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GUIDEBOOK

S. U. N. Y. BROCKPORT and MONROE COMMUNITY COLLEGE

Guidebook to Field Trips

45th Annual Meeting - September 28-30, 1973

Rochester, N.Y. Area

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PREFACE

In preparing this guidebook the basic premises accepted were that simplicity was to be primary and maximum flexibility of style and opinion would be maintained.

Therefore, the editor made no attempt to alter any author's style or opinion. In this way, of course, the editor's task became easier. All that remained was to do the usual proofing, make minor changes and prepare the parts as a whole. Even this task was simple since each field trip is a whole unit and the guidebook merely a collection of field trip descriptions.

If the trips and the meeting are successful it is because of the efforts of many people; the contributors, my patient faculty and students, my secretary and many others including Mrs. Marion Cassie who designed the cover. My thanks go to them and most particularly to Thomas X. Grasso of Monroe Community College who is my co-host.

We hope you will enjoy the trips and the many different styles in this book.

Philip C. Hewitt
Editor

INTRODUCTION

The geology of the Rochester area involves some intriguing problems. These are primarily based in the fields of paleontology and stratigraphy, glacial geology and geomorphology, mineralogy and other related subfields. A simple way to describe the geology as a whole is that it involves Lower Paleozoic (Ordovician to Devonian) sedimentary rocks veneered by dissected glacial deposits.

Although a few minor folds appear and the area displays a small number of faults, this is not the easiest place in which to observe structural geologic features. Nor will one find igneous or metamorphic rocks in place here. Rather they can only be seen as erratics from glacial deposition. It is obvious therefore, that the field trips selected for our area involve the type of geology which is so plentiful and well exposed here.

The emphasis for each trip is to teach. The method or style used by the field trip leaders may differ but the intent is the same. In every case the student is the person for whom the trips were planned and for whom the papers were written. The only assumption that is made is that the student has had at least a few courses in geology and will be able to follow the basic concepts involved.

The oldest rocks exposed in this area are of the late Ordovician and are found in the "Rochester Gorge" of the Genesee River Valley. Most of the rocks exposed at the surface in the northern part of the area (south of Lake Ontario) are Silurian in age. Knowing that the strata dip generally to the south it is obvious that younger strata will appear in the southern part of the region. Therefore, Devonian beds are exposed south of Rochester. Erosion by streams and ice and subsequent deposition by glacial action represent the most obvious later events following post-Paleozoic uplift. Yet weathering and erosion continue to leave their mark - erosion by humans shows strongly.

All field trips have been designed to add to the brief outline above. The mineralogic visit to the Penfield Quarry is placed in context with the stratigraphy and general geology of the Rochester area. At Hamlin Beach recent sedimentation will be observed - though no precise details can be given in this guidebook for that locality. Recent water levels and strong wave action have altered the entire picture there. No one can predict what conditions will be like at the time of the trip. We shall have to wait and see.

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TRIP I. (Continued)

Trip A

GLACIAL GEOLOGY OF THE WESTERN FINGER LAKES REGION

Victor E. Schmidt
State University College at Brockport

Note: This trip and discussion are designed primarily for undergraduate students, rather than for specialists in glacial geology -- who are, nonetheless, most welcome.

An attempt, however imperfect, is made to distinguish observations from inferences, hypotheses, and speculations based on these and other observations.

The number of proposed stops is probably greater than time will allow, and so selection will be made on the basis of weather conditions and the interests of the group.

Route:

Leave Rochester, 8:00 AM. Take Rt 15A south, through Henrietta, Rush, and Lima, to Hemlock.

At Rush, Rt 15A crosses westward-flowing Honeoye Creek, carrying water from three of the western Finger Lakes to the Genesee River, which flows northward to Lake Ontario.

At Sibleyville, 1.3 mi from Rush, the route crosses a broad, swampy, flat-bottomed valley, interpreted as a glacial drainage channel which carried a river of glacial meltwater eastward, along the front of the glacier. (If time permits, a slight detour via Phelps Rd and Wagner Rd will allow a better view.)

Directly west of Honeoye Falls, 3.6 mi from Rush, is an outcrop of Middle Devonian Onondaga limestone, the formation over which Honeoye Creek falls at Honeoye Falls.

Long, streamlined hills--typical drumlins--parallel the route; the road goes over several, and a large one can be seen to the west, from approx 4 mi south of Lima.

South of Hemlock, leave Rt 15A and take Rt 20A east. Rt 20A ascends the east side of Hemlock Valley. Then it crosses a field of drumlins, many of them wooded, at about 1200 ft.

Scale 1:250,000

5 0 5 10 15 20 25 Miles

5 0 5 10 15 20 25 30 35 Kilometers

5000 0 5000 10000 15000 20000 25000 30000 35000 Yards

CONTOUR INTERVAL 100 FEET

DATUM IS MEAN SEA LEVEL

Stop 1

Rt 20A between Hemlock and Honeoye, 2.5 mi east of jct with Rt 15A. (Bus to let group off on left side of road, opposite bedrock exposure; then to wait on left side of road beyond road cut ahead.)

Bedrock exposure:

Shale of the Sonyea Group, Upper Devonian. Note bedding, joints, and concretions. Are there any fossils?

Questions:

How resistant is this shale to weathering? How resistant would it have been to glacial abrasion; to glacial plucking?

Road cut:

Cut in the south end of a drumlin. An unsorted mixture of rock material, from clay-size to boulders. Much dark gray shale and clay. Many exotic rocks. Many stones show scratches.

Exotic stones: (Possibly groups determine percentages)
Composition - crystallines___: red sandstones___:
limestones and dolomites___: others___%
Shape - well rounded___: subrounded___:
subangular___: angular___%
With scratches___%

What is the fabric of this material, if any? (Possible demonstration.)

Inferences:

The material is lodgment till which includes much ground-up and broken-up "local" shale. This till was deposited beneath an actively moving glacier. Well rounded, yet scratched, pebbles represent glacially transported and abraded streambed or lakeshore gravel.

The drumlins were formed by the "plastering" of till on bedrock. Their streamlining is a result of shaping by delicate adjustment of deposition and erosion (re-erosion?) to such conditions as load, velocity, pressure, and temperature of the bottom ice.

Route continued:

Stay on Rt 20A, which descends the west side of Honeoye Valley. At Honeoye, leave Rt 20A and turn south on West Lake Rd (County Rd 36).

Honeoye Lake, one of the smallest Finger Lakes, drains northward into the Genesee River. Deltas show on both sides of the lake; the largest, California Point, on this side, has a trailer "park".

How does the spacing of the cottages appeal to you?

Stop 2

West Lake Rd, 4.6 mi south of Honeoye. (Bus to stop on old road.)

View:

South end of Honeoye Lake. Steep valley sides; no roads descend the slopes here. Small streams in steep gullies marked by dark conifers. One of these streams goes under the road, nearby.

Briggs Gully, a bedrock gorge directly across the lake, descends 700 ft in approx 2 mi. At its lower end is a gently sloping area, underlain by gravel, which extends into the lake.

South of here, Honeoye Valley shows an interesting cross-profile which makes a sharp break with the upland surface on either side. Is this cross-profile a catenary curve? How does one tell?

Compact lodgment till is exposed in the bed of the small gully nearby. Exotic boulders of augen gneiss, anorthosite, etc.

Inferences:

Honeoye Valley was originally a preglacial stream valley, later deepened and steepened as a result of glaciation. It was affected by glacial abrasion, plucking or quarrying, and possibly also by frost wedging beneath the glacier and ahead of it. In addition, there probably was considerable erosion by meltwater. Undoubtedly the valley was subjected to, not a single glaciation, but repeated glaciations - both advances and retreats.

The small streams which flow down the steep slopes are consequent streams. They developed in consequence of a "new" land surface that resulted from glacial erosion of the preglacial valley. Hence these streams are postglacial consequents.

Briggs Gully was formed as a result of a great increase in the erosive ability of the creek in descending from an upland valley, at nearly the preglacial level, to the level of the present lake. It joins a hanging valley, at about 1700 ft., with the glacial trough of Honeoye Valley. Hence the gully is postglacial, or interglacial, or a combination of both. Material excavated from the gully has been, and is being, deposited in a combination alluvial fan and delta at the base. This adjoins the delta at the head of the lake.

Route continued:

Proceed southward, through Hunt Hollow.

The steep slopes of the glacial trough and the postglacial consequents show well. The rock slides may be due to cutting timber.

At Hunt Hollow note the knobby hills, and the flat-floored, swampy channel, containing ponds, in the valley bottom.

HONEOYE LAKE
RICHMOND
drumlins
Canadice Corners
School No. 1
Gulick
Canadice
one mile
a postglacial consequents
b postglacial (and/or interglacial?) gorge
c hanging valley
d fan-delta
e delta
f wall of glacial trough

Stop 3

West Lake Rd, approx 12.7 mi south of Honeoye, 0.1 mi west of jct with French Hill Rd. (Bus to park on shoulder, or on French Hill Rd.)

Road cut and hillside:

Gravel and sorted sand. Many pebbles, especially exotics, are well rounded. Many are scratched, including some that are well rounded. Are there any indications of the direction of water flow?

Knobby hills, with "dimples", similar to the hilly topography in Honeoye Valley between Hunt Hollow and here.

The hilltop affords an overlook of the flat-floored, swampy channel noted previously along the road northwest of here. This channel curves around the far side of the wooded hill ahead (SSW). The topographic map (Naples, 7.5') shows the relationship clearly. Almost the same situation occurs about 0.5 mi to the east.

In the distance are high bedrock hills: Hatch Hill (ESE), above Naples, at 1800+ ft; Knapp Hill (SE) at 2040+ ft; Pine Hill (S) at 2040+ ft; unnamed hill (SSW) above Atlanta, at 2012 ft. Valleys between these hills include: Canandaigua Valley, south end between here and Hatch Hill; Cohocton Valley, north end between Pine Hill and the hill above Atlanta; North Cohocton-Dansville Valley, east end this side of the hill above Atlanta.

At the junction of these valleys is a large area of knobby topography. Much higher and nearer is a flat-topped gravel terrace.

Inferences:

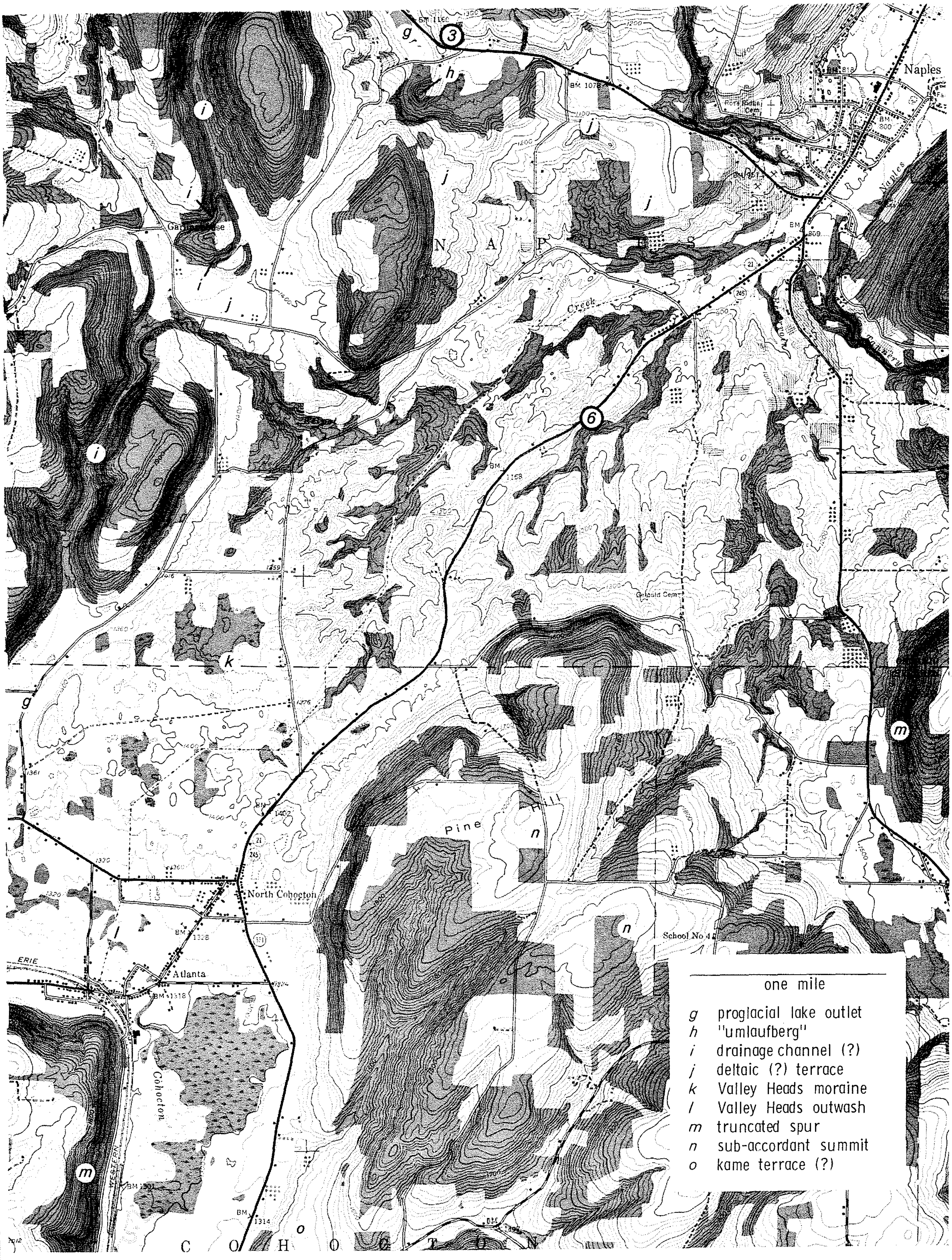
The material in the road cut is morainic. Much of it, at least, was deposited by meltwater, possibly in standing water of an ice-margin or proglacial lake. The knobs and "dimples" on the hillside represent a constructional slope of the moraine.

The flat-floored channel is the spillway of a proglacial lake, at 1140+ ft, in the Honeoye Valley. The wooded hill ahead is a "run-around hill" or umlaufberg - probably a knob of bedrock isolated by the proglacial lake overflow when its former course was blocked on this side by ice or morainic material.

Route continued:

Go eastward, descending into Naples, at the southwest end of Canandaigua Valley. Continue northward on Rt 21 through Naples; then bear left on Bristol Springs Rd (County Rd 12).

West of Naples, at the mouth of Grimes Gully, D. D. Luther found the "Naples Tree" in 1882. This is the "trunk" of a lycopod or club moss, 16½ ft long, of Upper Devonian age, now on display in the New York State Museum in Albany.



Naples
North Cohocton
Atlanta
Pine Hill
School No 4
Cohocton
C O H O C T O N
one mile
g proglacial lake outlet
h "umlaufberg"
i drainage channel (?)
j deltaic (?) terrace
k Valley Heads moraine
l Valley Heads outwash
m truncated spur
n sub-accordant summit
o kame terrace (?)

Stop 4

Bristol Springs Road (County Rd 12) 2 mi north-northeast of Naples, 1.5 mi north of jct with Rt 21. (Bus to stop on east side of road).

Overlook: (at vineyard of Mr. David Gentner)

South end of Canandaigua Lake, with Parish Flat and West River Valley. West River, flowing from the northeast, makes a barbed junction with northward-draining Canandaigua Valley.

Small postglacial consequent streams descend the steep sides of the valleys in small ravines, marked by dark conifers.

Parish, or Conklin, Gully (SE) is a bedrock gorge, with a gravel pit near its base. The gorge ends at a broad, semicircular area of gently and uniformly sloping farmland.

Inferences and comments:

The barbed junction of West River Valley and Canandaigua Valley supports the concept of ancient south-flowing consequent drainage of this region, later reversed as a result of stream capture or the blockage of valleys by glacial deposits. Fairchild inferred that, during Tertiary times, the Canandaigua Valley drained into the west-flowing Dansville River; at the present site of Sonyea this joined the obsequent, north-flowing Genesee River, and then continued northward to the subsequent Ontarian River (1926, p. 224 and Plate 84).

Parish Flat is a modern delta deposited at the head of Canandaigua Lake. The gentle slope at the base of Conklin Gully is on an alluvial fan. The gravel being excavated near the base of Conklin Gully may be part of a delta built by this stream into a proglacial lake that occupied the valley to this height when drainage to the north was blocked by glacial ice. More likely, it is in a kame terrace built between stagnant ice in the valley and the bedrock side of the valley. There is a bench partway up the valley side along Conklin Gully, but its cause is not known. It may be due to resistant bedrock, or possibly is a higher delta or kame terrace.

Note the attempts by man to "improve" Canandaigua Lake and its environs by bulldozing shale from the slope into the lake, allowing more cottages to be built. Fortunately, this endeavor seems to have been stopped by New York State. But others continue!

Route continued:

Proceed northward to Bristol Springs and Ontario County Park.

Lunch stop coming up.

one mile

a postglacial consequents
b postglacial (and/or interglacial?) gorge
d fan-delta
e delta
f wall of glacial trough
p barbed junction
q alluvial fan
r high-level delta (?)

Stop 5 (Lunch stop)

Ontario County Park, 1.5 mi west of Rt 64 in Bristol Springs. (Bus to stop on road within the Park; group to walk uphill.)

Road from Bristol Springs ascends the west side of Canandaigua Valley. Shale and sandstone of the West Falls Group, Upper Devonian, are exposed, as well as considerable glacial drift.

View eastward:

Appalachian Plateau, dissected by deep valleys. Sub-accordant summit level at approx. 1900-2000 ft.

Highest hill (NNE) is Stid Hill, 2080+ ft. Moderately sharp hill (ENE) is Bare Hill, 1540+ ft, with Canandaigua Valley on this side of it and Vine Valley to the right and beyond it. Like West River Valley, Vine Valley also makes a barbed junction with Canandaigua Valley.

Inferences and question:

The sub-accordant summit level is an erosion surface, considered by Cole to have been reduced below the Upland Peneplain (1938, pp. 194, 196; 1941, p. 148). The main valleys below this surface were deepened by preglacial streams as a result of rejuvenation, and later deepened further by glacial erosion. Is this view valid?

The "Jump-off":

Overlook, at approx 2100 ft, of Berby Hollow, approx 1300-1400 ft at the bottom. This valley contrasts sharply with the upland surface. Its cross-profile approaches a catenary curve.

Berby Hollow contains no major drainage -- only small creeks. Divide area is in the middle distance. Hummocky hills of gravel on the valley floor; some of these have been destroyed.

Question and inferences:

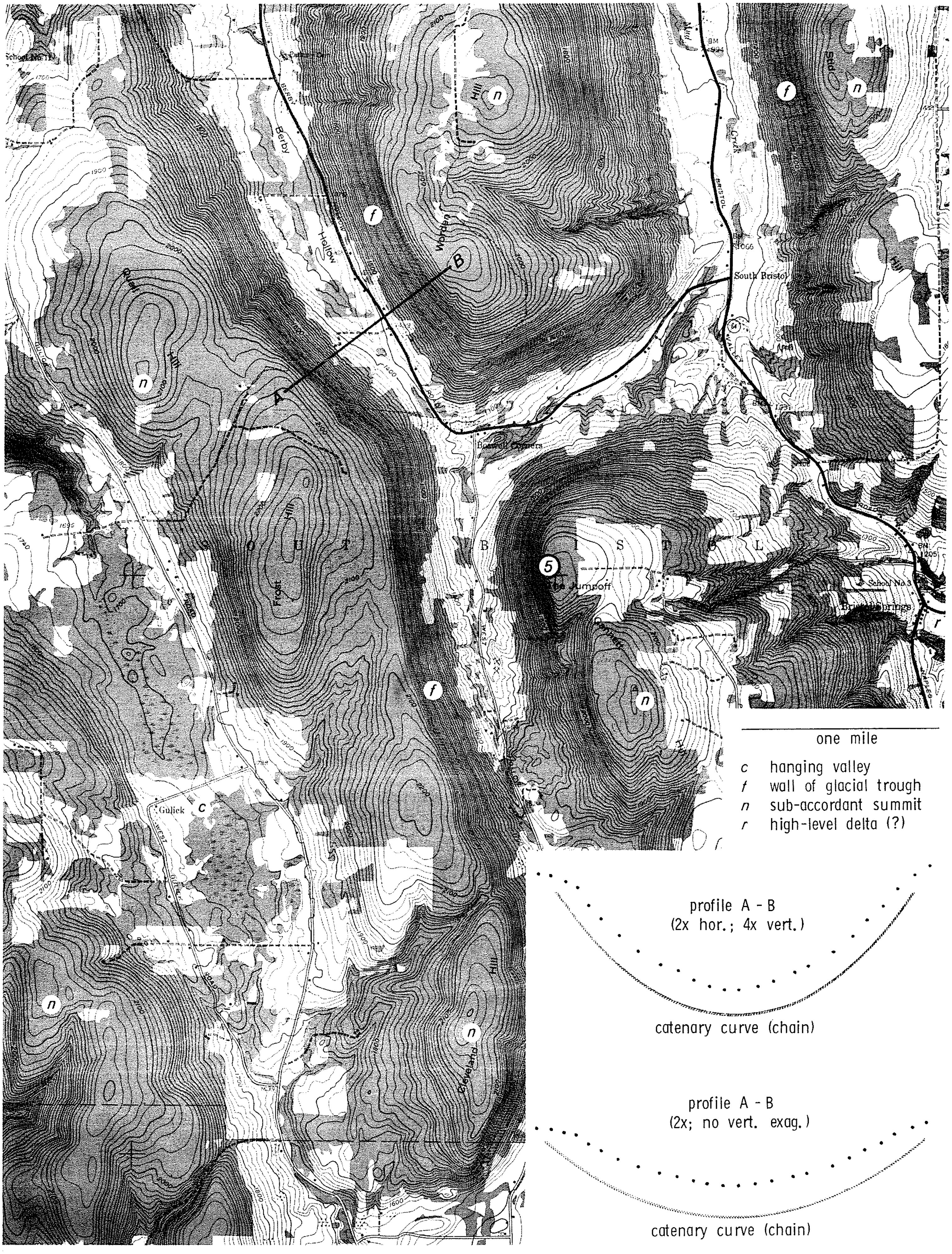
How much of the shape of Berby Hollow is due to preglacial rejuvenation and stream incisement, and how much to glacial erosion?

