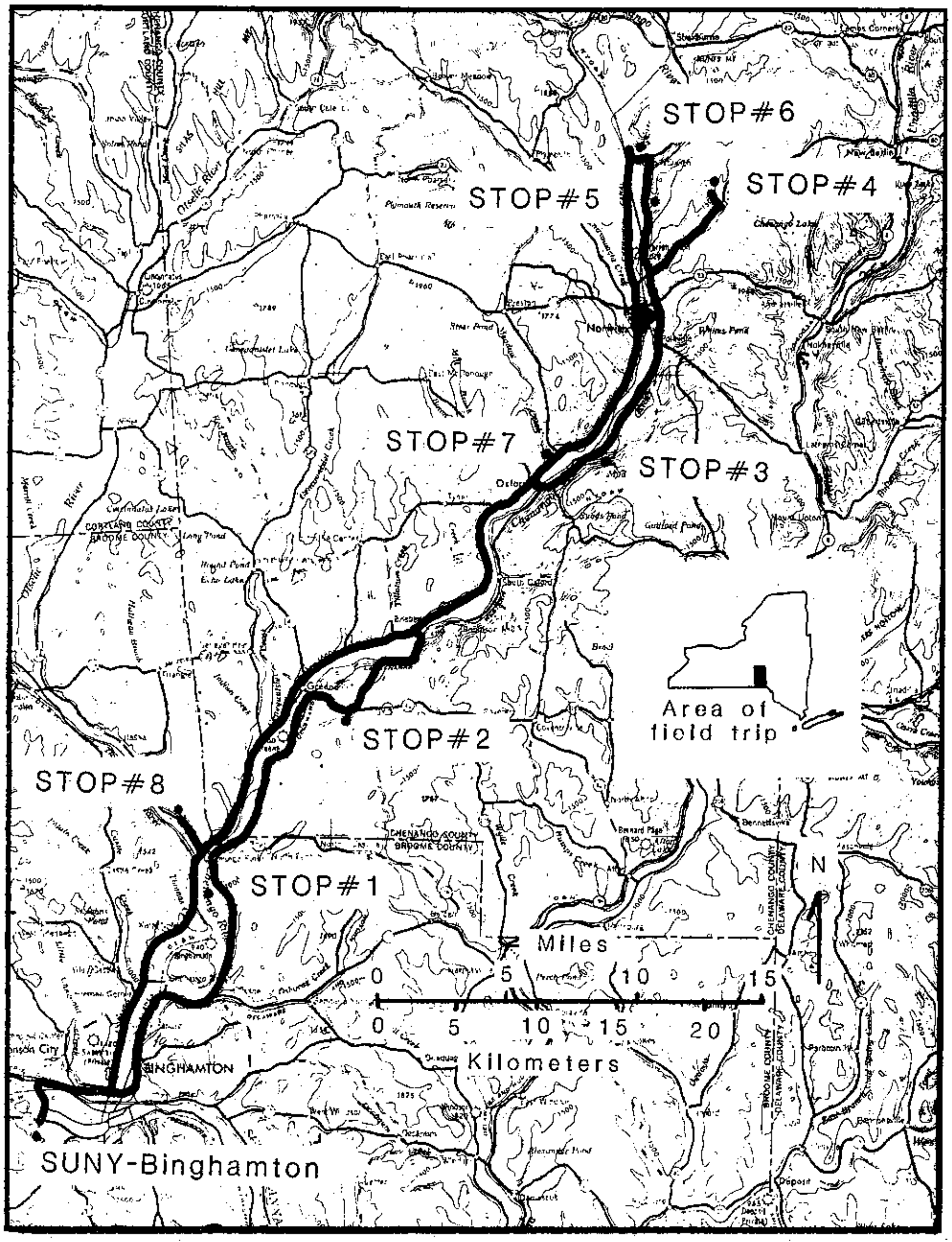


Figure 1. Field trip route and stops.

between 15 and 76 m (50 and 250 ft) thick. I have presented the idea of a single Woodfordian ice sheet that deposited the Olean and Binghamton deposits, with a miminum age of 16,650 $\pm$ 1800 radiocarbon years B.P. for wood at the base of a bog (Cadwell, 1972a, 1972b, 1973a, 1973b, 1974, 1975, 1978). Incorporated in this idea is the concept of "valley ice tongue" retreat. An ice tongue may have extended several miles down valley beyond the upland ice-margin position. Krall (1977) described the Cassville-Cooperstown moraine as a late Wisconsin recessional moraine. Aber (1978) described the erratic-rich drift in the Appalachian Plateau of N.Y.

THE PROBLEM OF ICE RETREAT

The number of glaciations in central New York is difficult to delineate. Denny and Lyford (1963) 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 moraine. Cadwell (1978) described the bedrock control of retreating ice margin positions in the northern Chenango River valley. Figures 2 and 3 suggest the mode of formation as the ice retreats in the uplands.

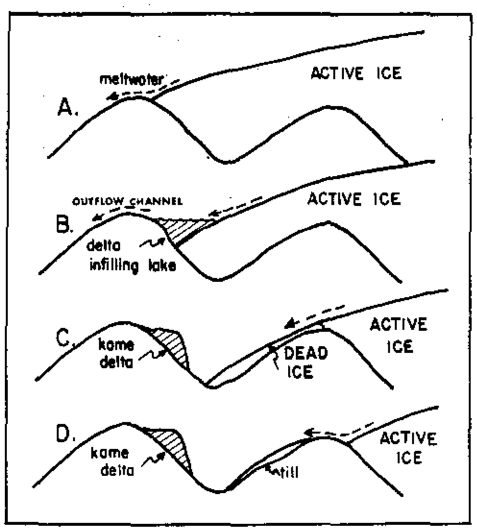


Figure 2. Diagram of profile of upland ice retreat.