Gravel hills on the valley floor are ablation deposits let down by the last remnants of glacial ice, probably stagnant.

Exotics in the till here include red sandstone of the Grimsby (Medina), and possibly Queenston, formations. These formations outcrop in a belt passing through Rochester and along the south shore of Lake Ontario, below approx 400 ft. The presence of their fragments here indicates that the ice sheet covering the site of Rochester must have reached a thickness of at least 1700 ft, about 4 times as high as the Xerox Tower in Rochester.

Route continued:

Return to Naples and continue southward on Rt 21.



A
B
f
n
c
r
5
South Bristol
Berby
Hollow
Frost Hill
The Jumpoff
Gulick
Cleveland Hill
S O U T H B R I S T O L
one mile
c hanging valley
f wall of glacial trough
n sub-accordant summit
r high-level delta (?)
profile A - B
(2x hor.; 4x vert.)
catenary curve (chain)
profile A - B
(2x; no vert. exag.)
catenary curve (chain)

Stop 6 (See map on page 7).

Rt 21, 2 mi southwest of Naples, 1.4 mi southwest of jct with Rt 53. (Bus to stop on left side of road, at little hill with power pole.)

Road cut and vantage point:

Unsorted mixture of clay-size to cobble-size material. Many exotic rocks. Limestones, especially, show scratches. Calcareous nodules (concretions?) also occur in the material. The stones consist of -- crystallines____: red sandstones____: carbonates____: local gray siltstones and sandstones____% Approx____% show scratches.

Hummocky topography, with many hollows, covers a large area between bedrock hills, at the junction of the major valleys.

Three terraces visible in distance: largest, wooded (E of N) at 1100-1120 ft; smallest (N) at 1200 ft; highest (NNW) at 1340 ft.

Inferences and questions:

Material in road cut is till, possibly containing much scraped-up proglacial lake clay. Hummocky topography marks an end moraine, probably correlative with similar moraines at the heads of other Finger Lakes valleys, named the Valley Heads Moraine by Fairchild (1926, p. 226 and Plate 88). This moraine was deposited during a several-hundred-year time of balance between forward movement and the backward melting of the ice, during the last general recession. C-14 dates indicate this may have taken place as recently as 12000 years BP. (What are the most recent data?)

What is the origin of the calcareous nodules? How old are they?

The terraces are possibly high-level deltas deposited in three different levels of proglacial lakes occupying this valley while drainage toward the north was blocked by ice. If so, one or more of them may have been deposited by outflow from a proglacial lake in Honeoye Valley. However, these terraces may instead be kame terraces, deposited between stagnant ice and the valley side, possibly ice-margin deltas built by meltwater streams.

Route continued:

Proceed westward and southwestward across the Valley Heads Moraine, toward Atlanta, and then westward on Sawdust Rd (County Rd 36).

Note morainic topography, including kettles. A flat-bottomed channel runs southwestward along the west side of the valley. Fairchild identifies this as the spillway over the moraine of Lake Naples, a proglacial lake in the south end of the Canandaigua Valley (1895, p. 362), presumably post-Valley Heads in age.

Immediately south of the moraine, the route crosses the North Cohocton-Dansville Valley, floored by gravel, probably outwash.

Stop 7

Black Creek Rd, 2 mi west of Atlanta, 0.4 mi south of jct with Sawdust Rd (County Rd 36). (Bus to stop on shoulder, before marsh.)

Blackcrick Hollow:

Steep-walled north-south gorge. Flat, swampy floor south of the divide at 1460+ ft. Bedrock exposed in walls. Alluvial fans at the base of tributary streams.

Inferences and questions:

This is a marginal drainage channel or glacial lake spillway (How does one tell the difference?), formed by meltwater erosion of a preglacial valley or col. (How much lowering of the preglacial divide is indicated? Can this be estimated from the map?)

If this channel is the former spillway of a proglacial or ice-margin lake, presumably in the North Cohocton-Dansville Valley, at 1460+ ft, what kept the lake from escaping through the southward-draining Cohocton Valley? Possibilities include:

a) Stagnant ice blocking the Cohocton Valley at, or south of, North Cohocton and Atlanta.

b) The end of a lobe of ice, possibly the Canandaigua lobe at North Cohocton, or the Keuka lobe at Bath, blocking the Cohocton Valley during or before Valley Heads time.

c) Valley Heads or "advance" Valley Heads end moraine, or even earlier end moraine (Arkport or Almond?), blocking the Cohocton Valley south of North Cohocton.

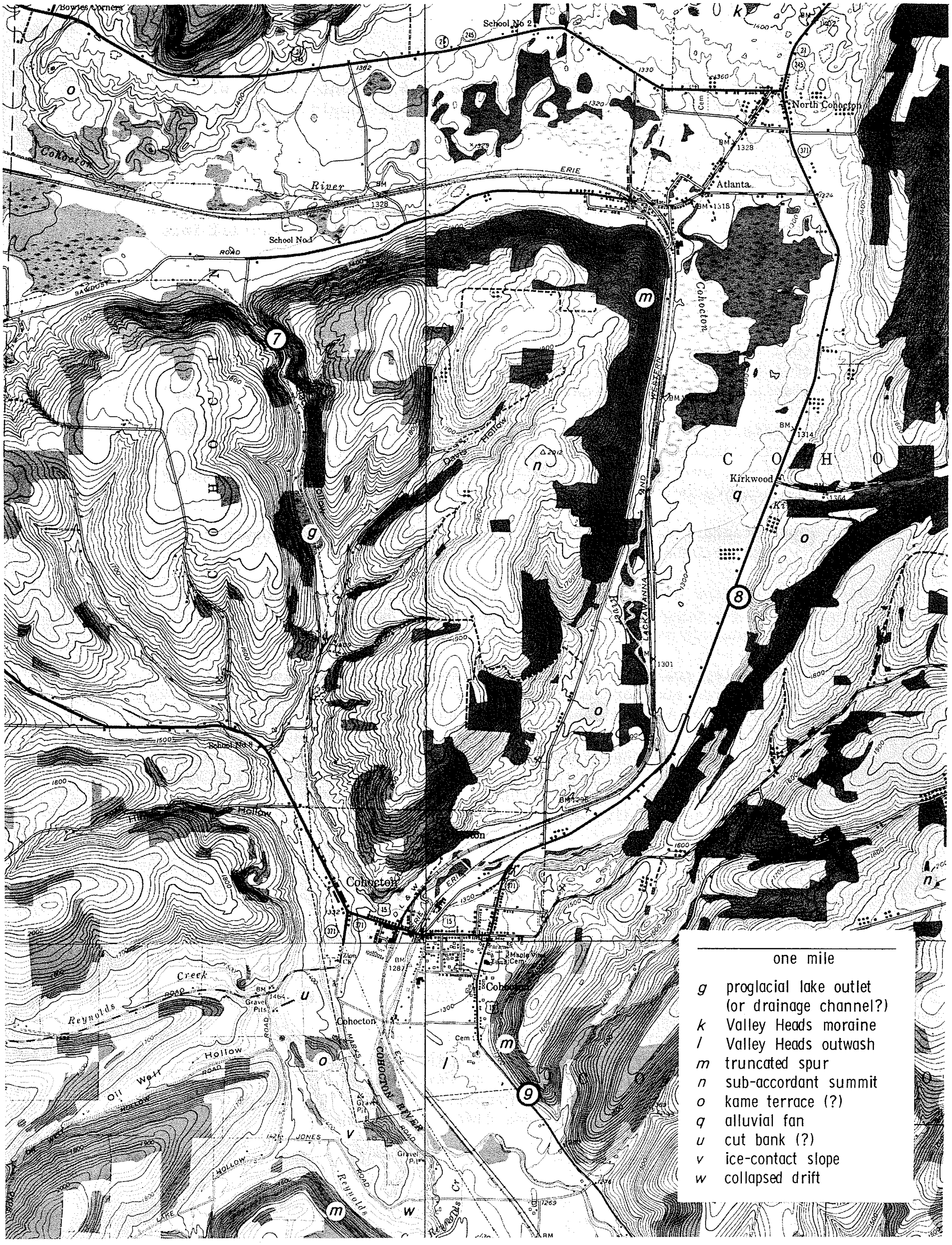
Is it just happenstance that a pitted gravel terrace (kame terrace or delta?) on the north side of the North Cohocton-Dansville Valley, nearly opposite Blackcrick Hollow, attains the same elevation (1460+ ft) as the divide in Blackcrick Hollow?

Route continued:

Keep going south through Blackcrick Hollow to Cohocton.

The Blackcrick Hollow drainage channel or spillway seems to lead toward a series of gravel terraces on the west side of the Cohocton Valley, north, west, and especially south of Cohocton. Some of these attain elevations of 1480+ ft and possibly more.

What is the nature of these terraces? Are they deltas, kame terraces, outwash, or what? Why are there several levels? What caused the concavely curved bank at one level, visible from Loon Lake Rd, Rt 371, just west of Cohocton? Later, if time permits, these features will be seen and discussed.


one mile
g proglacial lake outlet (or drainage channel?)
k Valley Heads moraine
l Valley Heads outwash
m truncated spur
n sub-accordant summit
o kame terrace (?)
q alluvial fan
u cut bank (?)
v ice-contact slope
w collapsed drift
North Cohocton
Atlanta
Kirkwood
Cohocton
School No 2
School No 1
School No 8
Bowles Corners
Davis Hollow
Reynolds Creek
Oil Well Hollow
Cohocton River
7
8
9

Stop 8

East side of Rt 371, 2 mi north-northeast of Cohocton, south of the mouth of Kirkwood Gully.

Terrace and gravel pit: (on property of Mr. Myron Crouch)

Somewhat sorted and stratified "bright" gravel and sand. A great variety of exotic rocks. Pebbles mostly well rounded. Well rounded boulders of resistant crystalline rocks; poorly rounded blocks of local sandstone. Many "ghost" pebbles of weathered carbonates, including cherty Onondaga limestone.

The pebbles consist of -- crystallines___: red sandstones___: carbonates___: local gray siltstones and sandstones___%
They are -- well rounded___: subrounded___: subangular___: angular___% The depth of leaching of the gravel is _____ ft.

The face of the terrace is fairly straight, but shows some "dimples". A similar terrace, with kettles, occurs on the opposite side of the valley, toward the southwest.

Inferences and questions:

The gravel was deposited by energetic meltwater, close to the ice margin. Could it be, in part, an alluvial fan deposited by Kirkwood Creek up against glacial ice in the valley?

Does the terrace indicate an "advance" Valley Heads position (Muller, 1966), or is it pre-Valley Heads in age? Connally considers it to be the easternmost remnant of Arkport Moraine (1964, p. 43). Just how was it formed? Possibilities include:

a) Deposition by meltwater at the margin of an active ice tongue -- an end moraine or lateral moraine, possibly eroded later by meltwater from the Valley Heads ice.

b) Deposition by meltwater between a mass of stagnant ice and the east side of the valley -- a typical kame terrace.

c) Deposition of outwash gravel on top of buried stagnant ice in the central portion of the valley; this later melted out, causing the collapse of the gravel in the central portion, but not here at the side (Rich, 1943, p. 98).

d) Deposition of outwash gravel up to the level of the terrace, followed by dissection by a later meltwater stream, leaving the terrace as a remnant of the former high-level outwash deposit.

Route continued:

Turn and go south on Rt 371 to Cohocton, and then on Rt 15 to rest area 0.9 mi south of Cohocton.

Stop 9

Rest area on east side of Rt 15, 0.9 mi south of Cohocton.

View:

Cohocton Valley, an essentially straight, steep-walled, nearly northwest-southeast valley, floored by gravel. The thickness of the gravel, not known, may be obtainable from well logs.

Across the valley is a bench of gravel which attains an elevation of 1480+ ft. It is directly south of Blackcrick Hollow. The face seems to show two levels here; more north of here.

Inferences and questions:

Cohocton Valley is a "through" valley, probably eroded to a large extent by glacial meltwater, as well as by glaciers. According to Fairchild, the preglacial divide was north of Bath (1926, Plate 84). The valley shows truncated spurs, and is floored by a valley train of Valley Heads outwash. Tributary streams have built alluvial fans on top of this outwash.

The gravel bench appears to be a kame terrace, consisting of outwash gravel deposited against stagnant ice. Ice-contact surfaces show especially well on the opposite (southwest) side of the deposit, where it stands free from bedrock. At its southeast end there appears to be an area of collapsed drift.

Is it possible that this gravel bench is, instead, a delta built into a lake in the Cohocton Valley? If so, what held in the lake?

In any case, what caused the two or more levels on the deposit?

Route continued:

Turn north on Rt 15, back to Cohocton. If time permits, in Cohocton take Rt 371 south, to stop at a pit in the gravel bench, and possibly to view ice-contact surfaces and collapse topography. If not, continue northward on Rt 15 and turn west on Hinkle Hollow Rd, 0.6 mi beyond jct of Rts 15 and 371.

Just west of Cohocton, Rt 371 ascends several terraces, one with a concavely curved bank. Could this be the cut bank of a meander, possibly of an outwash stream flowing between ice on the east and the gravel bench on the west?

A gravel pit south of Rt 371, near jct with Oil Well Hollow Rd, shows dirty outwash gravel. Foreset bedding in sand and the dip of flat pebbles suggest water flow from the north and northwest.

If there is time, continue south on Lake Hollow Rd to view ice-contact surfaces, and onto Jones Rd to see collapse topography. Then turn north on Marks Rd, to rejoin Rt 15 in Cohocton, and turn west on Hinkle Hollow Rd, 0.6 mi beyond jct of Rts 15 and 371.

Hinkle Hollow Rd at one place is nearly 2100 ft above sea level, affording a good view of the surrounding summit level -- inferred by some to be an uplifted peneplain. The till on this hilltop contains relatively few exotics.

Farther west the road descends into the next north-south valley, containing Loon Lake and much glacial drift in knobs and terraces. Connally identifies this drift as Arkport Moraine (1964, p. 43), which is possibly "advance" Valley Heads Moraine.

At North Loon Lake Church, turn left on North Loon Lake Rd. Here, if time permits, a brief stop will be made to view several kettles in a kame terrace. Was each of these formed by a separate block of buried ice, or was there just one large, irregular block? Was the ice completely or partially buried? How can one tell?

The road passes Loon Lake, interpreted to be a kettle lake. Note crowding of the lakeshore by cottages. Would it not be better to have the lake and the surrounding area made a park, to be enjoyed by all? This would also reduce pollution of the water and prevent <u>all</u> the interesting gravel deposits from being destroyed!

Stop 10

Rt 21, 0.2 mi northwest of Country Rd 92, west of Loon Lake.

<u>Hillside and gravel pit</u>:

Irregular, steep gravel slope with hollows and projections. Gravel is "bright", containing many rounded exotics, somewhat sorted and stratified. A very small percentage of rounded pebbles and cobbles consist of conglomerate containing a variety of pebbles, including crystallines, red sandstones, limestones, and dolomites -- all firmly cemented.

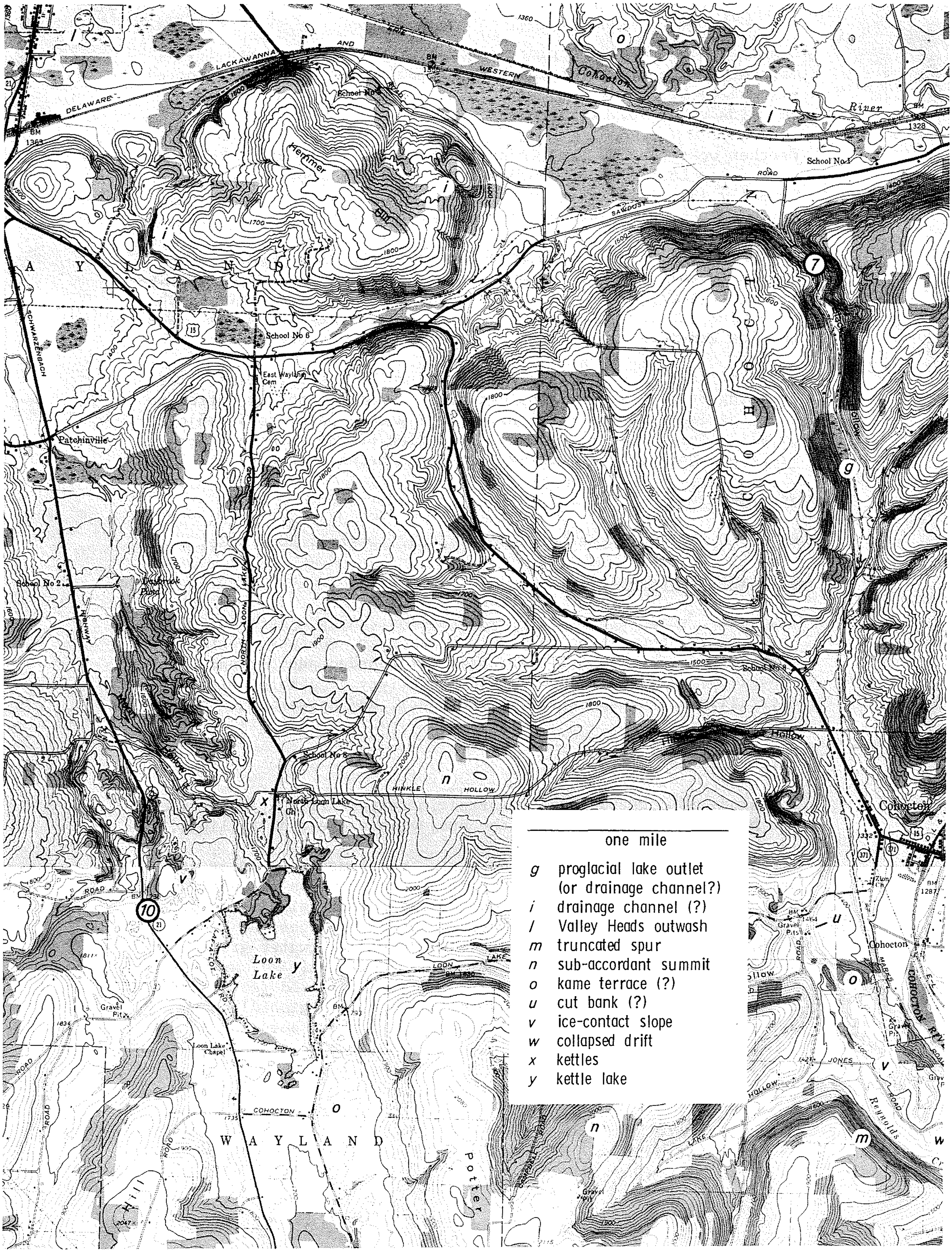
Inferences and questions:

The slope is constructional, formed in contact with stagnant ice. The hollows are kettles, and the projections crevasse fillings.

The pebbles and cobbles of exotic-rich conglomerate consist of meltwater-deposited gravel of a previous glaciation cemented during an interglacial time, then eroded during a later glaciation and rounded and deposited by meltwater. Abraded pebbles and boulders of similar conglomerate have been reported from meltwater gravels in several localities in central New York (Schmidt, 1947), and also have been found in till. How much time was required for cementation of this conglomerate to take place? Was an interglacial stage necessary, or would an intraglacial substage have been sufficient? Could it have taken place during minor oscillation of the ice front?

Route continued:

Go northward on Rt 21 to Wayland, crossing outwash. In Springwater turn right on East Av, and ascend the east side of Hemlock Valley.


one mile
g proglacial lake outlet (or drainage channel?)
i drainage channel (?)
l Valley Heads outwash
m truncated spur
n sub-accordant summit
o kame terrace (?)
u cut bank (?)
v ice-contact slope
w collapsed drift
x kettles
y kettle lake
DELAWARE LACKAWANNA AND WESTERN
Cohocton River
Hemmer Hill
Patchinville
School No 6
School No 2
School No 8
Loon Lake
Loon Lake Chapel
HINKLE HOLLOW
Cohocton
WAYLAND
Potter
Hill
Reynolds

Stop 11

Straight Rd, just west of Price Rd, 1.7 mi east-northeast of Springwater. (Bus to go east on East Av, Springwater, to Price Rd, then north to Straight Rd; park on Price Rd. Group to walk downhill.)

Vantage point:

Hemlock Lake (left, NNW) and Canadice Lake (right, N). Difference in levels is obvious (905 ft; 1096 ft). These are two of the smallest Finger Lakes, and nearly the farthest west. Both drain northward to the Genesee River.

Sub-accordant summits: hill west of Springwater (WSW) 2060+ ft; Marrowback Hill (NW) 1940+ ft; Bald Hill (N) 1860+ ft. According to Fairchild, Marrowback Hill is capped by Wiscoy shale and Bald Hill by Gardeau sandstone, both Upper Devonian (1928, p. 81).

West of Springwater, a creek descends the valley side in a steep gorge.

Inferences and questions:

The apparent southward confluence of Canadice and Hemlock Valleys suggests former southward drainage, followed by reversal. Did this reversal occur preglacially, as a result of the capture of south-flowing consequent streams by an encroaching north-flowing obsequent stream? Or did it result from glacial deposition in the valleys south of the lakes? VonEngeln implies the latter, and on this basis distinguishes Finger Lakes "West" from Finger Lakes "East" (1961, pp. 27, 38-45). Well logs might throw light on this matter.

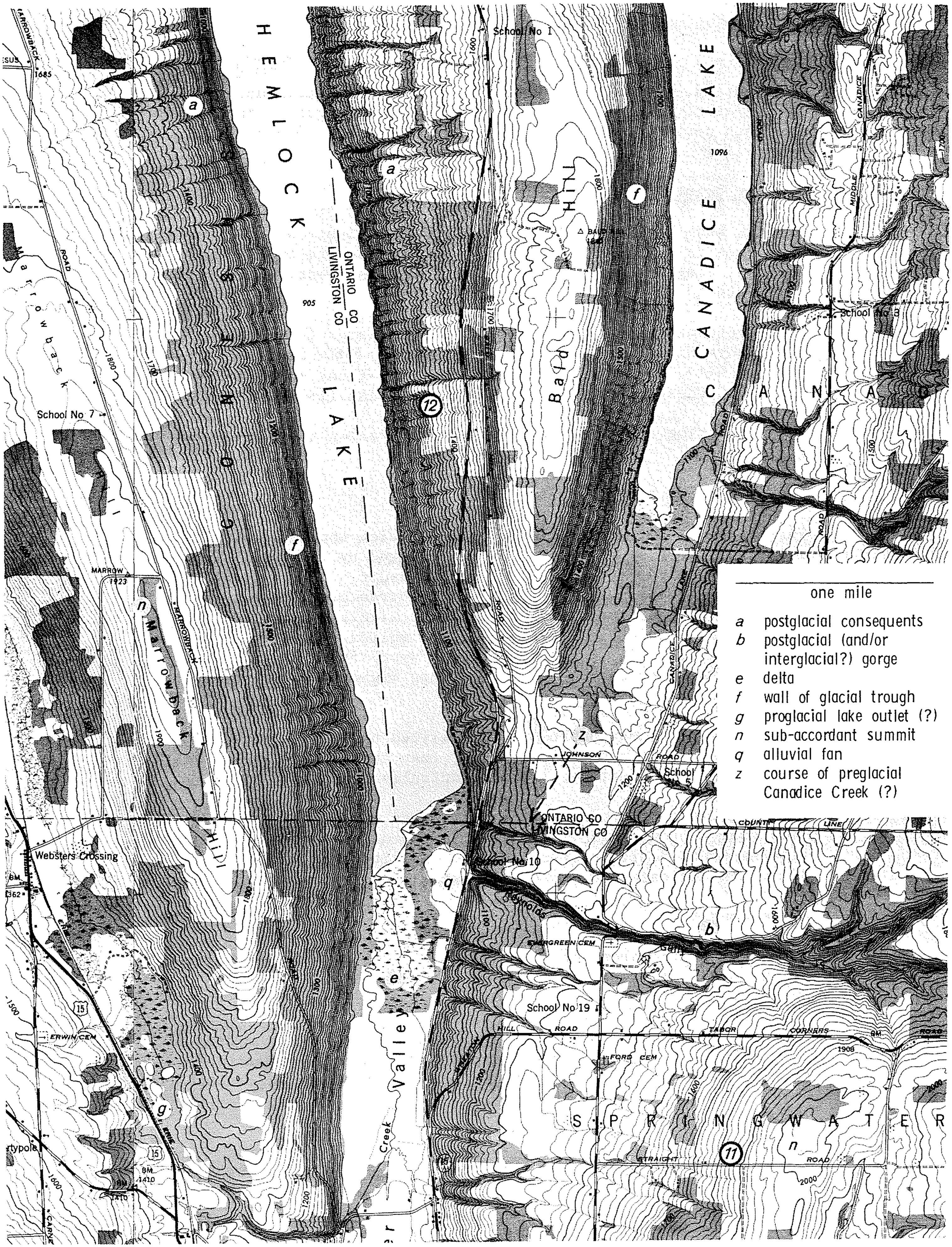
The hill summits may represent an uplifted peneplain, although they probably are considerably lower than the former level of this uplifted erosion surface, if there actually is one.

The gorge west of Springwater possibly was eroded chiefly by overflow from a proglacial lake in the south end of the valley of north-flowing South McMillan Creek, on the opposite side of Marrowback Hill. In any case, the gorge is postglacial, interglacial, or both.

Route continued:

Return to Springwater, or to Rt 15A north of Springwater. Proceed north on Rt 15A to overlook of Hemlock Lake, 4.6 mi north of Springwater.

North of Springwater the road runs along the delta at the head of Hemlock Lake. It then passes over a large alluvial fan at the base of Reynolds Gully, a postglacial (or interglacial, or both?) gorge 2 mi north of Springwater.



one mile
a postglacial consequents
b postglacial (and/or interglacial?) gorge
e delta
f wall of glacial trough
g proglacial lake outlet (?)
n sub-accordant summit
q alluvial fan
z course of preglacial Canadice Creek (?)
HEMLOCK LAKE
CANADICE LAKE
ONTARIO CO
LIVINGSTON CO
Bald Hill
Marrowback
Marrowback Hill
School No 1
School No 3
School No 7
School No 10
School No 19
Websters Crossing
Reynolds Gull
EVERGREEN CEM
ERWIN CEM
FORD CEM
JOHNSON ROAD
HILL ROAD
TABOR CORNERS
STRAIGHT ROAD
COUNTY LINE
SPRINGWATER
Valley Creek
MARROW 1923
12
11

Stop 12

Rt 15A, 4.6 mi north of Springwater

Overlook:

Hemlock Lake lies in a long, narrow, straight, essentially north-south trough. The depth of the trough, from the top of Marrowback Hill (W) at 1940+ ft to the deepest part of the lake, 809 ft, is 1131+ ft.

Inferences and comments:

The narrowness and straightness of this trough suggest that it was developed from a narrow valley of a relatively small stream. Possibly the trough was preceded by a narrow, steep-walled sluiceway eroded by south-surging meltwater during glacial advance.

Hemlock Lake is a major source of the Rochester area water supply. It is delightfully clear, and makes good canoeing. Note the contrast with Honeoye Lake in regard to the crowding of cottages along the lake shore. Hemlock Lake and Canadice Lake could be the start and nucleus of a Finger Lakes National Park!

Route continued:

Stay on Rt 15A to Rochester. Retracing the route north of Hemlock provides another opportunity to see the drumlins and glacial drainage channel viewed earlier, on the southbound trip.

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Trip B

A COMPARISON OF ENVIRONMENTS

by

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The Middle Devonian Hamilton Group in the Genesee Valley

The Devonian System of New York State varies from carbonates at the bottom (Helderbergian and Ulsterian Series) to coarse continental clastics at the top (Chautauquan Series) and represents a westward migrating deltaic complex built during Middle and Late Devonian time, (Rickard, 1964).

This deltaic complex, the Catskill Delta, is today represented by a wedge of sedimentary rock that thickens and coarsens eastward toward the Hudson River. These rocks are highly fossiliferous and structurally simple, thereby, lending themselves to detailed faunal, stratigraphic and paleoecologic studies.

Since the Middle and Upper Devonian of New York represents a deltaic complex, at any instant in time during the Devonian there existed a series of transitional environments aligned approximately parallel to the old shoreline from west to east or offshore deep water to onshore shallow water. These contemporaneous environments are not only transitional with one another laterally, but they also succeed each other vertically since the delta prograded westward across New York State. Each environment is today characterized by its own distinctive rock type and fossil assemblage. For example, the fine shale deposits of the Middle Devonian in the west (Lake Erie) gradually coarsen to siltstones and sandstones eastward (Catskills). The fine shales of the Middle Devonian on Lake Erie are in turn succeeded by the coarser siltstones and sandstones of the Upper Devonian.

The purpose of this field trip will be to sample and contrast several offshore Devonian biotopes representing two major environments; a poorly oxygenated phase of dark shales ("Cleveland" facies), and an oxygenated environment of soft calcareous blue-gray shales and limestones ("Moscow" facies).

Stratigraphy

The units to be examined belong to the upper part of the Middle Devonian Hamilton Group and the lower part of the overlying Upper Devonian Genesee Group. A table of these units is illustrated on the following page (* = units to be examined).

The Geneseo and Ledyard black shales and the Leicester Pyrite are representatives of the "Cleveland" phase, while the other members represent the "Moscow". Although the Geneseo is younger than the Ledyard it more or less resembles the Ledyard because the Geneseo represents a recurrence of the "Cleveland" phase in New York State at the beginning of the Late Devonian. Oscillations of the strand line are responsible for numerous recurrences of environments throughout Middle and Late Devonian time in New York; the Ledyard and Geneseo is just one example.

AGE	GROUP	FORMATION	MEMBER	APPROXIMATE THICKNESS IN FEET
Late Devonian		Other Upper Devonian Units		
	Genesee	West River Shale		65
		Genundewa Limestone		6
		Penn Yann Shale		30
		Geneseo Black Shale*		50
		Leicester Pyrite*		0-.2
Middle Devonian	Hamilton	Moscow	Windom Shale*	50
			Kashong Shale*	80
			Menteth Limestone*	1
		Ludlowville	Deep Run Shale*	7
			Tichenor Limestone*	2
			Wanakah Shale*	46
			Ledyard Shale*	57
			Centerfield Limestone*	7
		Skaneateles	Levanna Black Shale*	230
			Stafford Limestone	2
		Marcellus	Oatka Creek Black Shale	30
		Onondaga Limestone		145
		Silurian Formations		

* = units to be examined

Paleoecology

There are several parameters of extreme importance in determining ancient environments. Many more exist than will be treated in this brief discussion.

Feeding Types

The feeding types of bottom dwelling organisms (or, "how they go about making their living") are very useful in paleoecology as they reflect certain physical characteristics of the environment.

To meet the objectives of this field trip, especially the sequence at Jaycox Run (see page 10), I have chosen to subdivide and group various taxa into six major feeding groups.

Large Epifaunal Filter Feeders

This group embraces those organisms living on the substrate and deriving nourishment by straining sea water for its contained organic material and microrganisms. Since currents carry nutriments, the higher the current activity, the more food there is in suspension for filter feeders. They are found on mud, sand, and silt substrates and dominate faunal assemblages in fine to coarse grained rocks deposited in turbid water.

Included in this group are the larger articulate brachiopods, and the epibyssate bivalves (Stanley 1972), *Mytilarca* (*Plethomytilus*), *Gosselettia*, *Cornellites*, *Pterinopecten*, *Leiropecten*, Pseudaviculopecten. Crinoids and blastoids are also placed in this feeding group but it should be recognized that they may have been microphagous carnivores or both. They seem to be abundant in more facies than the typical microrganism eating coelenterates and bryozoans.

Small Epifaunal Filter Feeders

This group, though somewhat artificial includes mostly the brachiopods Ambocoelia and Chonetes. These two genera are most abundant in rocks carrying a low **diversity** fauna. As diversity increases these small filter feeders usually decline drastically. It seems to me that, at least for the Genesee Valley region, they are indicative of stressed environments of low oxygen and extremely soft mud bottoms. Their small size and shell shape (deep recurved beak of Ambocoelia and spines along the hinge of Chonetes) seem to be especially adaptive on soft mud substrates, for keeping the commissure off the bottom.

Infaunal Filter Feeders

Infaunal filter feeders are most abundant in well sorted sands and silts. The same physical requirements of currents high in organic matter apply both to large epifaunal and infaunal suspension feeders.

Included in this group are the endobyssate (Stanley, 1972) bivalves, Cypricardella, Leptodesma, Actinopteria, Ptychopteria, Goniophora, Modiomorpha, Leiopteria, Actinodesma (Glyptodesma); the inarticulate brachiopod Lingula; and the problematical fossil Taonurus probably a suspension feeding marine annelid.

According to Stanley (1972) the byssus of endobyssate bivalves anchored into the substrate, therefore, these forms live partially buried and are semi-infaunal. Endobyssate bivalves usually have at least three of the following morphological features (Stanley, 1972, pg. 181):

1) elongate shape
2) reduced lobate anterior
3) broad byssal sinus
4) absence of appreciable ventral flattening

Infaunal Deposit Feeders

Deposit feeders are those organisms which burrow into and feed directly on the soft sediment extracting the organic nutriments contained therein and disposing of the inorganic mud as waste products. They are most abundant in fine grained quiet water deposits (shale) where the mud was rich in organic matter. Deposit feeders are not abundant in coarser grained sedimentary rocks such as siltstone and sandstone because these rock types reflect environments of high current activity. The fine grained organic particles will be kept in suspension and therefore unavailable as a food source for deposit feeders.

Many worms, the nuculid bivalves Nucula, Nuclites, Paleoneilo, and the bivalves Panenka and Pterochaenia are herein labelled infaunal deposit feeders, although Pterochaenia may have been epiplanktonic attaching to floating seaweed.

Vagrant Epifaunal Deposit Feeders; Scavengers; Carnivores; Herbivores

The vagrant epifaunal forms such as trilobites, snails and starfish are examples of this group. They actively move on the substrate, but some may have occasionally jumped or swam above it and occassionally burrowed into it for food and/or protection, as perhaps the trilobites Phacops and Greenops.

The genera assigned to this feeding group may have exhibited more than one feeding type, some being deposit feeders and scavengers, or omnivores, etc. Some may have even attached themselves to crinoids like the gastropods Platyceras and Nauticonema (Knight et.al, 1960). Most other gastropods were probably deposit feeders or herbivores, but a few most certainly were borers using the radula as a drill. They are found in all sediment types but most abundantly in organic rich substrates such as dark shales and siltstones.

Microphagous Carnivores

Corals and bryozoans, the microphagous carnivores, fed mostly on smaller organisms, even perhaps microganisms. Therefore, they require well circulated water much like filter feeders; however, the water must not be heavily charged with sedimentary particles because, if sedimentation is too rapid they cannot become firmly established. In short, they are suffocated. This explains their conspicuous absence from siltstones and sandstones.

Many bryozoans are epizooites living attached to the shells of most other invertebrates. Hederella and Reptaria are examples. Some crinoids might more properly belong here than with the epifaunal filter feeders.

Habit

There are only two basic habits exhibited by marine invertebrates.

Pelagic forms are those that live free from direct dependence on the bottom and are either floaters (planktonic) or swimmers (nektonic).

Their number and size is more a reflection of physical conditions in the overlying water than on the bottom. They are most abundant in dark and black shales reflecting anaerobic conditions on the bottom thereby preventing the establishment of a well developed benthonic fauna.

The epipelagic brachiopods Leiorhynchus and Orbiculoidia (inarticulate) probably attached to floating objects, while the pteropoda Stylionia and the cephalopod Orthoceras were nektonic. Furthermore, Orthoceras and perhaps related nautiloids spent considerable time on the bottom as vagrant carnivores feeding on brachiopods or trilobites.

Benthonic organisms are those that live on the sea floor (epifaunal) and burrow into it (infaunal). Furthermore, they may be permanently attached (sessile benthonic) or highly mobile (vagrant benthonic). Feeding type and habit are closely related. For example, most carnivores, are also highly mobile and most epifaunal types are filter feeders.

Species Diversity

Species diversity is the number of different species believed to have inherited a given area of the sea floor. Diversity can be correlated with the physical environment through the use of the following principle.

Under rigorous environmental conditions such as an exceptionally soft bottom, low oxygen levels, or extremely high current activity, only a few species are adaptable and hence able to survive. However, these few species may be represented by numerous individuals as competition would be at a minimum.

An environment that can support many different species probably reflects opulent conditions of oxygen, temperature, salinity, food supply, etc., and hence many more species are able to survive.

FAUNAL ANALYSIS OF JAYCOX RUN

Jaycox Run (Stop #2) exposes a nearly complete section of the Ludlowville Formation which can be divided from oldest to youngest into the Centerfield, the Ledyard, Wanakah and Tichenor Members totalling 130 feet. The Menteth member of the Moscow Formation caps the section (Plates #1 & #2).

Methods and Acknowledgement

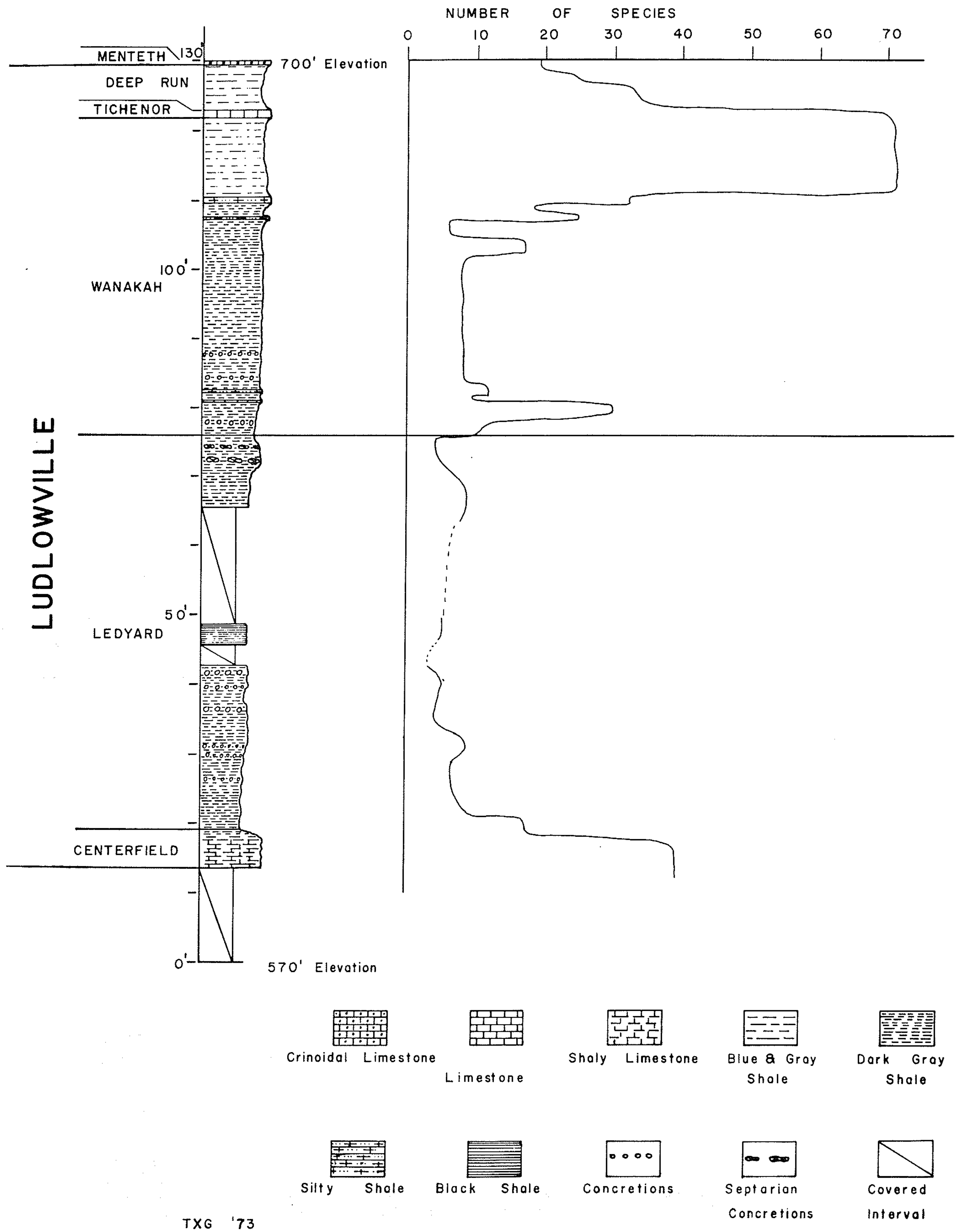
The section at Jaycox Run was measured with a hand level and folding wooden rule over a two week period. The author was assisted in the field by Richard D. Hamell who aided immensely in measuring and sampling the section, and without whose aide this project could not have been brought to a successful conclusion.

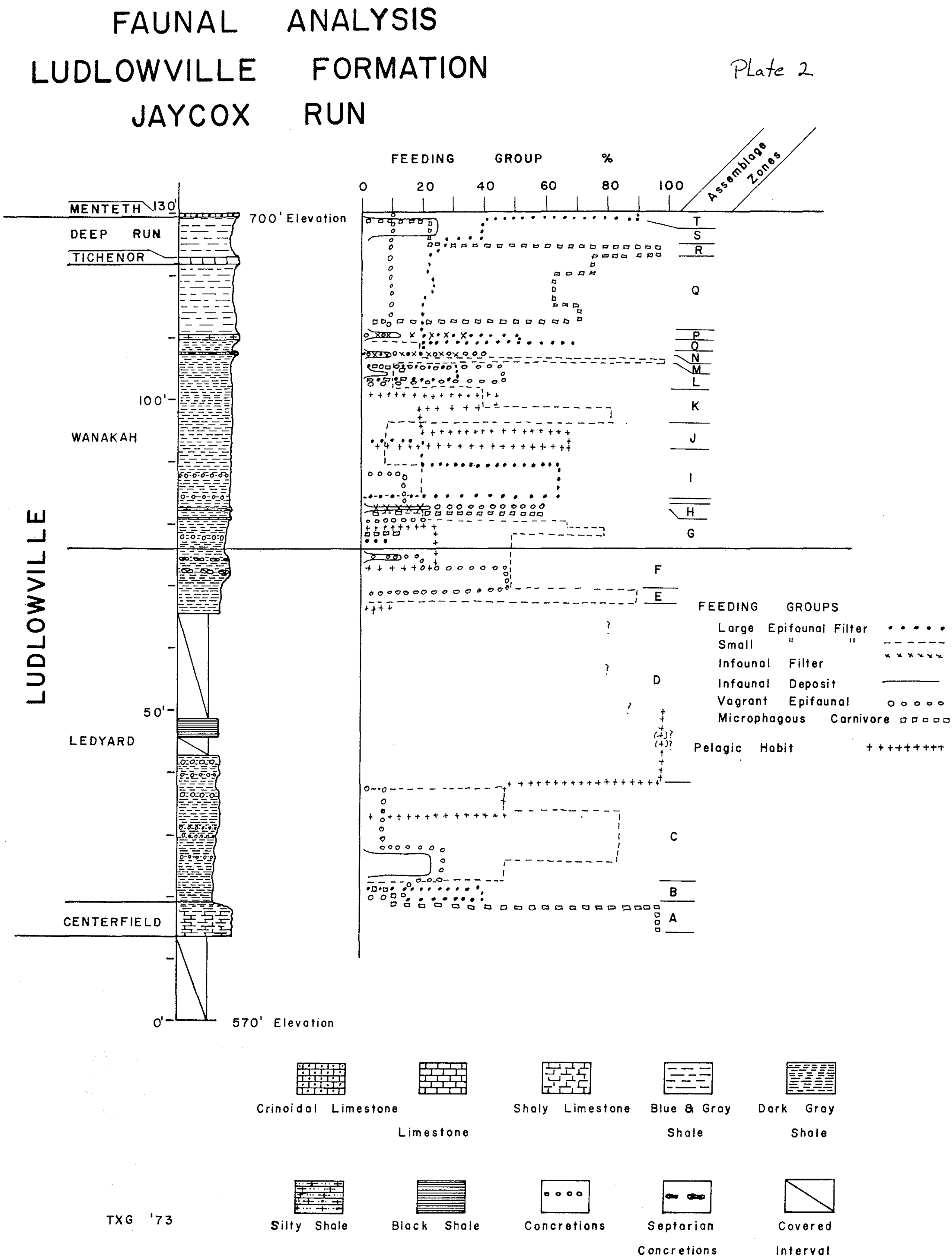
The number of species represented at each horizon were counted and identified in the field. Only those of questionable identity were collected. At each abundantly fossiliferous horizon (Zones-A, B, G, H, L, P, Q, S, T) two to four hours of sampling were consumed, (Plates #1 & #2).