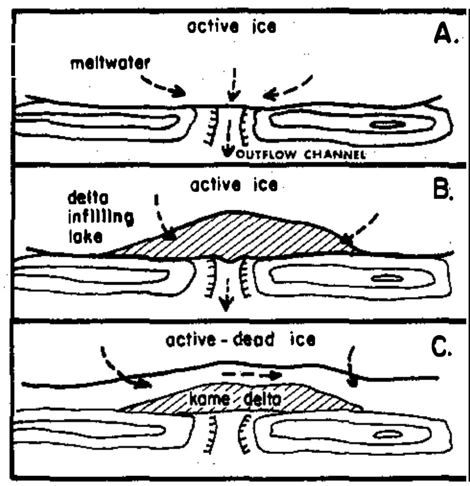


Figure 3. Sketch map of upland ice retreat.

Figure 2 illustrates a profile of upland ice retreat. Margin locations and associated deposits are governed by preglacial topography. Figure 3 is a sketch map of upland ice retreat. In Figure 3A the ice is against the mountain, with meltwater flowing through an outflow channel. In Figure 3B the hachured area represents a proglacial lake and delta. Meltwater continues to drain through the outflow channel. Figure 3C represents continued ice-margin retreat. Meltwater ceases to flow through outflow channel and remains within the stream valley. Deposition of a kame-terrace sequence may occur as meltwater adjusts to the present stream level. Criteria that led to the identification of these ice-margin positions 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 (bedrock hills surrounded with outwash deposits), and (5) the sequence of valley meltwater deposits.

The valley meltwater deposits are the primary emphasis for this field trip. Of particular importance is the relationship between the retreating valley ice tongue and glaciofluvial and glaciolacustrine deposits. The sequence creates a depositional mosaic or suite of deposits associated with the retreating ice tongue (Figure 4). Field trip stops 3 and 5 examine kame deltas associated with an ice tongue near Oxford.

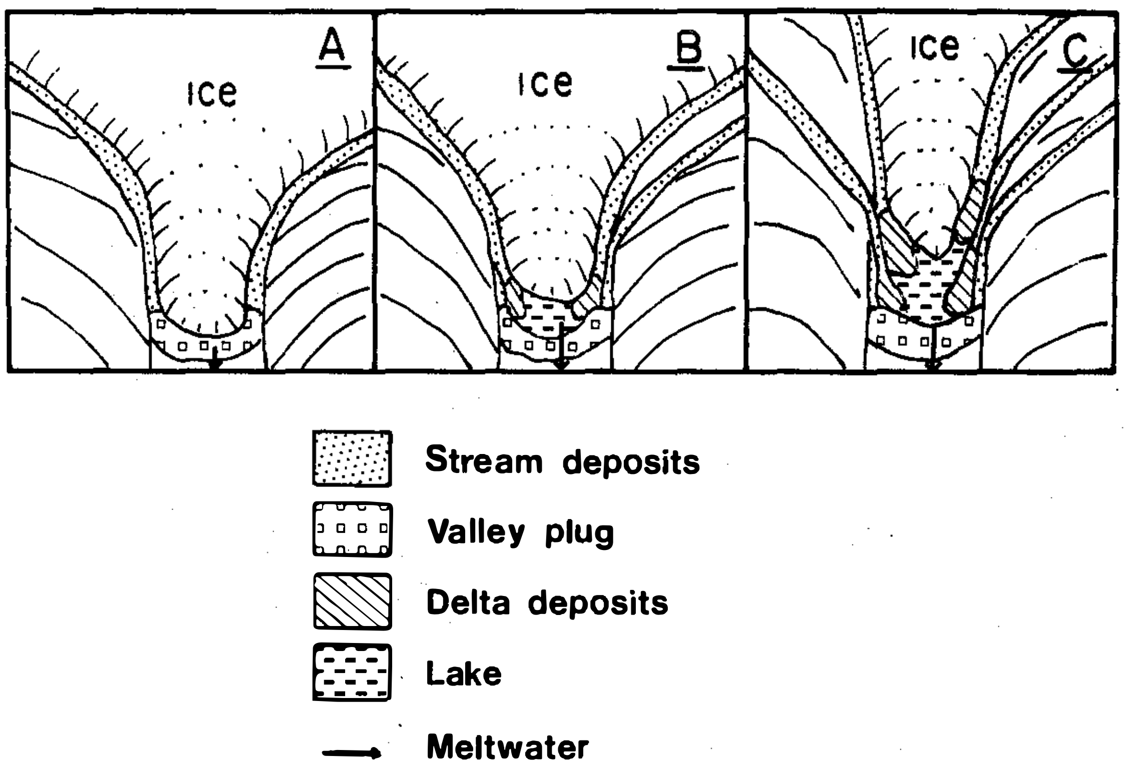


Figure 4. Generalized diagram of ice-tongue retreat with associated valley and upland deposits.

Deglaciation Chronology

The Woodfordian ice sheet retreated primarily by backwasting in the uplands. Stagnant ice deposits continuous from one valley to another across a divide are absent in the study area. This suggests that active ice tongues remained in the valleys. The size of the ice tongues remaining during retreat was governed by such factors as rate of upland retreat and 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 ice tongue retreated by both backwasting and downwasting.

Ice margins identified in the field trip area are indicated in Figure 5. During the development of each margin an ice tongue remained in the main Chenango River valley.

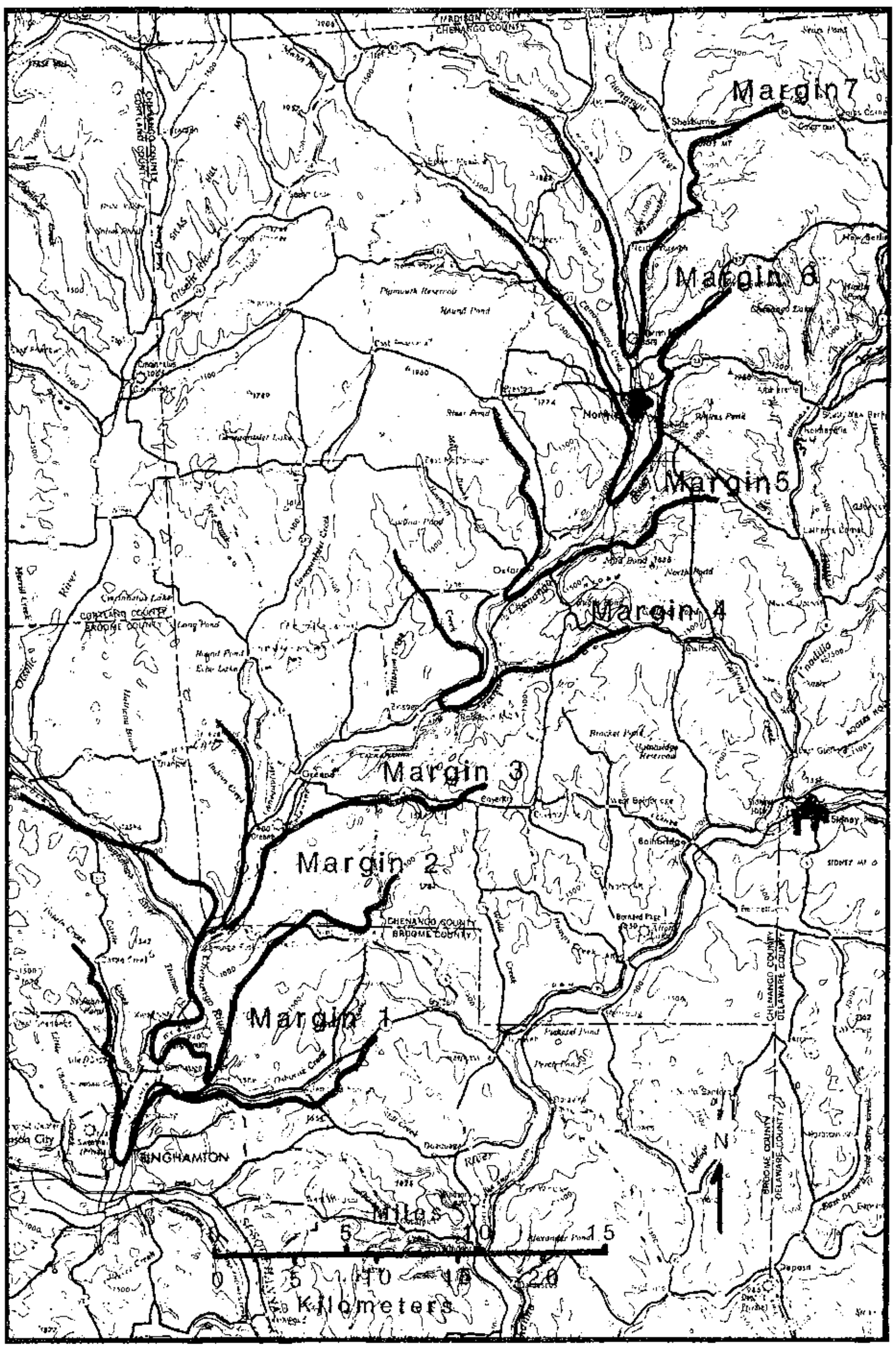


Figure 5. Retreatal ice margin positions in the southern Chenango River valley.

Margin 1. During development of this margin an ice tongue extended in the Chenango River valley south to Binghamton. The umlaufberg at Kattellville was exposed through the ice and meltwater carved the windgap in the upland.

Periglacial conditions existed south of the ice front. Evidences of these climate conditions are found at tor localities, at the top of Ingraham Hill, southwest of Binghamton. Meltwater flowed laterally to the ice tongue and, as the ice tongue diminished in size, kames and kame terraces were deposited along the east and west valley walls of the Chenango valley. This kame terrace can be seen at the 9.0 mile position on the field trip. Meltwater flowed out of high-level channels south of Port Crane during early stages of ice retreat.

Margin 2. During the development of this margin, streams flowed laterally to the ice tongue. Ice dammed the valley at Port Crane forcing meltwater to flow on the west side of the umlaufberg in the Kattellville valley (112.0 miles in field-trip description). The manner of retreat of the ice front changed, briefly, from backwasting to downwasting as meltwater deposited thick sands and gravels in the vicinity of the Chenango Valley State Park at Chenango Forks. Meltwater streams were unable to transport the large amounts of sand and gravel, and the valley became choked with debris. This debris (valley plug) controlled the local base level of deposits laterally to the ice within the valley to the north.

Large blocks of ice left within these deposits formed kettles, such as Lily and Chenango Lakes. An ice-channel filling is preserved where the debris was deposited between the blocks (See the topographic map, STOP 1, of Chenango Valley State Park in the field-trip guide). Numerous other kettles are preserved to the north of these lakes, similar perhaps to pitted outwash. A radiocarbon age date of 16,650 ± 1800 yBP (BGS-96) was obtained from wood at the base of peat in a kettle-hole bog.

Margin 3. The most notable feature associated with margin 3 is the Wheeler Creek esker complex. A topographic map of this area is included in the field-trip guide for STOP 2. This discontinuous esker is 6.4 km (4 mi) long with an average relief of 12 m (40 ft). The ice at the margin was very thin, barely covering the south end of the esker complex. An ice tongue remained in the main Chenango valley south to Chenango Forks. Meltwater flowed westward from the region of the esker to the ice tongue. With continued retreat meltwater flowed in the main Chenango valley adjacent to the ice and deposited the kame terrace noted at mile 20.2 in the road log.

Margins 4 and 5. The kame field and kame terraces northeast of Brisben were deposited as the upland ice retreated to margin 4. During retreat to margin 5, the terminus of the valley tongue was just south of Oxford Station. Large amounts of sand and gravel surrounded the stagnating blocks of ice and formed a valley plug that served as a dam and controlled base level for deposition of the Lynk delta (STOP 3) and the Emerson delta (STOP 7).