The relative abundance of each species was estimated on the numbers of individuals recognized in the outcrop after a suitable period of collecting. One hour in unfossiliferous horizons and approximately two hours for fossiliferous horizons. Although this is not a statistically precise method, it is the best method to use when sampling a thick interval of strata with a limited

Plate 1

FAUNAL ANALYSIS
LUDLOWVILLE FORMATION
JAYCOX RUN




FAUNAL ANALYSIS
LUDLOWVILLE FORMATION
JAYCOX RUN
Plate 2
FEEDING GROUP %
Assemblage Zones
MENTETH
DEEP RUN
TICHENOR
WANAKAH
LEDYARD
CENTERFIELD
LUDLOWVILLE
700' Elevation
570' Elevation
FEEDING GROUPS
Large Epifaunal Filter
Small " "
Infaunal Filter
Infaunal Deposit
Vagrant Epifaunal
Microphagous Carnivore
Pelagic Habit
Crinoidal Limestone
Limestone
Shaly Limestone
Blue & Gray Shale
Dark Gray Shale
Silty Shale
Black Shale
Concretions
Septarian Concretions
Covered Interval
TXG '73

amount of time and where the nature of the exposure changes constantly from a bedding plane surface to a vertical face.

Individuals of a species were assigned a code number according to the table below:

Code	Number of Specimens	Mean	Descriptive Term
1	1-3	2	Very Rare
2	4-12	8	Rare
3	13-52	32	Present
4	53-204	128	Common
5	205-820	512	Abundant
6	Over 820	2048	Very Abundant

The relative abundance of each species by counting specimens can be misleading due to fragmentation (crinoid stems), shedding of exoskeletons (trilobites) and separation of valves (bivalves, brachiopods, ostracods). Crinoid stems and bryozoan colony fragments, especially fenestellids were counted numerically, therefore, the codes assigned to these groups probably are abnormally high.

The maximum number of either trilobite cephalons or pygidia were counted and thoracic segments were counted as individuals if the exhibited more than five pleura (after Bray, 1971).

The various species present at each horizon were then grouped into the feeding type and habit categories discussed above. The sum of the means of all species in any one category was then divided by the total mean of all the species for that stratigraphic interval. This results in a mean percent for each feeding type or a rough approximation of the community composition based on feeding types for each successive stratigraphic horizon. Plate #2 was then constructed utilizing these data. For example: by examining Plate #1, one can see a fossiliferous horizon in the coarse, silty shale at 110 feet. By comparing this same horizon on Plate #2, it becomes apparent that the assemblage is composed mostly of filter feeders (large epifaunal 50%, infaunal filter feeders 36%); deposit feeders (10%) and a few vagrant epifaunal forms (4%).

One more point. Implicit in all this is the assumption that the assemblages sampled represent life or near life assemblages as define by Fagerstrom (1964).

Jaycox Run Section

Centerfield Member

Seven feet of the Centerfield is poorly exposed in the stream bed and small side banks (1-2') just upstream from the old railroad tressel at the base of Jaycox Run. It is mostly a shaly limestone or very calcareous shale at the base of the exposure becoming more shaly and darker upward grading into the Ledyard above. The upper boundary is not a lithologic one but a faunal one being placed at the top of the uppermost abundantly fossiliferous zone (Zone B).

Zone A: The lower part of the exposure is composed almost entirely of microphagous carnivores of bryozoa and corals. Solitary horn corals dominate the assemblage, to the exclusion of almost all other invertebrate species except bryozoans. In this aspect it is almost a coral biostrome and closely parallels those described by Oliver (1951): Heliophyllum halli is very abundant; Amplexiphyllum hamiltoniae, Heterophrentis simplex Aulopora sp. are abundant; Favosites alpenensis is common; Favosites hamiltoniae is present. (Descriptive terms for abundance throughout the text from the table on page 11.)

The overwhelming domination of microcarnivores certainly means minimal amount of clastic influx with abundant nutrients in shallow, warm, well lighted, agitated waters. Other species are represented by relatively few individuals.

Zone B: Atrypa reticularis Zone: Influx of clastics ended the rugosan-bryozoan domination allowing for the establishment of other feeding groups. Large epifaunal filter feeders dominate this zone especially the brachiopods Atrypa reticularis, (abundant), Mucrospirifer mucrunatus (present) and Megastrophia concava (rare). Vagrant epifaunal forms are conspicuous represented mostly by Platyceras (common) and Phacops rana (present). Corals and bryozoans still survive though reduced in numbers.

Ledyard Member

The Ledyard Member is composed of approximately 57 feet of dark gray calcareous bituminous shale with some black shale interbeds. Calcareous non-septarian concretions mostly small (less than 1 foot in diameter) are abundant at certain intervals throughout the unit. Larger septarian concretions are found toward the top of the Ledyard.

Zone C: Ambocoelia-Chonetes zone: Gradually deteriorating conditions for epifaunal filter, microcarnivore, and infaunal filter feeders beginning during later Centerfield time culminated in their complete removal by Ledyard time. Soft muds high in organic matter allowed infaunal deposit feeders (worm tubes common) and vagrant epifaunal deposit feeders (Phacops rana-common) to flourish initially along with the small filter feeding Ambocoelia (common) and Chonetes (common). Perhaps this interval should be set off as a subzone based on the abundance of Phacops rana. Many of the trilobites are complete, a few are enrolled. They are found nearly parallel with the horizontal, dorsal surface up and some reversed with the ventral surface up. This means that Phacops and to a lesser extent Greenops moved on the substrate plowing or occassionally burrowing into it for food. The fine, bituminous,dark shales in which they are found were soft muds high in organic matter an indication perhaps that Phacops was a deposit feeder.

Zone D: Leiorhynchus Zone: Although this interval is nearly covered, some patches of it are exposed for sampling purposes. It is mostly a calcareous, bituminous, black shale with some dark shale interbedded with it. For all intents and purposes the only species found is Leiorhynchus quadricostatum (very abundant).

Anerobic conditions at or above the sediment-water interface existed during the time of deposition of Zone D.

Zone E: (Second Ambocoelia-Chonetes Zone) and Zone F (Phacops rana Zone) are recurrences of Zone C conditions. One unusual addition is a small thin zone at about 75 feet containing the gastropods: Moulonia itys (present), Nauticonema lineata (present), Loxonema hamiltoniae (rare), and Bembexia sulcomarginata (rare), the cephalopod Orthoceras (common), and the infaunal deposit feeding clams Nucula (rare), Paleoneilo (present), and Nuculites triquetor (rare). This deposit feeding assemblage indicates high organic matter in the substrate and oxygen levels high enough to support a diverse molluscan assemblage although composed of mostly small individuals.

Wanakah Member

The Wanakah member is composed of 34 feet of dark gray, bituminous, calcareous shale, succeeded by 1 foot of coarse, silty shale and 11 feet of gray, non-bituminous shale, totalling nearly 46 feet in all.

Zone G: Pleurodictyum americanum Zone: Although no lithologic break separates the Wanakah from the Ledyard Shales, the first appearance of Pleurodictyum americanum is generally taken to represent the lower boundary of the Wanakah (Cooper, 1930). Zone G is a highly fossiliferous zone containing species representative of all feeding groups described. Infaunal deposit feeders are only weakly represented. Well oxygenated conditions must have existed although the bottom sediment was fairly soft. Large epifaunal filter feeders are represented by several forms; Mucrospirifer mucronatus (common); Pterinopecten (very rare); Spinocyrtia granulosa (very rare) being a few.

Stereolasma rectum, the solitary small horn coral is common, apparently the larvae attaching to the shells of other invertebrates (Bray, 1971). Pleurodictyum is present, its larvae attaching to the shells of Loxonema. Aulopora is abundant in a thin layer toward the top of this zone. Small epifaunal filter feeders dominate the assemblage. This assemblage is one adapted to a soft bottom environment; the coelenterates found being those tolerant of turbid water and using the shell of other invertebrates as their "firm substrate" for larval attachment.

Zone H: Modiomorpha subalata Zone: Contained with a thin, coarse, silty, shale bed, capping a small waterfall at 82 feet is the first appearance of abundant infaunal filter feeders. A firmer substrate and increased current activity are probably responsible. The endobyssate bivalve Modiomorpha subalata is common, along with the vagrant gastropod Bellerophon (abundant) and the infaunal bivalve Paleoneilo is common. The silty substrate must have been rich in organic matter to support the infaunal deposit feeders.

Zone I: Mucrospirifer mucronatus Zone: Large numbers of the large epifaunal filter feeder Mucrospirifer mucronatus characterize the succeeding 10 feet of dark bituminous shale on top of the Modiomorpha Zone, Ambocoelia umbonata is common in this interval also. Mucrospirifer mucronatus is characterized by the hinge line extending laterally to form large spines or alae. These presumably functioned like skies to better distribute the weight on a soft substratum. The conspicuous absence of Mucrospirifer from other soft bottom horizons (C, E, & F) leads me to the conclusion that C, E, and F were zones of lower oxygen potentials or less particulate organic matter in suspension and available for food. One other possible explanation is the selective predation of Mucrospirifer larvae during or just before spat fall. This explanation seems to be fairly weak as searching through my mind I cannot conceive of an organism responsible for the selective destruction of just Mucrospirifer larvae.

Zone J: (Second Leiorhynchus Zone): This is a recurrence of Zone D.

Zone K: Third Ambocoelia-Chonetes Zone: This is a recurrence of zones C and E. The Ambocoelia, at least in this zone, seem to occur in clusters. Bray (1969) has dealt with cluster developement in Ambocoelia of the Ludlowville Formation in Erie County. They apparently initiate as a small patch on an otherwise lethal substrate due to their adaptability on soft substrates. Successive generations use the shells of earlier ones to attach the pedicle, thereby increasing the diameter of the cluster. As density increased fecal matter and other toxic substances could have built up to a point inhibiting further spot development and the cluster became extinguished. Other adjacent "immature" clusters would still survive.

Zone L: Stereolasma Zone: The Stereolasma zone represents a trend to more opulent conditions of oxygen, and food supply in the water and substrate. Microcarnivores are represented by Stereolasma rectum (common) vagrants by Phacops rana (abundant) large epifaunal filter feeders by the brachiopods, Athyris spiriferoides (common) Mucrospirifer mucronatus (common).

Zone M: Styliolina fissurella Zone: Bedding planes containing very abundant individuals of the pteropod Styliolina fissurella can be found above Zone L. They appear to represent catastrophic swarm kills with their shells current oriented in a NE-SW direction. Ambocoelia umbonata is abundant in other layers in this zone. A stressed environment of low oxygen, the Styliona zone contrasts markedly with the well aerated waters of the Stereolasma Zone.

Zone N: Nauticonema lineata Zone: This zone represents a recurrence of the gastropod faunal in Zone F. Infaunal filter feeders are most pronouned being represented by Taonurus (present). Infaunal deposit feeding is suggested by the numerous limonite stained worm tubes or trails.

Zone O: Second *Mucrospirifer mucronatus* Zone: This is a reoccurence of Zone I.

Zone P: *Cypricardella-Pseudaviculopecten* Zone: At the top of the largest falls in Jaycox Run at 110 feet occurs a foot interval of coarse calcareous silty shale or siltstone. It is characterized by large epibyssate bivalves, endobyssate bivalves, infaunal deposit bivalves, gastropods and brachiopods. This unit presents the highest energy environment of clastic deposition in the Ludlowville Formation of Jaycox Run. Organic material was abundant in suspension, and in the firm substrate. Epibyssates are represented by:

Pseudaviculopecten princeps, (present)
Pterinopecten (rare)
Cyriopecten (rare)
Gosselettia (rare)
Mytilarca (rare)

Endobyssates by:

Cypricardella bellistriata (common)
Actinopteria decussata (present)
Leiorpteria conradii (rare)
Modiomorpha mytiloides (rare)
Modiomorpha concentrica (present)
Actinodesma erectum (rare)
Goniphara hamiltoniae (very rare)

Gastropods by:

Moulonia itys (present)

M. lucina (large) (rare)

Nauticonema lineata (rare)

Brachiopods by:

Stropheodonta demissa (present)

Mucrospirifer mucronatus (common)

Mediospirifer audaculus (common)

Infaunal deposit feeders by:

Paleoneilo (common)

Zone Q: Hamilton Fauna: The uppermost 11 feet of the Wanakah member are the most fossiliferous in terms of numbers of species. All feeding types are represented and many species are common to very abundant. A faunal list would be exhaustive; suffice it to say that every common Hamilton form is represented in these 11 feet. This interval represents opulent conditions of temperature, food, substrate, and oxygen. The fossiliferous horizons are separated by a few inches of less fossiliferous shales indicating successive periods of greater deposition separated by the fossiliferous horizons of little or no deposition.

Tichenor Member

Zone R: Tichenor Fauna: The Tichenor Member, a 1 to 2 foot thick hard limestone represents a recurrence of Zone A of the Centerfield Members.

Deep Run Member

Zone S: Crinoidal-*Phacops* Zone: Zone S emcompasses the entire 7 or 8 feet of the blue gray limey shales of the Deep Run Member.

Large epifaunal filter feeders represented mostly by crinoids stems and microphagous carnivores by bryozoans are abundant, some endobyssate types are present, epibyssates being rare. *Phacops rana* is common but extraordinary in size. Some specimens are two to three times the normal size. This fact together with the abundant worm tubes (limonite tubes) suggest abundant organic matter on and in the substrate.

The absence of abundant corals would indicate an environment too turbid for them to become established.

Moscow Formation

Menteth Member

Zone T: Crinoidal Zone: Zone T contains most large crinoid stems. Other feeding tubes are only slightly represented, *Phacops rana* being the most common vagrant and *Taonurus*, (common) the infaunal filter feeder.

The assemblage suggests a very turbid high energy environment well suited for filter feeders.

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ROAD LOG

Hamilton Group

Total Miles	Miles From Last Point	Route Description
0.0		Start - Towne House - Elmwood Ave. and Mount Hope Ave. Proceed south on Mount Hope Ave.
0.3	0.3	Junction N.Y. 15A - proceed south.
1.0	0.7	Cross Barge Canal
1.0	0.0	Junction River Road - turn right (west).
1.8	0.8	Genesee Valley Park entrance on right. Proceed straight.
4.4	2.6	Railroad Crossing
4.8	0.4	Junction N.Y. 252 (Jefferson Road) Proceed straight (south) on River Road
5.0	0.2	RIT Campus entrance on left.
8.4	3.4	Bridge over New York State Thruway
8.6	0.2	Junction N.Y. 253 on left. Proceed south on River Road
8.8	0.2	N.Y. 253 continues west on right. Proceed straight (south) on River Road.
10.2	1.4	Intersection Rush-Henrietta Town Line Rd. Proceed straight (south)
11.1	0.9	Intersection Telephone Road Bear right on River Road
11.2	0.1	Junction N.Y. 251 Proceed straight (south) on River Road
13.8	2.6	Intersection Woodruff Road on left. Bear right on River Road

16.7	2.9	Small ravine on left exposing 11 feet of Onondaga Limestone.
17.2	0.5	Fork in road. Bear right on River Rd.
17.4	0.2	Enter village of Avon.
18.2	0.8	Junction River Road and U.S. 20; N.Y. 5 Turn right on U.S. 20; N.Y. 5
18.3	0.1	Cross railraod tracks; Junction N.Y. 39 on left (2). Turn left (south) on N.Y. Rt. 39.
19.5	1.2	Ashantee
21.4	1.9	Papermill Road on left. Proceed south on N.Y. 39
22.5	1.1	Triphammer Road on left. Turn left (east) onto Triphammer Road.
22.8	0.3	Gate on left just west of Conesus Creek.
		STOP #1-TRIPHAMMER FALLS (Centerfield Mbr.)
23.3	0.5	Return to N.Y. 39 - turn left (south)
24.6	1.3	Cross North Branch - Jaycox Run
25.7	1.1	Nations Road on right - turn right (west) Proceed on Nations Road to old railroad embankment.
		STOP #2-JAYCOX RUN (See text and plates)
27.9	1.1	Return to N.Y. 39 on Nations Road. Turn left (south) on N.Y. 39
29.1	1.2	Enter Geneseo
30.1	1.0	State University College at Geneseo on right.
30.3	0.2	Junction N.Y. 39 and U.S. 20A Turn right (west) on U.S. 20A; N.Y. 39

31.0	0.7	N.Y. 63 on right. Proceed straight (south) on U.S. 20A; N.Y. 39.
31.2	0.2	Fork in road. Bear right on U.S. 20A; N.Y. 39.
31.5	0.3	Geneseo Black Shale in road cut.
31.9	0.4	Cross Fall Brook.
32.1	0.2	Cross Genesee River
33.1	1.0	Cross Beards Creek
33.1	0.0	Boyd Parker Monument on left. Site of the murder of Lieutenant Boyd and Captain Parker, two members of General Sullivan's campaign of 1779 against the Iroquois Confederacy to end their continual harassment of colonial frontier settlements in New York. The victims' execution was prefaced by the most insidious torture apparently at the direction of the infamous Mohawk Valley Tory, Colonel Walter Butler.
33.4	0.3	Enter village of Cuylerville. Cross line of the old Genesee Valley Canal which connected Olean with the Erie Canal at Rochester. The Genesee Valley Canal was completed in 1856 and abandoned in 1878. Proceed on U.S. 20A, N.Y. 39.
34.6	1.2	Enter village of Leicester.
34.8	0.2	Junction N.Y. 36 - proceed straight (west) on U.S. 20A; N.Y. 39; N.Y. 36.
34.9	0.1	Turn right (north) on N.Y. 36.
35.7	0.8	Trailer Park and Kingston Road on right. Turn right. Turn right on Kingston Road and proceed to dead end.

36.1	0.4	End of Kingston Road.
		STOP #3 - LITTLE BEARDS CREEK
		The Kashong Shale is exposed at this locality and it carries an excellent "Moscow" facies fauna.
36.5	0.4	Return to N.Y. 36 Turn right (north) on N.Y. 36
37.0	0.5	New road on left; "Empire Dragway" sign.
37.2	0.2	Cross Taunton Creek.
37.3	0.1	First white house on left - north of Taunton Creek.
		STOP #4 - TAUNTON GULLY
		The upper 20 feet or so of the Windom Member is exposed at the base of the exposure. Upstream from this point there is nearly a continuous exposure from the Leicester Pyrite to the Genundewa Limestone which caps a waterfall at an elevation of about 850 feet.
		END OF TRIP - Return to Rochester via N.Y. 36; U.S. 20; River Road.

Trip C

LOWER UPPER DEVONIAN STRATIGRAPHY FROM THE BATAVIA-WARSAW MERIDIAN TO THE GENESEE VALLEY: GONIATITE SEQUENCE AND CORRELATIONS

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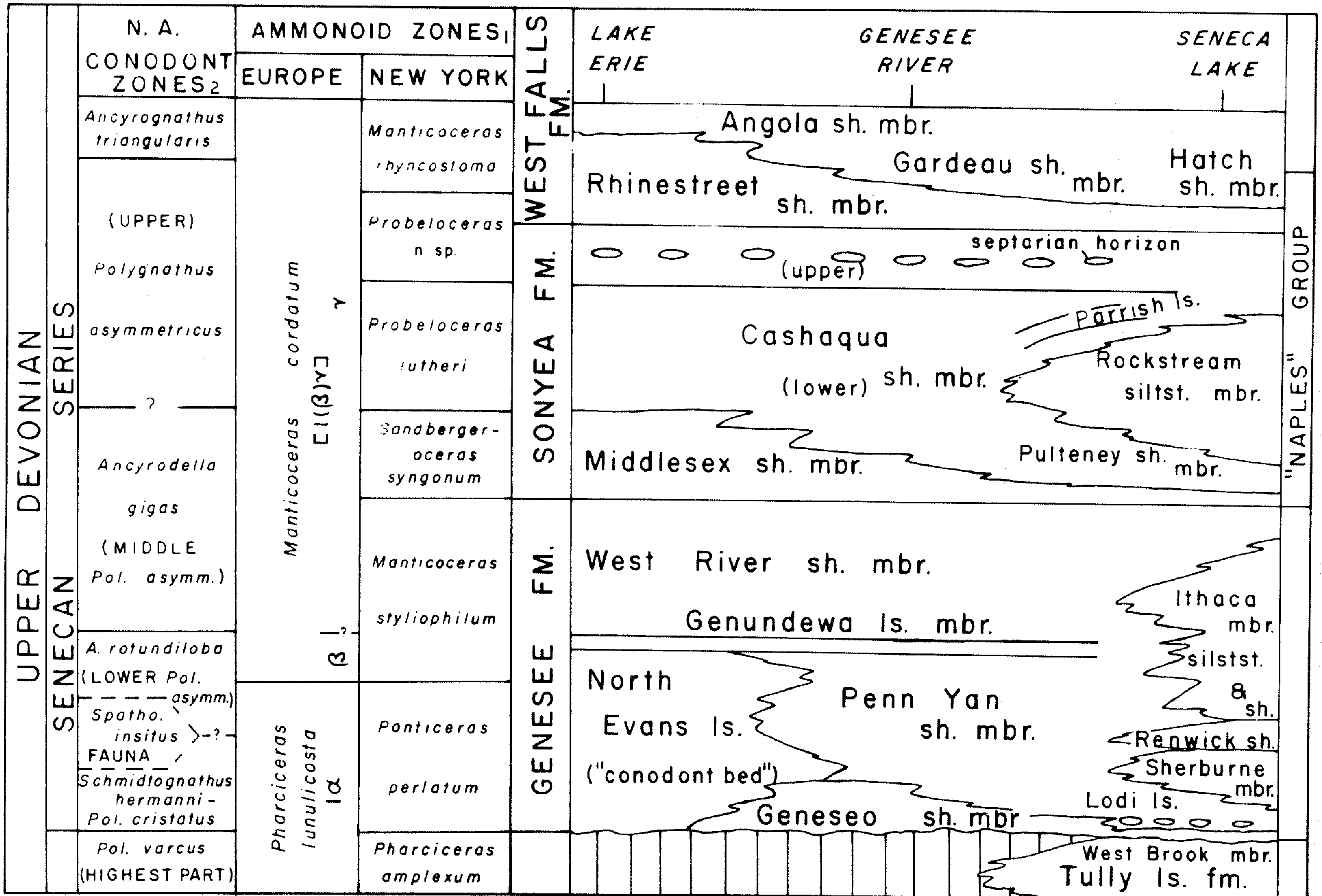
INTRODUCTION

Previous Work-

The starting point for stratigraphic studies of the Lower Upper Devonian rocks of Western New York is James Hall's (1843) Survey of the Fourth Geological District. In this classic report the names Genesee Slate, Portage Group (with Cashaqua Shale, Gardeau Shales and Flagstones, and Portage Sandstones) became firmly established for the undisturbed and remarkably well exposed sections in and around the Genesee Valley. This far off-shore (basin) succession begins with black and dark gray shales which pass upward into alternating gray, green and black shales, silty gray shales and siltstones, the latter becoming predominant toward the top.