Margin 6. During the retreat of the ice to margin 6, the valley plug south of Oxford still dammed the valley, creating a large lake and the temporary base level for the streams lateral to the ice. The ice tongue extended several miles south of Norwich and a lake extended south to the valley plug. The presence of this lake is substantiated by well data, indicating greater than 91 m (300 ft) of clay with sand and gravel. A well for the Norwich Pharmaceutical Company reveals gravel between 0 and 6 m (20 ft) and silt and clay to bedrock at 93 m (305 ft). Figure 6, a longitudinal profile of the Chenango River valley, has the thickness of sand and gravel plotted for the field trip area. The R following a well depth indicates depth to bedrock.

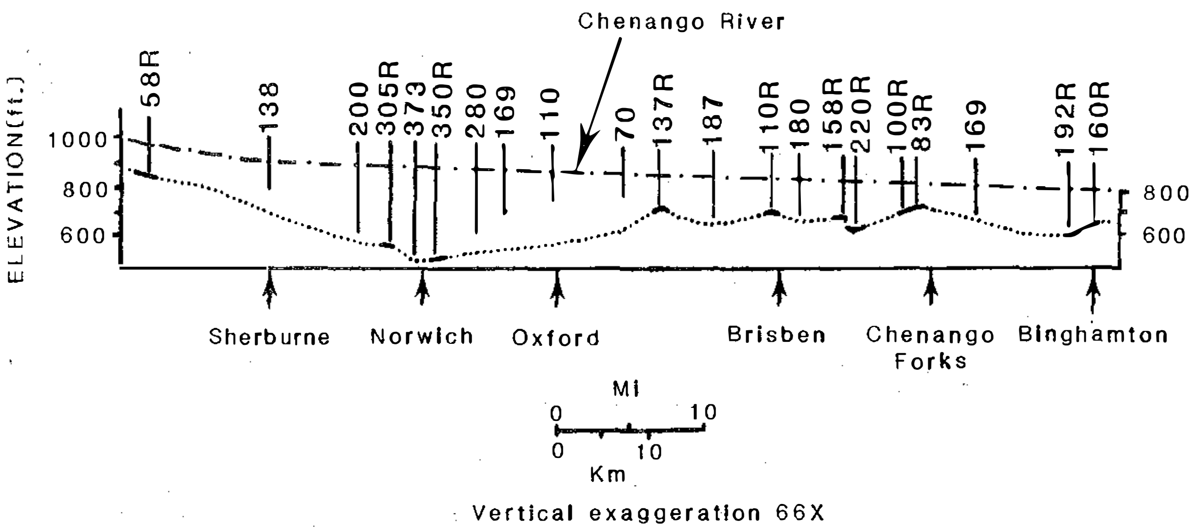


Figure 6. Longitudinal profile of the Chenango River. The dotted line is the inferred depth to bedrock in feet.

Margin 7. During the development of this margin,meltwater was flowing from the active ice margin through a zone of stagnating ice, to a moat or ice-dammed lake that developed at North Norwich. Major meltwater flow was along the western side of a nunatak, the prominent isolated hill north of Norwich, and transported fine-grained sands (1.93ø, 0.233mm) into a supraglacial ice-dammed lake. These sediments will be seen at STOP 6 in the field trip. It is suggested that an englacial empoundment of water was present beneath the supraglacial lake. The englacial pond drained, causing collapse of the supraglacial pond. This collapse caused dis-orientation of blocks of frozen (?) sediments as they dropped into the englacial void. Unconsolidated or unfrozen sediment was then deposited en masse, as a unit surrounding the blocks producing a massive (unstratified) unit. The lake refilled while remaining shallow, with formation of current ripples above the massive zone. For further discussion of the development of this lake,see Cadwell, 1974.

Deglaciation continued to the north of the Valley Heads Moraine, permitting some of the lakes to the northwest to drain through the Mohawk and Hudson Rivers. The ice then readvanced to the late Woodfordian Valley Heads moraine. Associated with this margin are thick valley-train deposits infilling the Chenango River valley.

REFERENCES CITED

Aber, James S., 1978, Erratic-rich drift in the Appalachian Plateau: its nature, origin and conglomerates: Ph.D. dissertation (unpub). University of Kansas, 115 p.

Brigham, A.P., 1897, Glacial flood deposits in the Chenango Valley: Geol. Soc. America Bull., v.8, p. 17-30.

Cadwell, D.H., 1972, Glacial geology of the northern Chenango River valley: New York State Geological Association Guidebook, 44th Annual Meeting, p. D1-D14.

____________, 1973a, Glacial geology of the Chenango River valley near Binghamton, New York, in Coates, D.R., ed., Glacial geology of the Binghamton-Catskill region: Contribution #3, Publications in Geomorphology, SUNY Binghamton, N.Y., p. 31-39, 77-80.

____________, 1973b, Lake Wisconsinan deglaciation chronology of the Chenango River valley and vicinity, N.Y., Ph.D. dissertation, (Unpub.), SUNY at Binghamton, N.Y., 102 p.

____________, 1974, Jokulhlaup lakes on existing glaciers as an aid to interpretation in Pleistocene stratigraphy, in Mahoney, W.C., ed., Quaternary environments: Geographical Monographs, v. 5, p. 137-152.

____________, 1975, Stratigraphic implications of the sequence concept of glacial retreat in south-central New York (abs.): Geol. Soc. America Abstracts, v. 7, n. 1, p. 36.

____________, 1978, Bedrock control of ice marginal positions in central New York: Geology, v. 6, n. 5, p. 278-280.

Coates, D.R., 1963, Geomorphology of the Binghamton area: New York State Geological Association Guidebook, 35th Annual Meeting, p. 98-113.

Connally, G.G., 1960, Heavy minerals in the drift of western New York: Proc. Rochester Acad. Sci., v. 10, p. 241-267.

____________, 1964, The Almond moraine of the western Finger Lakes region, New York: Ph.D. dissertation, (Unpub.), Michigan State University.

Denny, C.S., 1956, Wisconsin drifts in the Elmira region and their possible equivalents in New England: Am. Jour. Sci., v. 254, p. 82-95.

Denny, C.S., and Lyford, W.H., 1963, Surficial geology and soils of the Elmira-Williamsport region, New York-Pennsylvania: U. S. Geol. Surv. Prof. Paper 379, 60 p.

Fairchild, H.L., 1932, New York moraines: Geol. Soc. America Bull., v. 43, p. 627-662.

Fisher, D.W., Isachsen, Y.W., and Rickard, L.V., 1970, Geologic map of New York State: New York State Museum and Science Service, Map and Chart Series 15.

Hollyday, E., 1969, An appraisal of the groundwater resources of the Susquehanna River basin in New York State: U. S. Geol. Surv. Open File Report, 52 p.

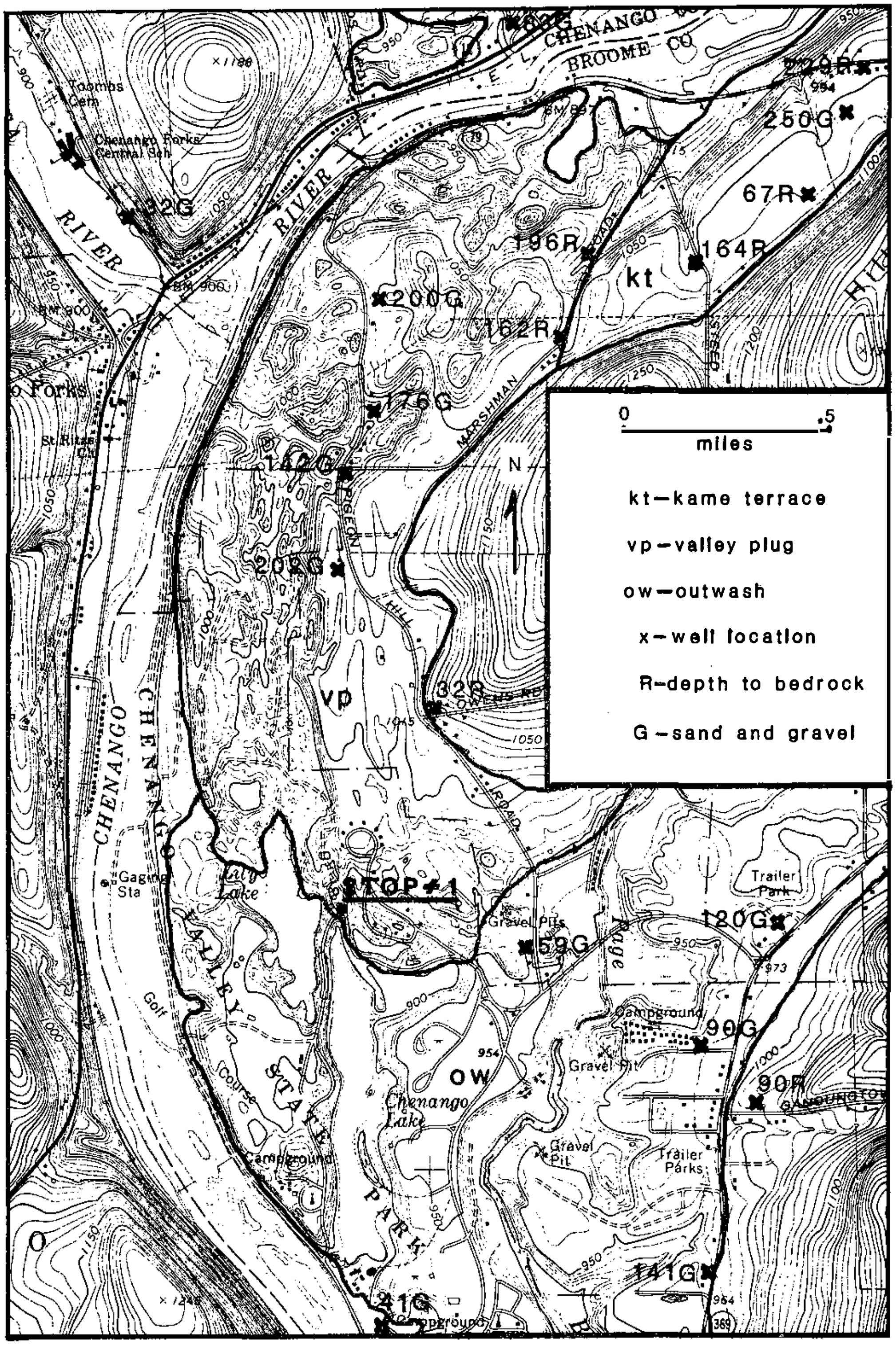
Krall, D.B., 1977, Late Wisconsinan ice recession in east-central New York: Geol. Soc. America Bull., v. 88, p. 1697-1710.

MacClintock, P., and Apfel, E.T., 1944, Correlation of the drifts of the Salamanca reentrant, New York: Geol. Soc. America Bull., v. 55, p. 1143-1164.

Moss, J.H., and Ritter, D.R., 1962, New evidence regarding the Binghamton substage in the region between the Finger Lakes and the Catskills, New York: Am. Jour. of Sci., v. 260, p. 81-106.

Peltier, L., 1949, Pleistocene terraces of the Susquehanna River: Pennsylvania Geol. Surv. Bull., G. 23, 4th Series, 158 p.

Tarr, R.S., 1905, Drainage features of central New York: Geol. Soc. America Bull., v. 16, p. 229-242.



STOP 1. Chenango Valley State Park and vicinity.