Although little remains of Hall's original subdivision his preliminary observations provided the framework for later detailed stratigraphic studies and the monographs of the rich faunas which these rocks contain (Hall, 1879; Clarke, 1898, 1904). Among the various elements of the chiefly pelagic and molluscan "Naples Fauna" the goniatite cephalopods have received the most attention. Although they lack the diversity of their Eurasian contemporaries, the goniatite faunas from New York have special value because their stratigraphic position and sequence can be rather precisely determined. The correlation of the New York succession with the European standard, by means of goniatites and conodonts, is now generally established (Fig. 1) although a few discrepancies and details still need to be worked out.

FIGURE 1 CORRELATION CHART (Adapted from Rickard, 1964)



1. Modified from House (1962, 1968). 2. Modified from Klapper & others (1971) and Ziegler (1971); European equivalents: ( ).

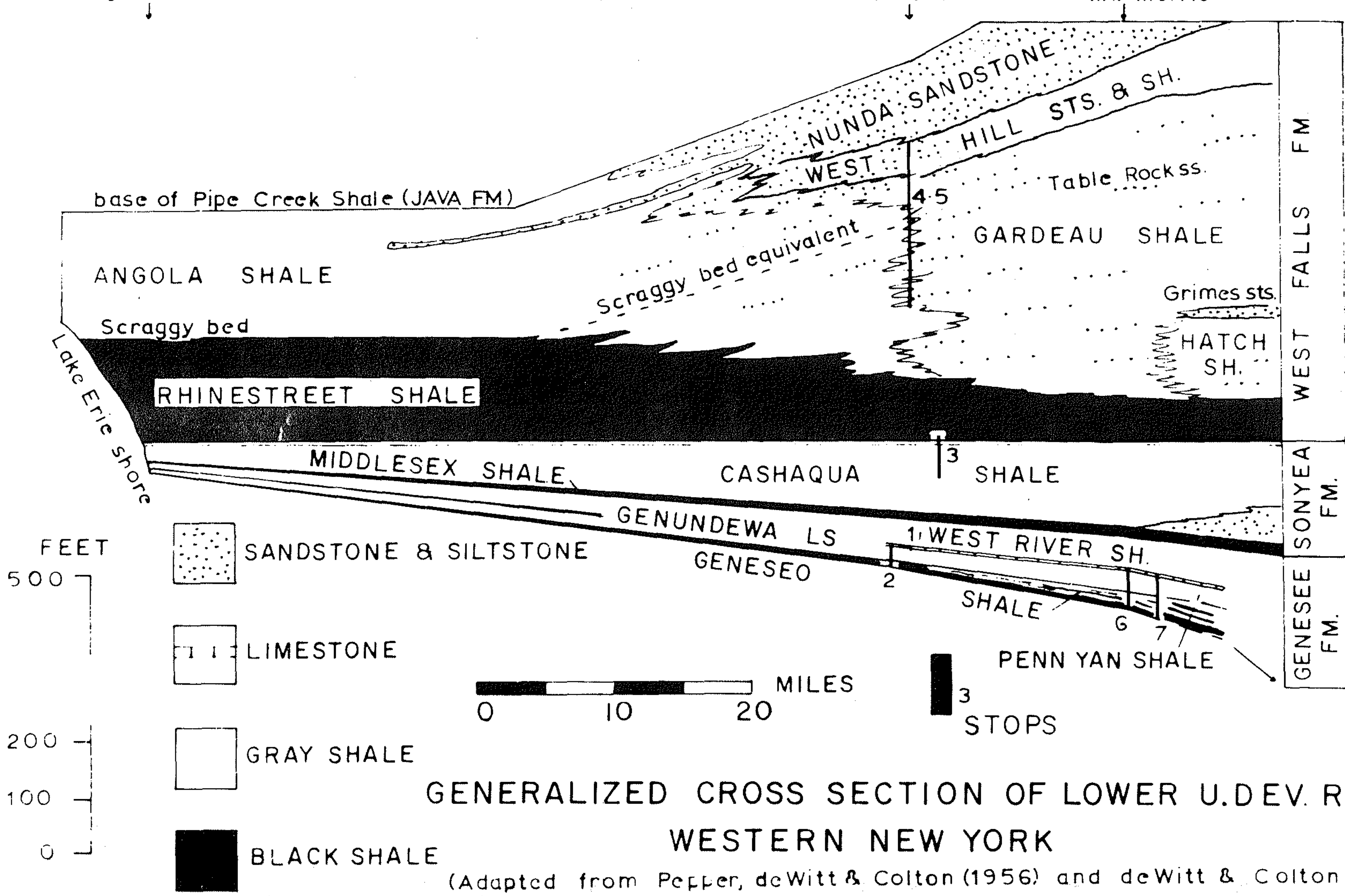
In nearly a century of study following Hall's report, attempts to correlate units of his subdivision (especially the higher ones) outside the Genesee Valley region were hampered by the complex intertonguing of the shaley succession of westernmost New York with the thicker more arenaceous succession of West-Central New York. The major problems were not resolved until the 1930's (Chadwick, 1933) with the realization that the major facies (for example, black shale, gray shale, and siltstone facies) were contemporaneous (facies equivalents) as well as successive, the more shoreward facies having migrated westward with the seaward progradation of the Catskill Delta.

The subdivision generally accepted at present (Pepper, deWitt, and Colton, 1956; Colton and deWitt, 1958; deWitt and Colton, 1959) is based on recognition of major cyclothemic units of alternating black and gray shale which tongue shoreward into westward thinning wedges of turbidite siltstones and sandstones (slope deposits) (Figs. 1, 2). The widespread black shales (successively: Geneseo, Middlesex and Rhinestreet) define the basal members of formations (from oldest to youngest: Genesee, Sonyea and West Falls). The black shales are thought to mark transgressive periods while the siltstones, sandstones and gray shales mark periods of increased rate of delta progradation. By tracing key black shales shoreward into the shelf and non-marine facies, Sutton (1963) was able to extend parts of the subdivision used in the west into the nearshore succession of the delta. These correlations formed the stratigraphic basis for detailed paleo-ecological studies of the shelf faunas (Sutton and others, 1970, Thayer, 1973).

Present study -

In 1965 M. R. House (University of Hull, England) with the author as field assistant, began a study of the goniatite sequence of the Upper Devonian of New York, concentrating on the units above the Sonyea Formation; at that time the author was completing a study of the Cashaqua Shale and more recently work has expanded to include details of the lower Genesee Formation.

FIGURE 2



GENERALIZED CROSS SECTION OF LOWER U.DEV. ROCKS-
WESTERN NEW YORK
(Adapted from Pepper, deWitt & Colton (1956) and deWitt & Colton (1959))

The preliminary results of House's study are available (House, 1966, 1968) and the purpose of this field trip is to demonstrate these and additional findings in sections from the Warsaw Valley to the Genesee Valley (Figs. 2 and 3); this area has been mapped in detail by Clarke and Luther (1908) and Sutton (1951). Of perhaps greatest interest has been the use of thin black shales (within the major cyclothemic units) for intraformational correlations over relatively long distances. Recognition of such units allows one to position the goniatite horizons in the stratigraphic succession, which is an important step in establishing a zonal standard and undertaking phylogenetic and paleoecological studies of the various faunal elements.

GENESEE FORMATION

Geneseo and Penn Yan shale members -

In the field trip area the black shales of the Geneseo Member overlie richly fossiliferous gray shales of the Moscow Formation and, locally, the thin lenticular Leicester Pyrite, both of Middle Devonian age (Fig. 4A - B). The so-called dwarfed fauna of the Leicester Pyrite includes bivalves, gastropods, brachiopods, crinoids and ostracods (Loomis, 1903); this is also the type horizon of the goniatite *Tornoceras (T.) uniangulare* (Conrad) (House, 1965, p. 105).

In Western New York the basal black shales of the Geneseo Member are succeeded by dark gray shales with thin limestones and concretion horizons which are followed by black shales interbedded with dark gray shales. The uppermost pair of these black shales, which can be traced from the Cayuga Creek section to the east side of the Genesee Valley, defines the top of the Geneseo Member. DeWitt and Colton (1959, p. 2816) regarded the interval of dark gray shales as a tongue of the Penn Yan Member but since these shales pinch out both east and west of the Genesee Valley they are here assigned to the Geneseo Member. The Penn Yan Member overlies the Geneseo Member and underlies the Genundewa limestone member and is composed of

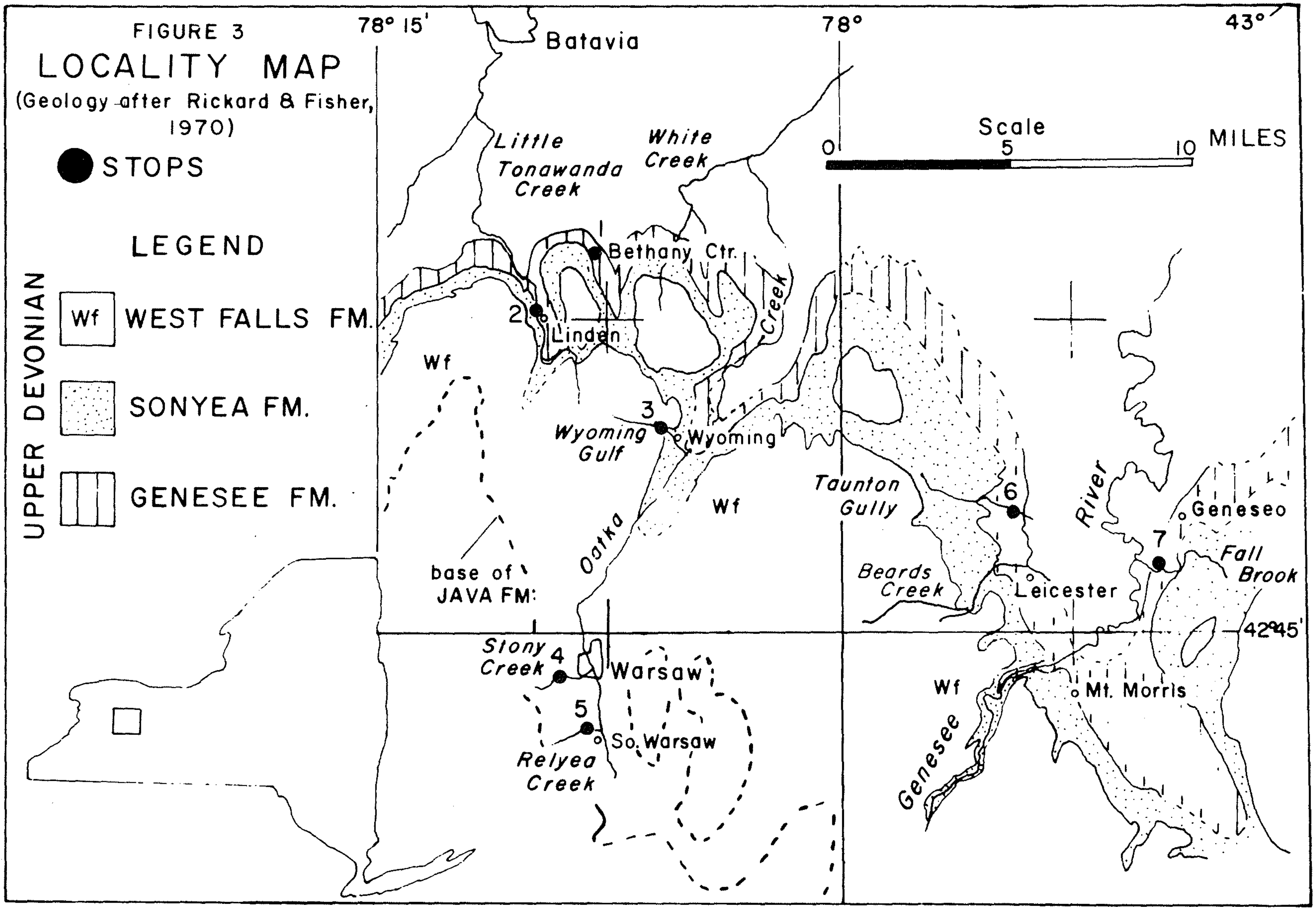


FIGURE 3

LOCALITY MAP

(Geology after Rickard & Fisher, 1970)

dark gray shales with numerous thin limestones and concretion horizons and a few thin black shales. In the Genesee Valley the combined Geneseo and Penn Yan Members are about 80 feet thick. This interval thins rapidly westward and west of Cayuga Creek, where the succession is strongly condensed, the two members cannot be differentiated; at Cazenovia Creek the interval is 2 feet thick and at Eighteenmile Creek it has thinned to less than 0.5 feet thick and the position of the members is occupied by the North Evans Limestone ("Conodont Bed"), a lenticular bone-bed calcarenite.

The rather meager fauna of the Geneseo and Penn Yan Members is characterized by the thin shelled bivalve *Pterochaenia fragilis* (Hall) and the small narrow cones of the cricoconarid *Styliolina fissurella* (Hall), the latter sometimes in great abundance. The zone fossil *Ponticeras perlatum* (Hall) and *Tornoceras* occur in both members in the field trip area but neither are common and most specimens are crushed; the best preserved ponticeratids come from the Lodi Limestone in the Penn Yan Member around Seneca Lake (Plate 1). Prior to House's (1968, p. 1065) discovery of *Manticoceras* in the Penn Yan Member east of the Genesee Valley, the zone of *Manticoceras* was thought to begin with the appearance of abundant goniatites in the Genundewa limestone member. House's report is corroborated here with the discovery in the Penn Yan Member of a goniatite horizon with *Manticoceras* in sections from Linden, N.Y. to the Genesee Valley.

Genundewa limestone member -

In the field trip area the Genundewa Member ("*Styliola*" limestone) consists of a series of 4 or 5 irregularly bedded, nodular limestones totaling about 1 to 2.5 feet in thickness and is distinguished by an extraordinary abundance of shells of *Styliolina fissurella*. The Genundewa thickens eastward from 8 to 9 inches around Lake Erie to about 16 feet in the type area at Canandaigua Lake, the thickening due mostly to the increase in thickness of the shales interbedded with

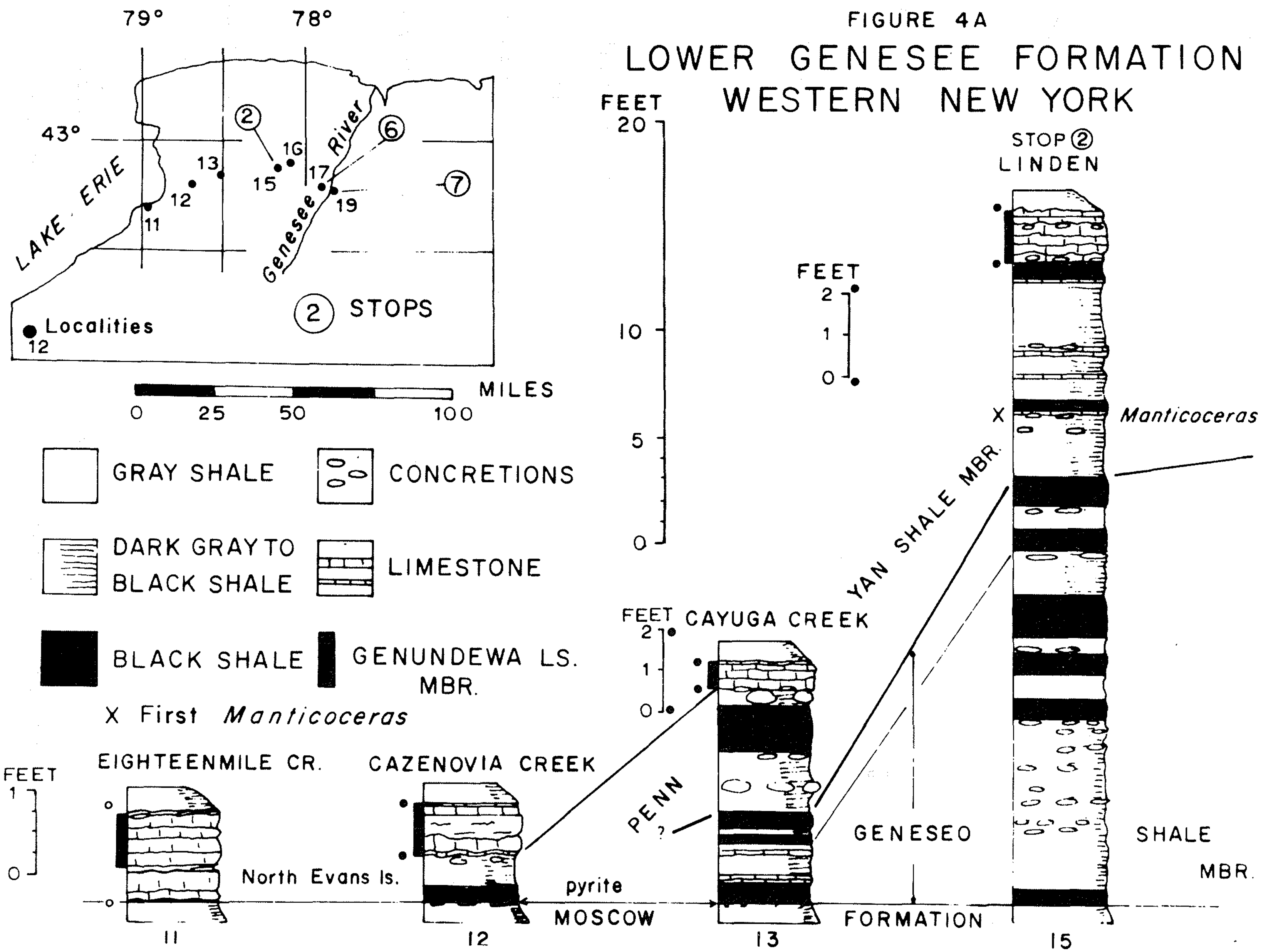
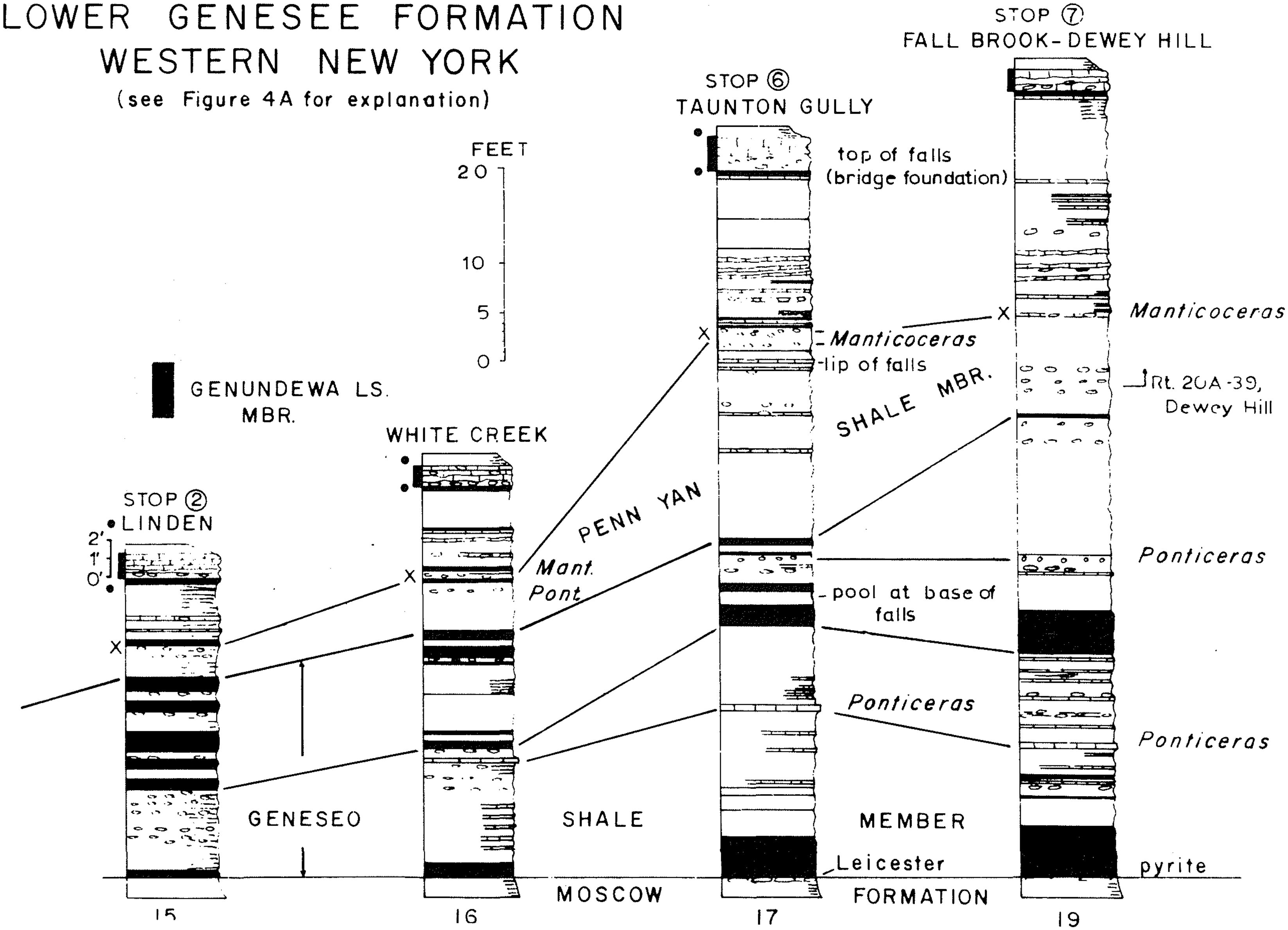


FIGURE 4A
LOWER GENESEE FORMATION
WESTERN NEW YORK

FIGURE 4B

LOWER GENESEE FORMATION WESTERN NEW YORK

(see Figure 4A for explanation)



the lenses. The Genundewa lithology is one of coarsely crystalline calcite and calcareous shells with variable amounts of pyrite, quartz and accessory glauconite (Sass, 1951).