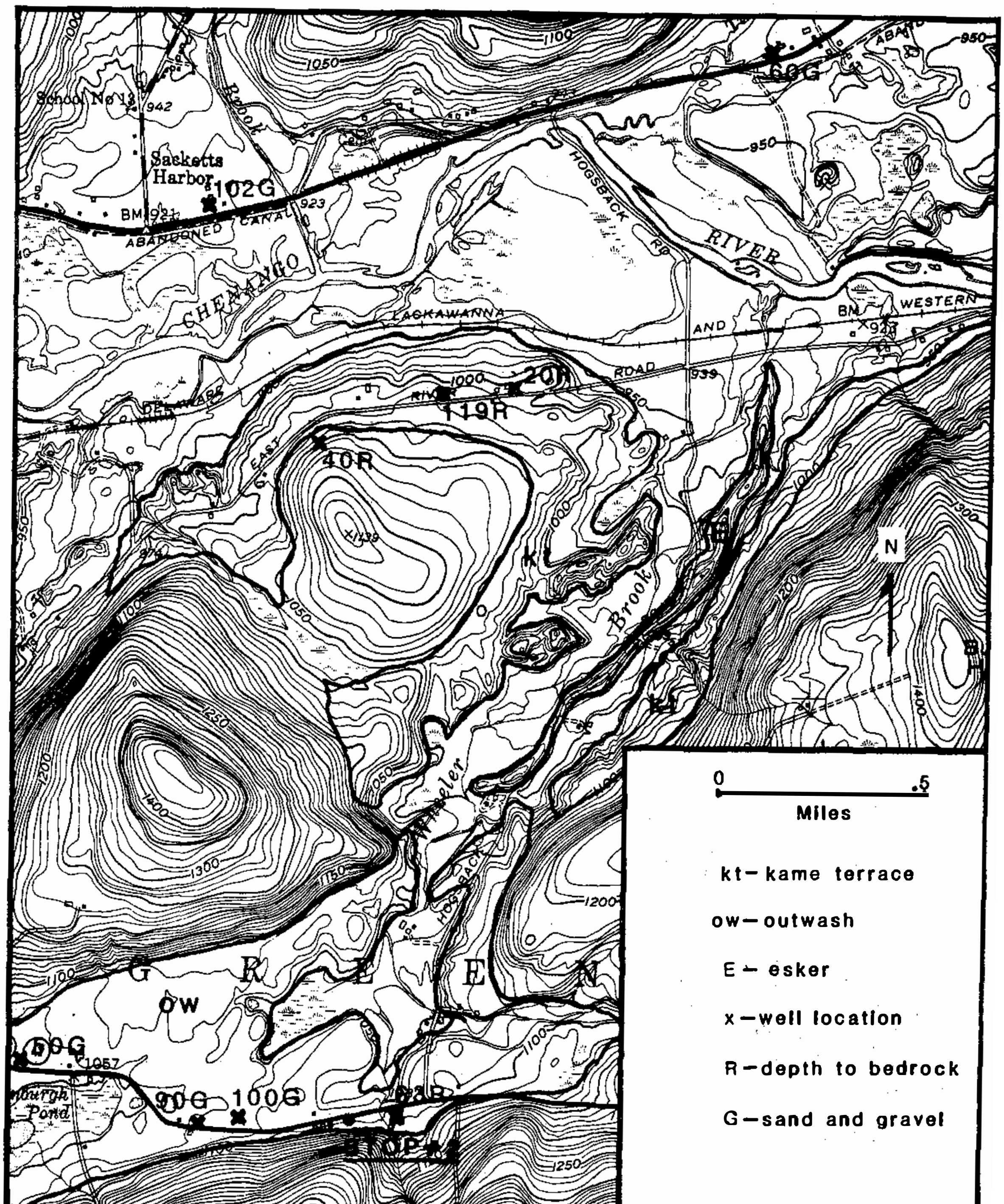
FIELD-TRIP ROAD LOG AND ROUTE DESCRIPTION FOR GLACIAL GEOLOGY OF THE CHENANGO RIVER VALLEY

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
0.0	0	This road log begins at the entrance to the SUNY Binghamton campus. Proceed west on Route 434.
0.2	0.2	Bear right on Route 201 N.
0.7	0.5	Cross over Susquehanna River.
1.0	0.3	Go around traffic circle and continue north on Riverside Drive West.
1.9	0.9	Junction Route 17. Proceed east on Route 17.
3.7	1.8	View south across Binghamton. Binghamton is built on outwash sands and gravels greater than 50 ft (15 m) thick.
5.1	1.4	Junction Rt. 81. Proceed east on 81 and 17.
5.9	0.8	Exit at N.Y. Route 7 North. Proceed north on Route 7N.
7.9	2.0	Note kame terrace to right.
9.0	1.1	Outwash sand and gravel exposed in the kame terrace.
9.4	0.4	Route 7 rises onto kame terrace at Hillcrest.
10.0	0.6	Route 7 becomes Route 88.
11.9	1.9	Exit Route 88 to Route 369. Turn left (north) on 369. Note gravel pits in sand-and-gravel outwash to the left of Route 369 as you proceed north.
14.2	2.3	Kame is on left.
15.8	1.6	Turn left toward entrance of Chenango Valley State Park.
16.5	0.7	Entrance to Chenango Valley State Park. STOP 1.

STOP 1. CHENANGO VALLEY STATE PARK

All of the glacial features preserved in this park were formed at the retreating Woodfordian ice margin. Massive amounts of sand and gravel was deposited around disintegrating blocks of ice (Refer to the topographic map of the state park and vicinity). These horizontally stratified sands and gravels are at least 200 feet (61 m) thick. An ice-channel filling is preserved between Lily and Chenango Lakes. The pebble lithologies are 10 percent limestone; 75 percent local siltstone, sandstone and shale; and 15 percent exotics (from outside the Chenango River drainage basin).