In addition to the ubiquitous *Styliolina,* the Genundewa fauna ("pronuncial" Naples Fauna of Clarke) includes the bivalves *Pterochaenia fragilis, Paracardium doris* (Hall), *Buchiola retrostriata* (v. Buch), species of *Honeoyea,* various gastropods, bactritid cephalopods, brachiopods, ostracods, conodonts, crinoids and plant fragments (see Sass, 1951 for faunal lists). The Genundewa horizon marks the appearance of an abundant diverse goniatite fauna comparable to the *Manticoceras cordatum* (I (ß) γ or Iß) zone-fauna of Europe (House, 1962, p. 256). Of the five species of ***Manticoceras*** reported from the Genundewa (none of which are adequately known), the zone fossil *M. styliophilum* Clarke is the most common. *Tornoceras (T.) uniangulare compressum* Clarke is locally abundant. The Genundewa is also the type horizon of *Probeloceras genundewa* (Clarke) a form which appears to be restricted to the upper part of the member.

The conodont faunas of the lower Genesee Formation, particularly those from the North Evans Limestone and the Genundewa Member are among the earliest to receive intensive study (Hinde, 1879; Bryant, 1921). Conodonts reported from the Genundewa Member include various species of *Polygnathus* and the zone fossil *Ancyrodella rotundiloba* (Bryant).

West River Shale member -

The dark concretion-bearing shales of West River Member (above the Genundewa Member) and the overlying black shales of the Middlesex Member (Sonyea Formation) have not been studied in detail and are not considered in this report.

SONYEA FORMATION

Cashaqua shale member -

In Western New York the Middlesex black shale member is overlain by the distinctive soft olive green shales of the Cashaqua Member. It is in this unit that the Naples Fauna attains its richest development. Two major facies are recognized in the member, a concretion facies in the farthest off-shore area between Lake Erie and Honeoye Lake and a nodule facies (Rye Point Shale of Sutton, 1960) extending eastward to Seneca Lake (Kirchgasser, 1967, 1969). The upper part of the Cashaqua is distinguished by an interval of dark gray shales which in turn are overlain, with sharp contact, by the black shales of the Rhinestreet Member of the West Falls Formation.

The concretion facies consists of alternations of olive green shales and discontinuous horizons of concretions and thin argillaceous limestones. East of the Genesee Valley the shales in the lowermost part of the Cashaqua Member interfinger with westward thinning turbidite wedges of siltstones comprising the Pulteney and Rock Stream Members (Walker and Sutton, 1967). The western concretion facies of the Cashaqua correlates eastward with the nodule facies, a condensed sequence of burrowed and current-reworked arenaceous shales and nodule beds believed to have accumulated on submarine swells formed by the siltstones of the Rock Stream Member (Kirchgasser, 1967, 1969).

Scattered through the rocks of the concretion facies are small, thin-shelled molluscs, the most common of which are *Styliolina fissurella, Buchiola retrostriata, Pterochaenia fragilis* and *Protospirialis minutissima* Clarke, along with minute brachiopods such as *Lingula ligea* Hall and *Chonetes lepidus* Hall. Among the cephalopods *Bactrites aciculum* (Hall), *Manticoceras sinuosum* (Hall) and *Tornoceras (T.) uniangulare obesum* Clarke and the zone fossil *Probeloceras lutheri* (Clarke) frequently occur although they are generally not well preserved. The best preserved goniatite faunas, dominated by *P. lutheri* or *M. sinuosum,* come from a series of concretion horizons in about the middle of the member west of field trip area and from the nodule facies in the area from Canandaigua Lake to Keuka Lake. It is in this latter area where the bottom conditions were more agitated and shallower that the Naples Fauna is most diverse. In addition to the forms listed above, the fauna there includes much larger bivalves such as species of *Lunulicardium* and *Honeoyea, Ontaria suborbicularis,* the gastropods *Loxonema noe* Clarke, *Palaeotrochus praecursor* (Clarke) and *Phragmostoma natator* Hall and auloporid corals. The Naples Fauna is particularly well developed in the nodular Parrish Limestone around Naples, N.Y. (Kirchgasser, 1965).

A series of dark shales with a few persistent thin black shales forms a well defined band in the upper Cashaqua from Lake Erie to the Canandaigua Lake area. These dark shales mark a recurrence of a facies comparable to that of the Geneseo and Penn Yan shales. The sparse fauna, which includes *Styliolina fissurella Ontaria suborbicularis, Buchiola retrostriata, Paracardium doris* and *Bactrites aciculum,* and rare goniatites, is distinguished by the common occurrence of *Pterochaenia cashaquae* Clarke. The upper dark shale facies of the Cashaqua is further distinguished by a horizon of septaria with abundant *Styliolina fissurella* which occurs a few feet below the base of the Rhinestreet Shale between Lake Erie and Canandaigua Lake. Around Conesus and Honeoye Lakes this horizon is noted for its well preserved baritic fauna in which *Palaeotrochus praecursor, Buchiola retrostriata, Loxonema noe, Phragmostoma natator, Bactrites aciculum, Manticoceras sinuosum* and *Tornoceras (T.) uniangulare obesum* are particularly common. This also is the type horizon of *M. neapolitanum* (Clarke) and a new species of *Probeloceras,* to be described in a forthcoming paper, which is distinguished from the common *P. lutheri* lower down in the Cashaqua, by its concave periphery. The conodont fauna of the Cashaqua includes *Ancyrodella nodosa* Ulrich and Bassler and *Palmatolepis punctata* (Hinde) indicating the Upper *Pol. asymmetricus* Zone.

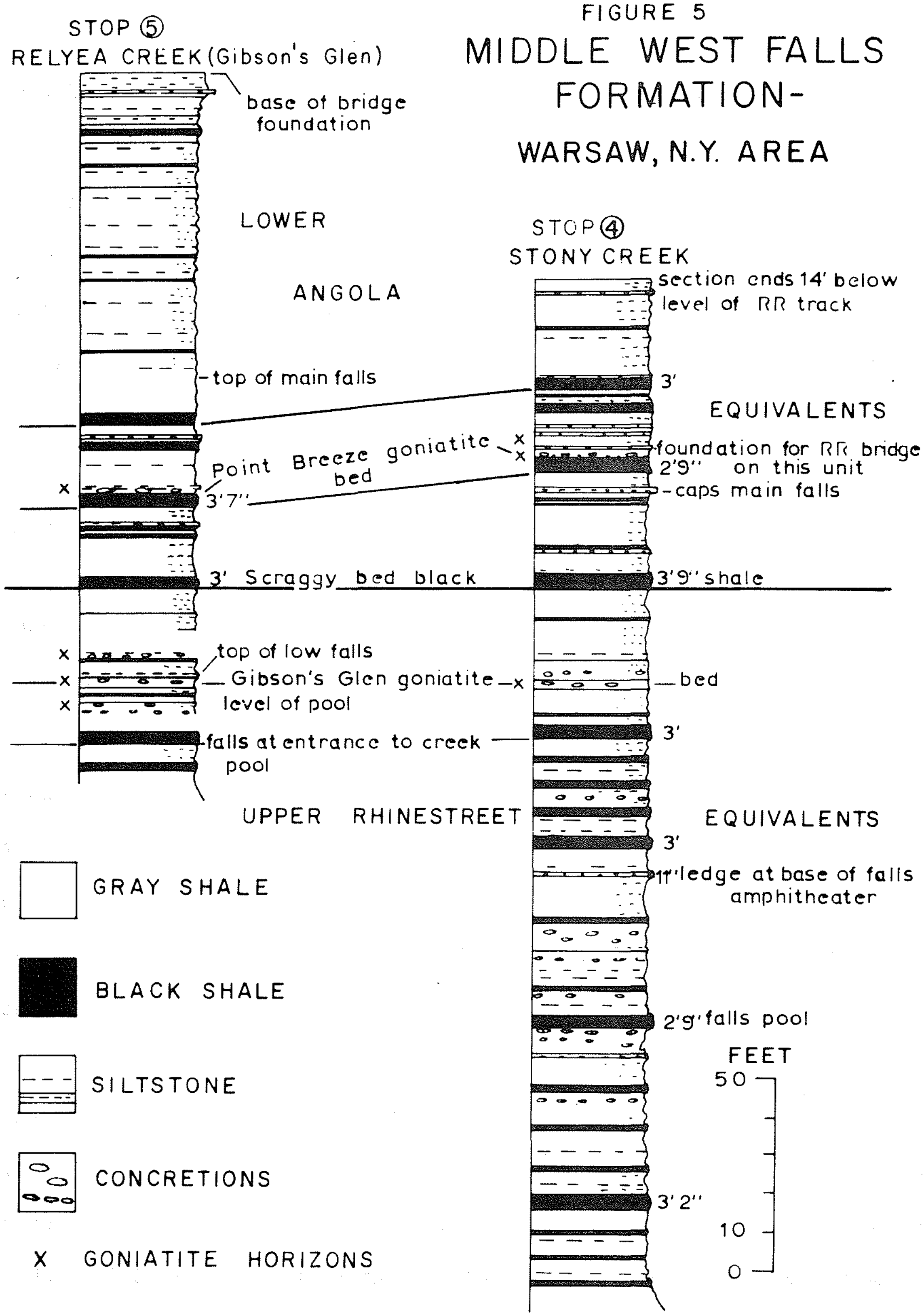
WEST FALLS FORMATION

Around Lake Erie the West Falls Formation is composed of the black shales of the basal Rhinestreet Member and the overlying gray shales of the Angola Member. The boundary between the Rhinestreet and Angola Members is marked by the Scraggy Bed (Luther, 1903), a horizon of irregular pyritic concretions. The lower Angola Member is characterized by minor cyclothemic units of thin black shale, burrowed gray shale and gray shale with concretions and thin siltstones. Several of the concretion horizons have goniatites, among them Clarke's goniatite horizons from Big Sister Creek, Angola, N.Y. (House, 1966, p. 55; 1968, p. 1065). The West Falls Formation thickens rapidly to the east (shoreward) as the black and gray shale facies of the west intertongue with more arenaceous facies (Fig. 2).

The lowermost minor cycles of the Angola Member have been traced bed-by-bed from Lake Erie shore as far as the Warsaw Valley, where the members of the West Falls Formation are (from oldest to youngest) the Rhinestreet black shales Gardeau gray shales, siltstones and black shales, the West Hill siltstones and gray shales and the Nunda sandstones. The black shale immediately overlying the Scraggy Bed, which to the west marks the Rhinestreet-Angola boundary, occurs in the upper part of the Gardeau Member (Figs. 3, 5). In Stony Creek (Stop 4) and Relyea Creek (Stop 5) the well known Gibson's Glen (Relyea Creek) Goniatite Bed occurs 24 to 25 feet below the Scraggy Bed black shale, in rocks equivalent to the upper Rhinestreet of westernmost New York (House, 1968, p. 1066). Another key goniatite horizon, named the Point Breeze Goniatite Bed (House, 1968, p. 1066) has been traced from its type exposure in the lower Angola on Lake Erie shore into Warsaw succession where it occurs 23 feet above the Scraggy Bed black shale in Relyea Creek and 30 feet above the same shale in Stony Creek. Attempts to trace the above mentioned horizons farther east into the succession

FIGURE 5

MIDDLE WEST FALLS FORMATION- WARSAW, N.Y. AREA



in the Genesee Valley (gorge section in Letchworth Park, Mr. Morris) proved unsuccessful but L. V. Rickard (NYS Museum; personal communication, 1973), working with subsurface data, has recently traced several key horizons into the Genesee Valley section and sections farther to the southeast.

In the field trip area the goniatite-bearing concretion horizons of the Gardeau Member (equivalent to Upper Rhinestreet and Lower Angola to the west) include the zone fossil *Manticoceras rhynchostoma* Clarke, forms like *M. sinuosum* (Hall), large oxyconic manticoceratids (laterally compressed with acute periphery) along with *Tornoceras* and *Aulatornoceras*. In general the fauna of the Gardeau Member is a diminished Naples Fauna with many forms ranging upward from the Cashaqua Shale (see Clarke and Luther, 1908, p. 60-61 for faunal list).

The shales of the lowermost Rhinestreet Member are well known for their conodonts (Ulrich and Bassler, 1926; Huddle, 1968) and the faunas include *Ancyrodella nodosa* and *Palmatolepis punctata,* indicating the Upper *Polygnathus asymmetricus* Zone. The succeeding *Ancyrognathus triangularis* Zone begins in the Gardeau Member (Klapper and others, 1971, p. 302).

Explanation Plate 1 - Lower Upper Devonian goniatites from the Genesee, Sonyea and West Falls Formations, Western New York.

1-2. *Manticoceras rhynchostoma* Clarke. Angola Shale (West Falls Fm.) 1. Lateral view; Big Sister Creek, Erie Co., N.Y. From Miller, 1938 after Clarke, 1898. 2. Cross-section; Angola, N.Y. From Miller, 1938 after Clarke, 1898.

3-4. *Probeloceras* n. sp. Cashaqua Shale (Sonyea Fm.) (Probably from septarian horizon in upper dark shale facies of Cashaqua around Honeoye Lake). 3. Lateral view and 4. Cross-section. Specimen figured (as *P. lutheri*) by Clarke, 1898, pl. 7, fig. 4 and House, 1962, pl. 45, figs. 5, 6; text-fig. 3C-D.

5-7. *Manticoceras sinuosum* (Hall). Cashaqua Shale (Sonyea Fm.) 5. Cross-section; baritic specimen from septarian horizon in upper dark shale facies, Cottonwood Point, Conesus Lake. 6. Cross-section; concretion horizon 34.5 feet below top of member, Cayuga Creek, Cowlesville, N.Y. 7. Lateral view; pyritic specimen, shales 35 feet below top of member, Beards Creek, near Pine Tavern, N.Y.

8-9. *Probeloceras lutheri* (Clarke). Cashaqua Shale (Sonyea Fm.) 8. Lateral view; concretion horizon 55 feet below top of member, Wyoming Gulf, Wyoming, N.Y. 9. Cross-section; concretion horizon 34.5 feet below top of member, Cayuga Creek, Cowlesville, N.Y.

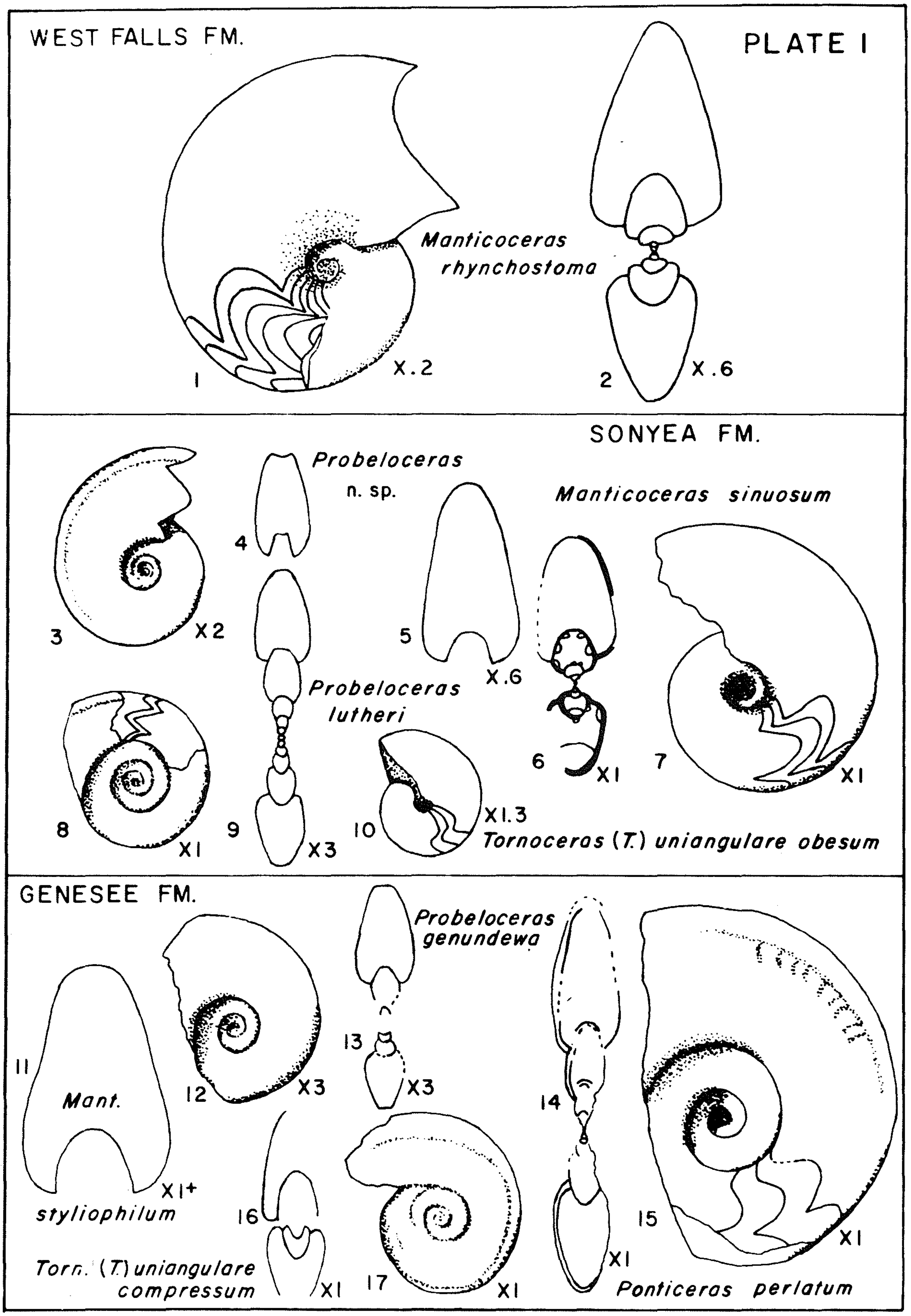
10. *Tornoceras (T.) uniangulare obesum* Clarke. Cashaqua Shale (Sonyea Fm.) Concretion horizon 22 feet above base of member (top of Rock Stream Siltstone), Randall Gully, near Bristol Center, N.Y.

11. *Manticoceras styliophilum* Clarke. Genundewa Limestone (Genesee Fm.) Near Canandaigua Lake. From Miller, 1938 after Clarke, 1898.

12-13. *Probeloceras genundewa* (Clarke). Genundewa Limestone (Genesee Fm.) 12. Lateral view and 13. Cross-section. Top of member, Beards Creek, Leicester, N.Y.

14-15, 17. *Ponticeras perlatum* (Hall). Genesee Formation 14. Cross-section and 15. Lateral view; Lodi Limestone (Penn Yan Shale), Ovid, N.Y. 17. Lateral view; Geneseo Shale: Limestone 13 feet above base of member, Fall Brook, near Geneseo, N.Y.

16. *Tornoceras (T.) uniangulare* compressum Clarke. Genundewa Limestone (Genesee Fm.). Cross-section; Bethany Center, N.Y. From House, 1965.



WEST FALLS FM.
PLATE I
Manticoceras rhynchostoma
1
X.2
2
X.6
SONYEA FM.
Probeloceras n. sp.
Manticoceras sinuosum
3
X2
4
5
X.6
6
X1
7
X1
Probeloceras lutheri
8
X1
9
X3
10
X1.3
Tornoceras (T.) uniangulare obesum
GENESEE FM.
Probeloceras genundewa
11
Mant.
X1+
styliophilum
12
X3
13
X3
14
X1
15
X1
Ponticeras perlatum
16
X1
Torn. (T.) uniangulare compressum
17
X1

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TRIP : Lower Upper Devonian Stratigraphy from the Batavia-Warsaw Meridian to the Genesee Valley: Goniatite Sequence and Correlations.

ROAD LOG

Cumulative Miles	Miles from last point	Description
(7 1/2' Quadrangle Maps)		
0.0	0.0	Assembly point: Parking lot, Towne House Motor Inn, Rt. 15 and Mt. Hope Street, Rochester, N.Y. Departure time: 8:00 A.M. Turn right (S) out of parking lot onto U.S. Rt. 15 and proceed toward N.Y. Thruway (Interstate 90).
5.4	5.4	Turn left at N.Y. Thruway Entrance (Interchange 46) and proceed WEST BOUND toward Buffalo.
21.7	16.3	Exist Thruway at Interchange 47.
22.3	.6	Turn onto N.Y. Rt. 19 and proceed SOUTH to LeRoy, N.Y.
27.0	4.7	Jct. Rt. 19 and N.Y. Rt. 5, LeRoy, N.Y.; continue SOUTH on Rt. 19.
(Stafford)		
32.1	5.1	Jct. Rt. 19 and U.S. Rt. 20. Take Rt. 20 WEST.
34.7	2.6	Jct. Rt. 20 and N.Y. 63. Continue West on Rt. 20.
36.1	1.4	West branch White Creek. Continue West on Rt. 20 past East Road (0.6 miles) and Black Creek (1.0 miles) and proceed up the hill.
38.1	2.0	STOP 1: BETHANY CENTER, N.Y. Park below the overpass at right turnoff to Bethany Center. Walk down hill on north side of Rt. 20 and observe loose blocks of Genundewa Limestone on the embankment. Although the rocks are weathered and picked over,this remains one of the best collecting sites for the fauna of the Genundewa Limestone. In addition to the ubiquitous *Styliolina,* the more common fossils are species of *Pterochaenia* and *Bactrites, Tornoceras (T.) uniangulare compressum* and forms referable to *Manticoceras styliophilum*. The less weathered blocks of limestone yield abundant conodonts when digested in dilute acetic acid. Continue WEST on Rt. 20; pass under Center Road overpass and continue past Jct. with Marsh Road (on left) (0.9 miles).

Cumulative miles		Miles from last point	Description
39.8		1.7	Turn left (S) onto Silver Road (farm on left with many silos) and enter one of more scenic areas of Genesee and Wyoming Counties.
40.4		0.6	Turn left onto Mill Road and follow valley of Little Tonawanda Creek past Jct. with Smith Road (on left) (0.6 miles).
41.5		1.1	STOP 2: LINDEN, N.Y. Walk to edge of Little Tonawanda Creek and observe section of lower Genesee Formation (Geneseo, Penn Yan and Genundewa members) in falls of side creek (Fig. 4A-B) (Private Property).

The contact with the underlying Moscow Formation is at about creek level. At this locality the Geneseo-Penn Yan interval is 31 feet thick; at Eighteenmile Creek near Lake Erie this same interval is less than 0.5 feet thick and on the east side of the Genesee Valley (Stop 7) it is 80 feet thick.

The Geneseo-Penn Yan contact is drawn at the top of a pair of black shales which outcrop in the face of the falls; the horizon of these shales has been traced westward to Cayuga Creek and eastward to the east side of the Genesee Valley.

Manticoceras first appears in the Penn Yan Member in a concretion horizon 8.5 feet below the base of the Genundewa Limestone, which caps the falls. *Tornoceras (T.) uniangulare compressum* and forms referable to *Manticoceras styliophilum* are common in the Genundewa Limestone in this area.

Continue SOUTH on Mill Road and follow left (east) side of the triangular intersection above falls at village of Linden.

41.8		0.3	Turn (E) left at the intersection.
42.0		0.2	Take the right (S) branch of Y-intersection onto Skates Hill-Belknap Road and proceed toward West Middlebury.
43.0	(Dale)	1.0	Village of West Middlebury. At T-junction, turn left (E) onto West Middlebury Road.
45.5	(Wyoming)	2.5	Turn right (S) at T-junction (Wrights Corner) and proceed SOUTH on East Bethany Road toward Wyoming, N.Y.

Cumulative miles	Miles from last point	Description
47.4	1.9	STOP 3: WYOMING GULF. Park on right (S) side of road at Jct. with Wass Road (on right).
		Contact between Cashaqua and Rhinestreet Shales occurs in road cut above the intersection.
		The dark shale facies of the upper Cashaqua is rather poorly exposed here but the characteristic fossil *Pterochaenia cashaquae* is common at some levels; The horizon of baritic septaria which characterizes the uppermost Cashaqua is not exposed at this locality. A 3 inch thick black shale about 10 feet below the base of the Rhinestreet has been traced in about the same position from Lake Erie to Honeoye Lake.
		Walk down the hill and observe roadcuts (or stream section) of the concretion facies of the Cashaqua. The following fossils are common in olive green shales and concretions: *Styliolina fissurella, Buchiola retrostriata, Paracardium doris, Pterochaenia* sp., *Protospirialis minutissima, Bactrites aciculum* and *Probeloceras lutheri.* Less common are: *Ontaria suborbicularis, Loxonema noe, Palaeotrochus praecursor, Spathiocaris emersoni* (crustacean), *Tornoceras (T.) uniangulare obesum* and *Manticoceras sinuosum.*
		In general the fauna is dominated by small shells and is less diverse than the Naples Fauna in the nodule facies of the Cashaqua around Canandaigua and Keuka Lakes where in more arenaceous, current-reworked, and probably shallower water sediments, the larger bivalves such as *Lunulicardium, Ontaria,* and *Honeoyea* were important elements.
		Continue SOUTH on East Bethany Road to Village of Wyoming.
47.9	0.5	Jct. N. Y. Rt. 19. Turn right (S) on Rt. 19 and proceed SOUTH along the Oatka Creek (Wyoming) Valley toward Warsaw, N.Y.
(Warsaw) 54.7	6.8	Jct. Rt. 19 and U.S. Rt. 20A, Warsaw, N.Y. Turn right (W) on Rt. 20A and proceed up the hill past exposures of the Gardeau Member, West Falls Formation.

Cumulative miles	Miles from last point	Description
55.7	1.0	STOP 4 - STONY CREEK. Park beyond RR tracks opposite RR station. Cross Rt. 20A (CAUTION) and walk 0.5 miles SOUTH along RR tracks to Stony Creek. Climb down embankment to left of bridge. CAUTION: STAY OVER TO LEFT, AWAY FROM THE FALLS !!
		Observe section in middle part of West Falls Formation (Figs. 2, 5). At this meridian, the western Angola shale facies (member) interfingers with the more arenaceous Gardeau facies. The succession consists of silty gray shales interbedded with siltstones black shales and concretion horizons. The siltstones, many of which are crossbedded and ripplemarked, are thicker and more numerous toward the top of the section.
		The black shale above the Scraggy Bed, which marks the Rhinestreet-Angola contact around Lake Erie, is represented in this section by a 3 foot 9 inch bed of black shale, 22 feet below the top of the 1 foot thick siltstone capping the main falls. The Gibson's Glen Goniatite Bed (Stop 5) occurs lower down, 25 feet below the base of the Scraggy Bed black shale, in rocks equivalent to the Upper Rhinestreet of westernmost New York. The Point Breeze Goniatite Bed, which has been traced from its type exposure on Lake Erie shore, occurs 7.5 feet above the 1 foot thick siltstone in rocks equivalent to the Lower Angola Shale to the west.
		Return to village of Warsaw.
56.5	0.8	Turn right (opposite school) onto Liberty Street and proceed two blocks.
56.9	0.4	Village Park, Warsaw, N.Y. LUNCH
		From main park entrance turn left onto Liberty Street, proceed one block and turn right onto Brooklyn Street.
57.3	0.4	Jct. Rt. 19. Turn right (S) onto Rt. 19 and proceed SOUTH toward South Warsaw, N.Y.
58.9	1.6	STOP 5 - RELYEA CREEK. (0.2 miles north of center of Village of South Warsaw).
		Section commences at edge of farm field, 500 yards west of Rt. 19 at c. 1100 feet altitude. (Private property).

Cumulative miles	Miles from last point	Description
		The Gibson's Glen Goniatite Bed, noted for its well preserved specimens of *Manticoceras rhynchostoma*, outcrops in the face of the low falls about 100 yards upstream from start of section (Fig. 5).; goniatites are also common in concretions about 5 feet above the top of the falls.
		The Scraggy Bed black shale outcrops about 100 yards farther upstream, about 2 feet above the base of the high falls. The Point Breeze Goniatite Bed occurs in the face of the falls, about 23 feet higher, beneath an 11 inch thick siltstone.
		Return to Warsaw via Rt. 19.
60.8	1.9	Jct. Rt. 19 and Rt. 20A. Turn right (E) onto Rt. 20A.
67.7	6.9	Jct. N.Y. Rt. 246. Continue EAST on Rt. 20A.
(Mount Morris-Leicester) 71.6	3.9	Jct. Rt. 20A and N.Y. Rt. 39. Turn left (N) on 20A-39 and proceed toward Leicester, N.Y.
73.9	2.3	Jct. Rt. 20A - 39 and N.Y. Rt. 36, Village of Leicester. Turn left (N) onto Rt. 36. Cross Beards Creek (0.2 miles) and continue past Covington Road (left) (0.3 miles), Little Beards Creek (1.1 miles) and New Road (1.3 miles).
75.5	1.6	STOP 6 - TAUNTON GULLY. Park on right side of Rt. 36 and cross the highway (CAUTION). The bus will proceed to rendezvous point at top of section. Those who do not wish to walk the entire creek section (about one mile) may stay on the bus:
		Proceed NORTH on Rt. 36.
75.8	0.3	Turn left (W) onto Peoria Road.
76.7	0.9	Turn left (S) onto Starr Road.
76.9	0.2	Bridge over Taunton Gully; rendezvous point.
		Section commences in Geneseo shale member (Genesee Formation) above Leicester Pyrite, about 2000 feet west of RR bridge at 730 feet elevation (Fig. 4B).
		Styliolina fissurella and *Pterochaenia fragilis* occur in the gray shales and thin argillaceous limestones above the basal black shales of the Geneseo and poorly preserved *Ponticeras perlatum* and *Tornoceras* sp. are not uncommon in the most prominent limestone outcropping 17 feet above the base of the member. This limestone is also recognized at White Creek, Beards Creek, and Fall Brook.

Cumulative miles	Miles from last point	Description
		The Geneseo-Penn Yan contact is drawn at the top of a pair of black shales about 4.5 feet above the 10 inch black shale near the level of the pool at the base of the main falls. The bed of small nodules immediately below the lower member of the pair of black shales contains rare *Ponticeras* in the Beards Creek and Fall Brook sections. Forms referable to *Ponticeras perlatum* occur in the concretion horizon 3 feet below the 1 foot interval of thin *Styliolina* limestones which form the lip of the falls; similar limestones are frequent higher in the Penn Yan Member.
		Manticoceras first appears in the section in a 2 foot interval of concretions and nodules beneath a 5 inch black shale, 16 feet below the base of the Genundewa limestone member. *Probeloceras genundewa* occurs in the topmost beds of the Genundewa which outcrop a few feet upstream from the road bridge.
		Return to Leicester via Rt. 36.
79.9	3.0	Turn left (E) onto Rt. 20A - 39 and N.Y. Rt. 36.
80.1	0.2	Jct. Rt. 20A - 39 and Rt. 36. Continue straight (E) on Rt. 20 A - 39 toward Geneseo, N.Y.
(Geneseo)		Proceed past Cuylerville onto floodplain of the Genesee River.
83.0	2.9	Genesee River
83.3	0.3	Fall Brook.
83.7	0.4	STOP 7 - DEWEY HILL
		Roadcut exposes upper Penn Yan shale and Genundewa limestones members (Genesee Formation) (Fig. 4B)
		The Geneseo and Penn Yan members are well exposed in the classic section in nearby Fall Brook but most of the Penn Yan is inaccessible except in the side creek. In the road section the Penn Yan is characterized by silty gray shales interbedded with many thin argillaceous limestones and a few concretion horizons. Several of the thin limestones are composed almost entirely of *Styliolina fissurella*.

Cumulative miles	Miles from last point	Description
		Poorly preserved goniatites identified as *Manticoceras* and *Tornoceras* occur in a 4.5 inch thick limestone above the interval of concretions near the base of the section, and similar forms occur about 3 feet higher in the lowest member of a set of three *Styliolina* limestones.
		The Genundewa limestone, which caps the Falls at Fall Brook, outcrops at the crest of the hill.
		Continue (E) on Rt. 20A - 39 to top of hill.
83.9	0.2	Jct. 20A - 39 and N.Y. 63. Turn left (N) and continue on Rt. 20A - 39 into village of Geneseo.
84.9	1.0	Jct. Rt. 39 and Rt. 20A. Proceed EAST on Rt. 20A.
91.0	6.1	Jct. Rt. 20A and N.Y. Rt. 256. Turn left (N) onto Rt. 256.
92.4	1.4	Jct. Rt. 256 and U.S. Rt. 15. Turn left (N) on Rt. 15 and proceed NORTH to Rochester.
106.5	14.1	Entrance to N.Y. Thruway (Interchange 46).
111.9	5.4	Towne House Motor Inn.

Trip D

EURYPTERID HORIZONS AND THE STRATIGRAPHY OF THE UPPER SILURIAN AND ?LOWER DEVONIAN OF WESTERN NEW YORK STATE

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Introduction

The Upper Silurian rocks of New York State comprise an interesting variety of distinct lithologies, e.g. red and green shales, some sandstone, limestone and dolostone, halite, gypsum, and anhydrite. While these rocks are of economic importance because of the halite and gypsum deposits they contain, much of current geologic interest in these strata is concerned with their sedimentology, correlation, and more recently, the paleontology of certain well-known fossiliferous units (see, for example, Treesch 1972, Rickard 1969, Berry and Boucot 1970, Berdan 1972). Often overlooked is the unusual eurypterid and scorpion faunas which these generally "unfossiliferous" rocks contain.

The purpose of this article and associated field trip is to familiarize the reader with the Upper Silurian and ?Lower Devonian rocks of the Genesee region, particularly the Bertie Group, and to examine outcrops of these rocks at localities which have yielded eurypterid remains.

Stratigraphy and Paleontology

The following rock units, in ascending stratigraphic order, constitute the Upper Silurian (Cayugan Series) and ?Lower Devonian (Helderbergian Series) of Western New York (Fig. 1). The lowest Cayugan unit is the Pittsford Shale (local member or facies of the Vernon Fm.), succeeded by the Vernon Fm., Syracuse Fm., Camillus Fm., Fort Hill Waterlime (new), Oatka Shy. Ds., members of the Fiddlers Green Fm. (formerly Falkirk), Scajaquada Fm., Williamsville Waterlime, Cobleskill Fm. (formerly Akron), Honeoye Falls Fm.

Recent stratigraphic studies which at least mention various portions of the Upper Silurian of Western New York include Rickard 1962, 1969, Fisher 1960, Leutze 1959.

A problem often encountered in the field is the identification of the various units in the upper portion of the Cayugan Series. Most commonly the Cobleskill Fm. is confused with all or the middle portion of the Fiddlers Green Fm. (and vice versa).

Indeed, at one time or another each of the units has been erroneously identified or confused with some other unit. The primary reasons for these errors are as follows:

1. The unconformity below the Devonian Bois Blanc-Onondaga Ls: This causes different units to be exposed beneath this unconformity at different localities. In central-eastern New York most of the units are always exposed because Helderbergian strata are exposed beneath this unconformity (Manlius, etc.)

2. Similarity of units: Many of the units appear to be lithologically similar in the field. For example, below the Cobleskill Fm. occurs a waterlime (Williamsville) and below the middle Fiddlers Green Fm. (Victor Member) occurs another waterlime (Morganville or basal Fiddlers Green). As recently as 1969 a new exposure of Morganville Waterlime was identified by Duskin (1969 p. 53) as "Oxbow" (=Williamsville Waterlime). The nearby banks were described as Forge Hollow Fm. (Duskin 1969 p. 36). I regard these exposures as typical Camillus Fm.

The lithologic (and paleontologic) similarities of various units are the result of cyclic sedimentation during the Upper Silurian (and probably at least a portion of the Lower Devonian). This resulted in the recurrence of similar lithofacies at various stratigraphic intervals in the section. For example, note in Figure 1 the occurrence of 'waterlime' units which formerly (except for the Williamsville Waterlime) were disguised in other formations (for example the Fiddlers Green and the Oatka).

The cyclic nature of the Upper Silurian sequence in New York has received little attention except on a broad scale wherein the entire Cayugan of New York is interpreted as a complete cycle, "underlain and overlain by relatively 'normal' marine carbonates, the Lockport and Cobleskill Formations respectively" (Treesh 1972). Furthermore, the well-known occurrence of the two Eurypterus faunas (the Eurypterus remipes remipes DeKay fauna of the "Herkimer Pool" and the Eurypterus remipes lacustris Harlan fauna of the "Buffalo Pool") is due to cyclic sedimentation which caused the deposition of similar sediments (facies) at two different times represented by the stratigraphically lower Fiddlers Green Fm. in the eastern or Herkimer area, and the stratigraphically higher Williamsville Waterlime of the western or Buffalo area.

While the two faunas have been known for about 150 years, it was only recently suggested that the two faunas were not contemporaneous but rather that they represented two parallel faunas different in age (Caster and Kjellesvig-Waering 1956). This novel idea was based on reported facies changes of the Bertie with the Brayman Shale of eastern New York. This suggested that the Bertie Group or some of its units, represented transgressive units and thus could not be of the same age throughout their extent. Nevertheless, the Bertie Group and even the coralline Cobleskill Fm. were shown as being contemporaneous units in their respective occurrences across the state (New York State Geological Survey Correlation Chart of the Silurian-Fisher, 1959).

Interestingly, the occurrence of two additional eurypterid horizons within the Bertie Group has gone unnoticed until recently (Ciurca 1969), except for the important early observation that eurypterid remains occur in the "Oatka beds, dark gray and shaly with a blocky waterlime at base" (Chadwick 1917). The new horizons occur in the Morganville Waterlime and the stratigraphically lower Fort Hill Waterlime. These new occurrences appear to represent yet other examples of the cyclic nature of the Upper Silurian sequence in New York. Obviously, cyclic sedimentation also occurred in adjacent nearby areas (Pennsylvania, Ohio, etc.).

The cyclic sediments, represented by the lithostratigraphic units which constitute the Bertie Group and the overlying preBois Blanc/Onondaga Lss. (Devonian) beds, are described below in ascending order. The Vernon and Syracuse Fms. and the overlying Camillus Fm. will not be described since only the upper portion of the Camillus Fm. will be observed during the associated field trip.

Cayugan Series

FORT HILL WATERLIME

This thin unit (1 - 2 feet) has previously been only inconspicuously noticed (except for the keen observations of Chadwick 1917) as a waterlime at the base of the "Oatka beds." The unit is treated by Ciurca (1969) as a lithologic unit which can be traced from west of Oatka Creek (North LeRoy area) to Phelps, New York (exposures along N. Y. 88 and also N. Y. S. Thruway). The Fort Hill Waterlime is a very fine-grained straticulate dolostone. The type section is the exposure on N. Y. 19 north of LeRoy. At this locality it is characterized by small mineraliferous vugs (calcite?), large SALT HOPPERS, ostracods, and eurypterid remains (at least two species). The same lithology is seen at exposures near Phelps (exposures on both sides of N. Y. 88, along the N. Y. S. Thruway just to the east, and exposures in Flint Creek at Phelps). Outcrops east of this locality are rare, especially at this interval. The Fort Hill Waterlime, therefore, has not been recognized east of the Phelps area.

OATKA FORMATION

The Oatka Fm. consists of "shaly" dolostone. The type section is presumably at Buttermilk Falls, Oatka Creek, north of LeRoy, N. Y. The section at Flint Creek, Phelps is proposed as a reference section. The unit is approximately 10 feet thick in the LeRoy area and also at Phelps. No fossils have been found or reported. It is underlain by the Fort Hill Waterlime and overlain by the Morganville Waterlime Member of the Fiddlers Green Fm.

FIDDLERS GREEN FORMATION

The Fiddlers Green Fm. was named by Hopkins in 1914 for strata overlain and underlain by gypsiferous strata. The occurrence in this formation of the Eurypterus remipes remipes fauna, and the suggestion that this formation was of more than local extent and represented the "Falkirk Member" of the Bertie of Western New York was strongly suspected by Rickard (1953). I have carefully traced the Fiddlers Green Fm. (type section is Butternut Creek north of the village of Jamesville in Onondaga County) into the "Falkirk" of Western New York (Ciurca 1969) utilizing key structures. The use of the term "Falkirk" in Western New York is therefore discouraged. Furthermore, I have divided the Fiddlers Green Fm. into three members which are well-displayed in Western New York and traceable into the Fiddlers Green Fm. of Central-Eastern New York. The three members are described below:

MORGANVILLE WATERLIME

This lower unit of the Fiddlers Green Fm. consists of very fine-grained dolostone having a conchoidal fracture and containing a rare Eurypterus remipes ssp. fauna (Ciurca 1969). The type section of the Morganville Waterlime is the exposure in Black Creek at Morganville, Genesee County where it is overlain by the crystalline Victor Member of the Fiddlers Green Fm. The Morganville Waterlime is traceable from Buffalo to Cayuga Junction on the east side of Cayuga Lake without difficulty and is probably represented as far east as Forge Hollow, Oneida County. It contains SALT HOPPERS or salt crystal impressions and ostracods at several localities and a Eurypterus remipes sp. fauna at Cayuga Jct. and also at Marcellus Falls, N. Y. This unit was confused with the "Oxbow Waterlime" by Duskin (1969 p. 53).

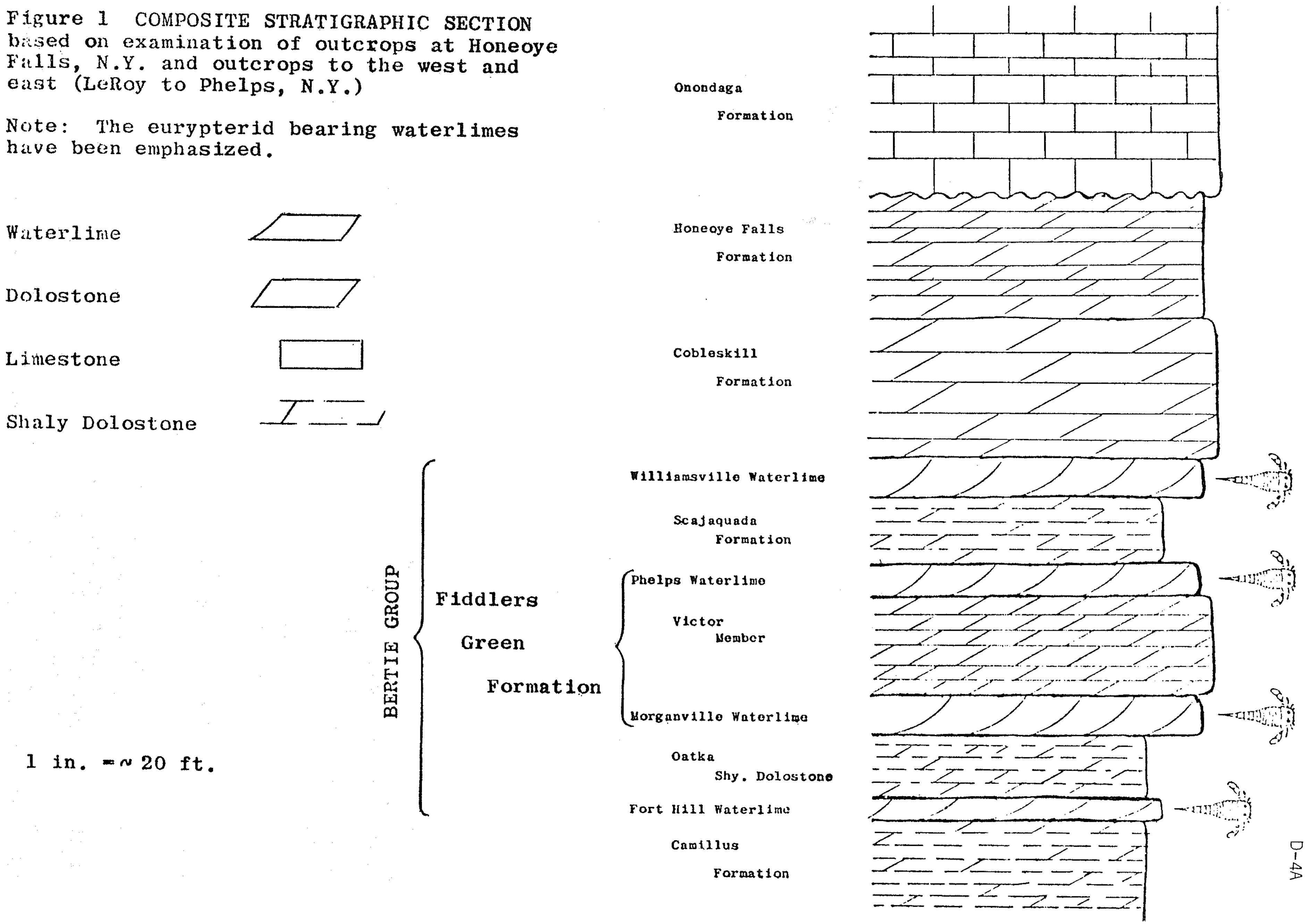
At Mud Creek, East Victor (immediately south of N. Y. 96) the Morganville Wl. forms a small falls and exhibits large conchoids. This occurrence is repeated in the village of Phelps beneath the N. Y. 96 bridge over Flint Creek).