		Return to entrance of the park, then proceed to the left onto Pigeon Hill Road.
16.6	0.1	Note the sand pit to the left. These sands were deposited in relatively quiet water adjacent to stagnating ice in the Page Brook valley. Meltwater was flowing from the north.
17.5	0.9	Meltwater channel. The sand and gravel here is at least 175 ft (53 m) thick.
18.0	0.5	Note large kettles in outwash gravels.
18.8	0.8	Junction with Route 79. Proceed to the right (north). A radiocarbon age date of 16,650 $\pm$ 1800 yBP was obtained from wood at the base of a kettle to the right, over the hill.
20.2	1.4	Turn left onto unnamed road, toward Greene. This kame terrace has at least 250 ft (76 m) of sand and gravel.
20.4	0.2	Enter Chenango County. This road is on a large kame terrace built when an ice tongue occupied the Chenango Valley. The sand and gravel is at least 196 ft (60 m) thick.
24.7	4.3	A gravel pit to the right (up the road) has outwash gravels. An ice tongue occupied the main valley as meltwater flowed from the ice margin to the east. The lithologies present are 4 percent limestone, 76 percent locals, and 20 percent exotics.
25.9	1.2	Enter Greene.
26.5	0.6	Junction with Routes 41 and 206. Turn right (east) onto Routes 41 and 206. Proceed across the kame terrace.
27.7	1.2	View across meltwater channel and outwash gravels. These sands and gravels are as much as 100 ft (30 m) thick.



STOP 2. Wheeler Creek ice-channel filling (esker).

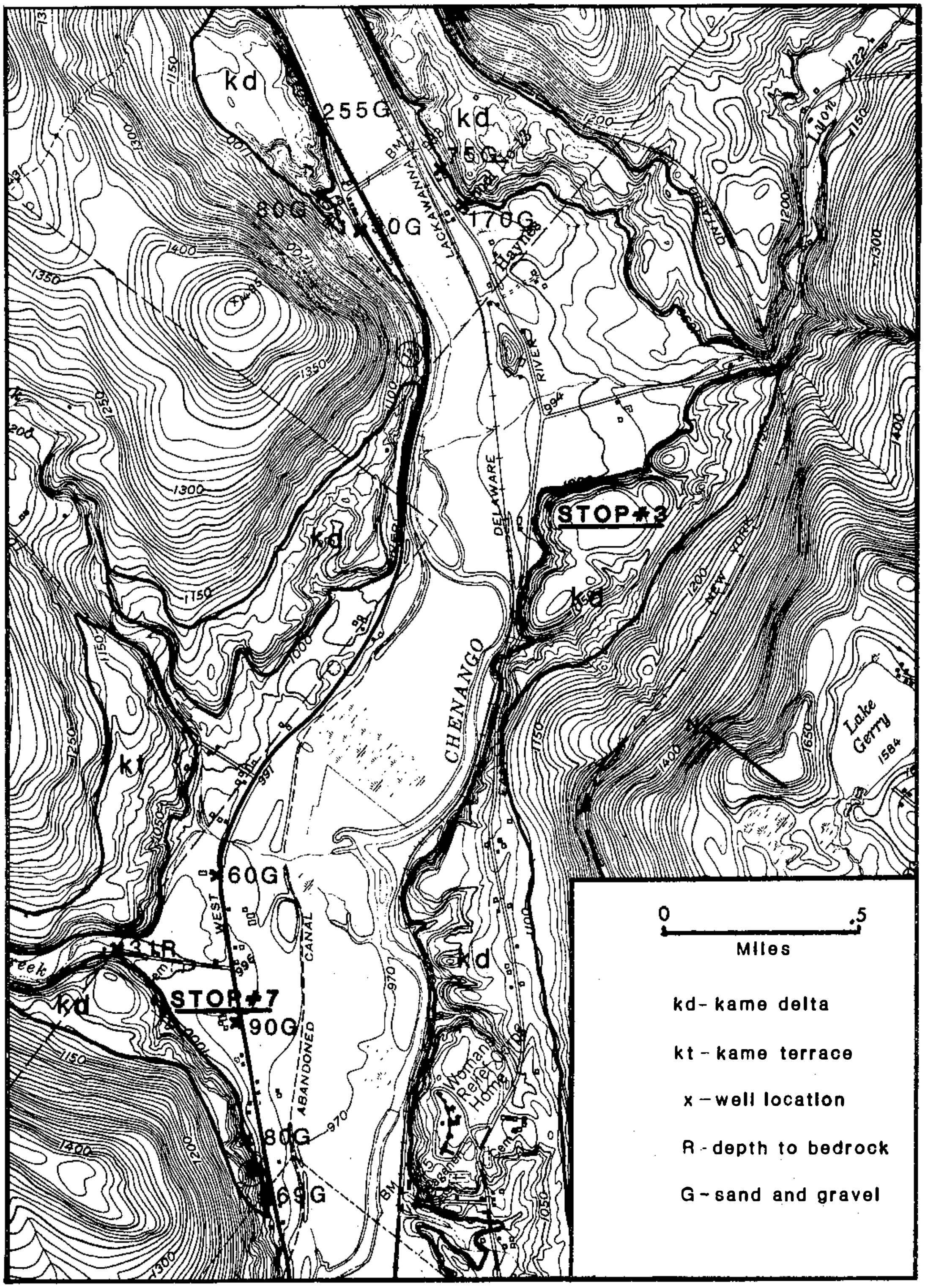
29.9	1.2	STOP 2. WHEELER CREEK ESKER

STOP 2. This will be a brief stop to discuss the formation of the Wheeler Creek esker (Refer to the topographic map). A thin ice margin was located at this point. Meltwater flowed westward from this margin toward the main Chenango Valley. The kame terraces and the esker were deposited adjacent to and beneath the ice, respectively.

		Proceed east on Routes 41 and 206.
30.0	0.1	Turn left onto Hogsback Road.
30.7	0.7	The esker can be seen on the left as you descend from the kame terrace. Meltwater flow was to the south.
31.0	0.3	Road is located on the crest of the esker.
32.0	1.0	Junction with East River Road. Turn right (east).
34.6	2.6	Turn left toward Route 12 (across bridge).
34.8	0.2	Junction Route 12. Turn right (north). Proceed north on Route 12.
40.1	5.3	Note the massive hummocky topography (valley (plug) on the east side of the valley. This sediment and ice served as a base-level control for deposition to the north. The significance of this will be discussed at STOP 3.
42.8	2.7	Traffic light, center of Oxford. Turn right on Route 220. Cross Chenango River.
43.1	0.3	Bear left on 220.
43.6	0.5	Turn left, toward Vets Home, on County Route 32. This road is on top of a large kame terrace.
45.7	2.1	STOP 3. LYNK DELTA

STOP 3. The Lynk Construction Company removes sand and gravel from this large delta/lacustrine complex. Meltwater was flowing from the east along Lyon Brook and sedimentation occurred in a lake adjacent to an ice tongue. Note the planar-surfaced features to the north. The elevation of all these features was controlled by the valley plug noted at mileage 40.1. The lithologies present are: 20 percent limestone, 52 percent locals, and 28 percent exotics.

		Proceed north on county Route 32.
46.6	0.9	Note pit in kame delta to the right.



STOP 3 and STOP 7. Lynk and Emerson kame deltas. These kame deltas were constructed adjacent to an ice tongue in the Chenango River valley.

50.4	3.8	Cross alluvial fan. The thickness of drift in the valley is at least 350 ft (107 m).
52.2	1.8	Intersection with Route 23. Proceed north on county Route 32 (straight through).
53.4	1.2	Junction Route 320. Turn right (east) on Route 320.
58.0	4.6	Turn left onto dirt road. Entrance into the Whapanaka State Forest.
59.5	1.5	STOP 4. WEDGE OR POP-UP?

STOP 4. Walk up into the bedrock quarry. This pit is used by the state for maintenance of the roads. The face of the exposure is oriented N20E along one of the joint planes. The wedges are developed along N75W. One wedge is well developed. Two others are partially developed. The wedges persist for at least 3 ft. to the east.

		Return to Route 320.
61.0	1.5	Turn right onto Route 320 (south).
65.6	4.6	Junction with Route 32. Turn right (north) onto Route 32.
68.3	2.7	STOP 5.

STOP 5. Picture stop of kame terrace. When this kame terrace was deposited an ice tongue occupied the main Chenango valley. Note kame delta on the west side of the valley.

70.1	1.8	Junction Route 12. Turn left onto Route 12 and cross the Chenango River.
70.7	0.6	Bear right toward North Norwich.
70.9	0.2	Bear right toward North Norwich.
71.0	0.1	Turn right on N. Main Street.
71.3	0.3	STOP 6. CHENANGO COUNTY SAND PIT

STOP 6. The exposure in this pit illustrates lake sands, silts,and clays, with current-ripple laminations. Several years ago exposures in this pit had a section beneath the well-stratified lake sands. In this lower section are examples of strata with vertical bedding; horizontal bedding that abruptly ceased into an unstratified zone; and cross-bedded sands with inclinations of up to 85 degrees. The lithologies present include: 18 percent red sandstone, 25 percent limestone, 42 percent locals, and 15 percent exotics.

It is hypothesized that a supraglacial lake developed with deposition of the lower sands. The lake abruptly drained causing frozen blocks of sediment to be rotated. Sedimentation continued around the rotated blocks depositing the ripple-drift sediments.

		Return to N. Main Street, turn left (south), proceed straight through North Norwich.
72.0	0.7	Junction Route 12. Proceed to the right (south) on Route 12.
73.2	1.2	Kame delta on right, with foreset beds dipping to the South.
76.2	3.0	Intersection Route 320. Proceed south on Route 12. Note exposure in kame terrace on right.
77.3	1.1	Junction Route 23. Proceed south on Route 12.
81.7	4.4	Good exposure in kame delta.
84.4	2.7	STOP 7. EMERSON PIT

STOP 7. This kame delta illustrates the variety of sediments and orientations in a delta deposited adjacent to an ice tongue. Refer to the topographic map for STOP 3.

		Proceed south on Route 12.
85.7	1.3	Intersection Route 220 in Oxford. Proceed south on Route 12.
86.7	1.0	Note ice contact kame delta to right. <u>Stop</u> if you have time.
88.0	1.3	View to the left (east) of valley plug that controlled the elevation of the deltas examined at STOPS 3 and 7.
93.6	5.6	Brisben.
99.3	5.7	Light at junction Route 206, Greene. Proceed south on Route 12.
100.7	1.4	View to left (east) to outwash units associated with Wheeler esker (STOP 2).
106.1	5.4	View east to Chenango Valley State Park area.
106.7	0.6	Enter Broome County.
107.3	0.6	Junction Route 79. Turn right (north) on 79.

109.1	1.8	STOP 8. TILL

STOP 8. The drift in this valley includes Olean-type till, Binghamton-type stratified units, and thick lacustrine clays. These units are interspersed between bedrock outcrops. Rotational slump blocks develop by a process of piping in the silt and clay beds.

		Turn around and proceed south on Route 79.
110.9	1.8	Junction Route 12. Turn right, proceed south on Route 12.
113.5	2.6	Good view to the south of Chenango River valley.
117.4	3.9	Junction Route 11. Proceed south on Route 12.
117.5	0.1	Entrance ramp to Route 81 south. Proceed south on Route 81.
120.7	3.2	Junction Routes 81 and 17. Bear right onto Route 17 (west).
123.9	3.2	Exit at Route 201 south (exit 70S). Proceed south on Route 201.
125.6	1.7	Junction Route 434. Follow signs to SUNY campus.
125.8	0.2	Entrance to SUNY-Binghamton.