VICTOR MEMBER (DOLOSTONE, LIMESTONE)

The middle Fiddlers Green Fm. consists of massive crystalline (sugary) dolostone, often mottled, and some limestone. The type section is in Mud Creek, East Victor, Ontario County south of N. Y. 96. A reference section is the excellent exposure along the N. Y. S. Thruway north of Phelps, New York. This unit is fossiliferous (though fossils are often poorly preserved and difficult to extract) and contains a brachiopod fauna, ostracods and eurypterid remains. It has been confused with the Cobleskill Fm. because of its crystalline and mottled appearance and because it contains a brachiopod fauna. The Victor Member has been traced from the Buffalo area to Cayuga Lake and probably extends much further to the east. A thin, fossiliferous limestone bed (A) occurs at the base and can be recognized at Phelps along N. Y. 88, and along the N. Y. S. Thruway just to the east. It is also seen as an extremely resistant (rings when struck) unit at Cayuga Jct. on the east side of

Figure 1 COMPOSITE STRATIGRAPHIC SECTION based on examination of outcrops at Honeoye Falls, N.Y. and outcrops to the west and east (LeRoy to Phelps, N.Y.)

Note: The eurypterid bearing waterlimes have been emphasized.



Cayuga Lake. Brachiopods are abundant in this unit at Phelps. Beds overlying Victor A consist of crystalline brownish to grey mottled dolostone containing some vuggy layers. The small vugs are often mineralized and this feature provided an additional source for confusion of this member with the Cobleskill Fm. of Western New York. At the N. Y. 88 locality, very nice cubes of fluorite have been found in some of the vugs.

PHELPS WATERLIME

At the top of the Fiddlers Green Formation of Eastern New York occurs a very fine-grained (sublithographic) dolostone having a conchoidal fracture. It has been and still is the primary source of eurypterid remains in the eastern portion of the state (so called "Herkimer Pool"). The most prolific locality since its discovery by Rickard (1953) is still Passage Gulf near Spinnerville, N. Y. The waterlime bed at the top of the Fiddlers Green Fm. at this locality has yielded thousands of specimens of eurypterid remains of the Eurypterus remipes remipes DeKay fauna. This waterlime unit has been traced from Passage Gulf westward to the Buffalo area where it has been referred to as the Phelps Waterlime (Ciurca 1969). The type locality of the Phelps Waterlime is along the N. Y. S. Thruway north of Phelps. At this locality the unit has also yielded the Eurypterus remipes remipes DeKay fauna. The Phelps Waterlime contains a zone of MUDCRACKS at the top of the unit which is traceable from Mud Creek at East Victor to east of Passage Gulf, Herkimer County. SALT HOPPERS are also relatively common in this unit.

SCAJAQUADA FORMATION

In Western New York shaly beds occurring between the underlying Fiddlers Green Fm. and the overlying Williamsville Waterlime were termed Scajaquada (Chadwick 1917). Somewhat thicker beds in Central and Eastern New York at this stratigraphic interval are referred to as the Forge Hollow Fm. (Rickard 1953). It seems best to retain these two names since the lithologic appearance is quite different in the two areas. In Central New York (for example the Lyndon-Heard Gypsum Quarries, abandoned) thick gypsum beds occur at this interval.

No fossils have been found in the Scajaquada-Forge Hollow Fms. in New York. As noted previously, gypsum beds are well-known in the Forge Hollow of Central New York.

At the WPA Quarry (Work Projects Administration Quarry) the Scajaquada Fm. contains MUDCRACKS. The locality is west of Auburn, New York. The author suggests that this be the arbitrary cutoff of the Scajaquada Fm. Localities to the south (Cayuga Lake area) and to the east should be referred to the Forge Hollow Fm. Interestingly, the WPA Quarry was described by Duskin in 1969 as "the best exposure of the Fiddlers Green the writer has seen, including the type locality. About 25 feet of the Fiddlers Green are exposed in three benches." When I examined this locality I found that the three benches were nothing more than Scajaquada Fm. overlain by Williamsville Waterlime, which was overlain by thick Cobleskill Fm. The Fiddlers Green Fm. is present but only in the streambed below and southward along the base of the same "rocdrumlin."

WILLIAMSVILLE WATERLIME

This fine-grained dolostone is perhaps the best known Upper Silurian unit, primarily because it was formerly quarried extensively (cement beds) and because such quarrying operations resulted in the discovery of abundant eurypterid remains (Eurypterus remipes lacustris Harlan fauna). Indeed, the Bertie has often been described in terms of the Williamsville Waterlime (Rickard 1953, p. 101) and many eurypterid remains from Western New York have been simply described as coming from the "Bertie Waterlime." Unfortunately, this tells us nothing of the exact horizon from which remains originated. Now that Eurypterus remipes remipes DeKay is known from the Fiddlers Green Fm. in Western New York, and that at least three other eurypterid horizons are now known, it is imperative that the exact stratigraphic horizon from which fossils are collected be known.

The Williamsville Waterlime of the Buffalo and Williamsville areas still yeilds eurypterid remains. To the east, however, eurypterid remains are very rare. The easternmost locality at which Eurypterus remipes lacustris Harlan has been found is Mud Creek, East Victor where the Williamsville Waterlime is well-displayed but quite unfossiliferous. This extends the geographic range of this species considerably.

Careful search of the Williamsville Waterlime east of Mud Creek has not yielded this species. However, a well-preserved coxa found in the upper Williamsville (or transitional beds) below the Cobleskill Fm. on Frontenac Island in Cayuga Lake (a new eurypterid locality) may represent this species. Paracarcinosoma scorpionis was recently found by the author in the Williamsville Waterlime in a ravine east of Clifton Springs (Ciurca, in preparation).

Other fossils found by the author in the Williamsville Waterlime (especially at Mud Creek) are gastropods, Linglua sp., and portions of phyllocarids (probably Ceratiocaris sp.).

COBLESKILL FORMATION

The Correlation Chart of the Silurian Rocks of New York State (Fisher 1960) still reveals the problem of the relationship between the "Akron Dolostone" of Western New York and the Cobleskill Fm. of Eastern New York. Careful tracing of key beds in the Fiddlers Green Fm. below the Akron-Cobleskill Fms. leaves no doubt as to the equivalent stratigraphic position of the Akron Dolostone and the Cobleskill "Limestone." This is not meant to imply that the Akron-Cobleskill is of the same age throughout its geographic extent. Undoubtedly, such a "coralline" unit probably is time transgressive in nature, and only careful study of the unit will reveal this and other relationships of the Cobleskill Fm. with underlying and overlying units. The name Akron Dolostone should be replaced by Cobleskill Fm. The term Cobleskill was introduced by Clarke in 1902 (see Rickard 1953, p. 81) and has priority.

The Cobleskill Fm. of New York should be regarded as a relatively fossiliferous unit exhibiting a number of facies changes from its type locality in Eastern New York to Buffalo, New York and into Canada. In Western New York the Cobleskill Fm. is generally a massive unit. It is fossiliferous, though apparently not to the same extent as exposures of this unit to the east (primarily Frontenac Island in Cayuga Lake, and Forge Hollow to the type locality).

Stromatoporoids have been reported in the Cobleskill Fm. at Oaks Corners Quarry (southeast of Phelps) and have been observed by the author west of Honeoye Falls (Five Corners area). Favosite corals have been observed by the author also in the Five Corners area. Horn corals (usually referred to Cyathophyllum sp.) are locally abundant, for example in the Bennett Quarry at Buffalo. They have also been observed at Mud Creek, East Victor. Recently brachiopods were encountered in this fm. at Honeoye Creek, Honeoye Falls, New York. No eurypterid remains are definitely known from the Cobleskill Fm. of Western New York.

At the request of Erik N. Kjellesvig-Waering, I checked the source of Eurypterus laculatus Kjellesvig-Waering known from a carapace in the New York State Museum Collections which had been collected from Black Creek, Morganville, New York and reportedly originated in the Cobleskill Fm. A study of the locality (Ciurca 1967) revealed no Cobleskill Fm. present. The eurypterid horizon was found to be Victor Dolostone (Middle Fiddlers Green Fm.) which is easily confused with the Cobleskill (see description of Victor Member). At Morganville the uppermost unit exposed is the Victor Member of the Fiddlers Green Fm. All higher units are missing due to the unconformity beneath the Devonian Onondaga and/or Bois Blanc Lss.

The fauna of the Cobleskill Fm. of Western New York needs to be restudied and precautions taken to make sure specimens are originating from the desired unit and not a lithologically similar unit such as the Victor Member of the Fiddlers Green Fm. The brachiopod fauna of the Cobleskill Fm. of Eastern New York has recently been redescribed (Berdan 1972).

Helderbergian Series

HONEOYE FALLS FORMATION

The strata exposed on Honeoye Creek at Honeoye Falls, New York have been repeatedly misinterpreted as belonging to various units of the Bertie Group or the Akron-Cobleskill Fm. For example, Rickard (1953, p. 100) noted that "at Honeoye Falls, for example, it is believed that the Onondaga rests unconformably upon the Falkirk member." Leutze (1959, p. 104) also agreed with this interpretation when he suggested that the base of the Fiddlers Green occurred to "at least Honeoye Falls, locality 259" where "there is a similar argillaceous bed at the bottom which develops huge conchoidal fractures on weathering." An illustration of the "Falkirk" (=Fiddlers Green) at Lehigh Valley R. R. just northwest of Honeoye Falls (Fairchild 1927, pp. 419, fig. 56) also identified this unit as occurring in the Honeoye Falls area.

The strata exposed below the Onondaga Fm. on Honeoye Creek (and downstream to the N. Y. 65 overpass) have been termed Honeoye Falls Formation (Ciurca 1967, 1969). No rocks belonging to the Bertie appear to outcrop at this locality. The geographically isolated Honeoye Falls Fm. is in a similar stratigraphic position to the Chrysler Fm. of Central New York and probably represents a Chrysler outlier. At Honeoye Falls the unit is characterized by massive and thin bedded dolostone including "waterlimes." MUDCRACKS have been observed in at least two horizons. No fossils have yet been observed other than rare remains of the eurypterid *Erieopterus microphthalmus* ssp. discovered by the author in 1964 *Erieopterus* has been known previously only from the Helderbergian Olney Ls.

While the contact with the underlying Cobleskill Fm. has not yet been observed, a small outcrop of the Cobleskill Fm. in Honeoye Creek has recently been observed below and within visual sight of the Honeoye Falls Ds. Therefore, the Honeoye Falls Fm. definitely rests upon the Cobleskill Fm.

The Honeoye Falls Fm. has also been observed in the unnamed ravine just south of Five Points, Rush Quadrangle (elevation about 620 - 630 ft.) and at the locality illustrated by Fairchild and mentioned above. Both localities are west of the type section at Honeoye Creek, Honeoye Falls, New York.

The strata exposed at all of these localities have always been misinterpreted as being Bertie or Cobleskill or both.

Unconformities

In Western New York Helderbergian strata, well-displayed in Eastern New York, are absent, this interval being represented by a large unconformity. The vertical relief on the unconformity, as displayed by the youngest and oldest units observed just beneath its surface, has been previously underestimated. The discovery of post Akron strata in Western New York, i.e. Honeoye Falls Fm., and detailed examination of most exposures from Buffalo to the Oaks Corners Quarry southeast of Phelps reveal a total relief of about 60 feet on the unconformity. This figure is based on the vertical distance from the top of the Honeoye Falls Dolostone down to the Victor Member of the Fiddlers Green Fm., the lowest unit found to be in contact with the Devonian Onondaga Fm.

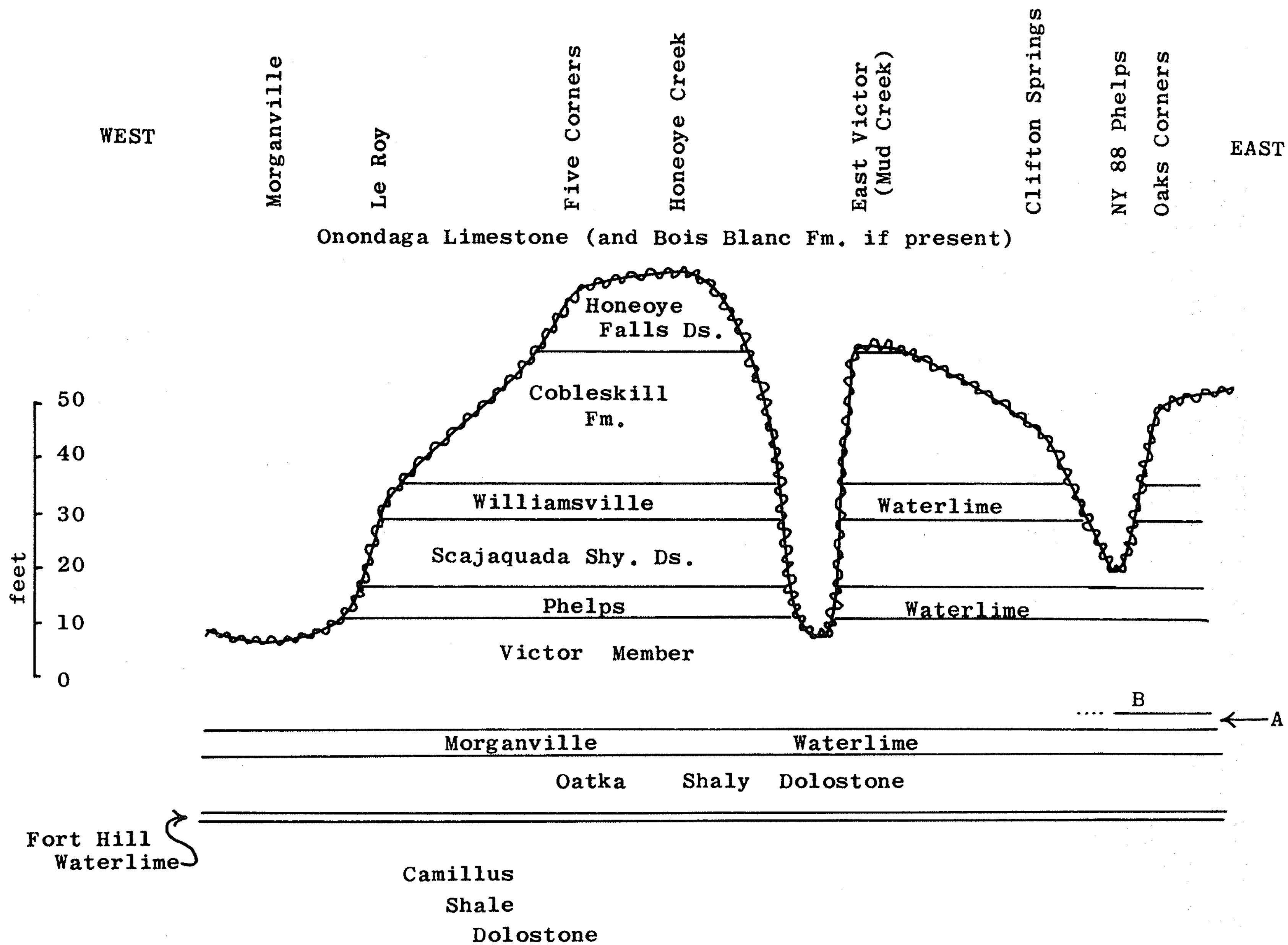


Figure 2 LITHOSTRATIGRAPHIC CROSS SECTION--Note the position and distribution of the Honeoye Falls Fm., and also the effect of the unconformity (beneath the Onondaga Fm.) on the nature of outcropping rocks.

This major unconformity is usually considered to represent an erosional interval. It has been suggested that the lack of highest Silurian and lower Devonian deposits in eastern Pennsylvania is due to nondeposition (Rickard 1969).

Other unconformities within the Upper Silurian have been proposed. It is not the scope of this brief article to review this aspect of Upper Silurian stratigraphy, but this notion should be kept in mind when examining Upper Silurian sections. For example, a minor sandy layer occurs at the base of the Scajaquada Fm. Could this be an indication of a slight unconformity?

More importantly, the exposures at Akron Falls in Erie County reveal no Phelps Waterlime. Assuming this to be true, is the absence of this unit due to erosion, nondeposition, or some unusual facies change? That a zone of MUDCRACKS occupies uppermost Phelps Waterlime from Mud Creek at East Victor to the village of Deck, a distance of about 150 miles, suggests exposure to the atmosphere of at least this much of uppermost Fiddlers Green Fm.
Figure 2 represents a cross section of the area in question.

Summary

Eurypterid remains occur at several horizons (zones) in the Upper Silurian and ?Lower Devonian of western New York State.

Cyclic sedimentation played a large role during the Cayugan and early Helderbergian resulting in the recurrence of lithofacies (and biofacies) at irregular intervals as observed at exposed lithostratigraphic sections today.

At Honeoye Creek (type section) in Honeoye Falls, N. Y. and nearby localities, no rocks belonging to the Bertie Group are known to outcrop. Most of the reported strata in this area have been assigned to the Honeoye Falls Fm. This formation embraces strata overlying the Cobleskill Fm. and underlying the Onondaga Fm. (or Bois Blanc Fm., if present) and appears (lithologically) to be related to the thick (50 feet) Chrysler Fm. of central New York and may simply be an outlier.

The eurypterid genus Erieopterus, previously unknown in western New York, has been discovered in the Honeoye Falls Fm. at the type locality and in the ravine near Five Points to the west. This suggests that the Honeoye Falls Fm. may be Devonian in age since this genus is known only from the Manlius Group of central New York, and recently (Kjellesvig-Waering and Ciurca, in preparation) from the upper Chrysler Fm. of central New York (Marcellus Falls-Syracuse areas).

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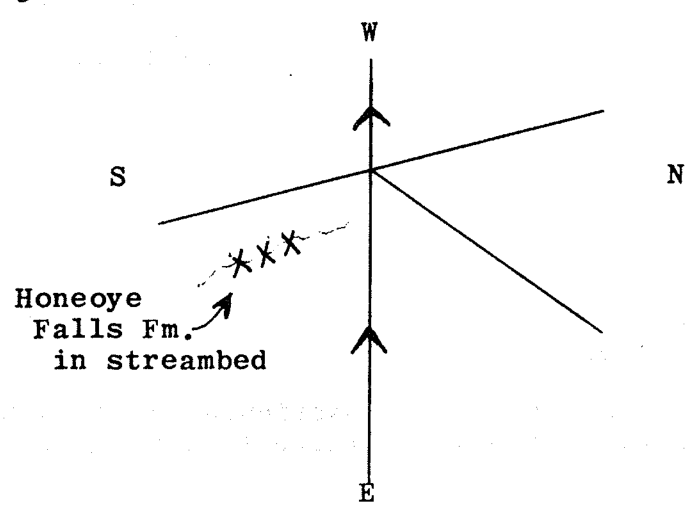
FIELD TRIP

0	0		NYS Thruway entrance on US 15 (West Henrietta Rd.)
2.1	2.1		mileage post 361
1.0	3.1		Syracuse 72 miles (sign)
6.9	10.0		parking area
2.3	12.3		milage post 351
3.8	16.1		Exit 44
6.5	22.6		mileage post 341
0.7	23.3		Exit 43
3.1	26.4		Clifton Springs Service Area
5.6	32.0		OBSERVE large roadcut exposing Camillus Fm. up thru lower Onondaga Fm. This is one of the best sections in western New York (reference section-see text)
0.9	32.9		mileage post 331
3.6	36.5		Exit 43 EXIT HERE fee 60 cents
1.0	37.5		NY 96 overpass CONTINUE SOUTH ON NY 14
0.9	38.4		TURN RIGHT ON CROSS RD. heading for Oaks Corners
1.5	39.9		RR tracks
0.1	40.0		STOP sign jct Preemption Rd (County Rd. No. 6) TURN RIGHT - SLOW DOWN quarry just ahead
0.1	40.1	*	STOP 1 Oaks Corners Quarry TURN LEFT just before RR tracks
			TURN AROUND AND GO BACK TO INTERSECTION
0.1	40.2		jct TURN RIGHT onto County Rd. No. 23
0.2	40.4		quarry visible on right
0.4	40.8		RR tracks SLOW DOWN
0.2	41.0		jct TURN RIGHT onto Lester Rd. and continue to NY 96
1.2	42.2		RR tracks
1.1	43.3		RR overpass SLOW DOWN jct NY 96, TURN LEFT into Phelps, N.Y.
0.5	43.8		traffic light in center of Phelps, N.Y. CONTINUE ON NY 96
		*	STOP 2
0.2	44.0		SLOW DOWN - bridge over Flint Creek. TURN RIGHT immediately after bridge onto Flint Street.
0.1	44.1		HEAD BACK to NY 96 - TURN RIGHT heading west SLOW DOWN
0.1	44.2		TURN LEFT onto William St.
0.1	44.3	*	STOP 3 bridge over Flint Creek
			TURN AROUND AND HEAD BACK TO NY 96
0.1	44.4		jct NY 96 TURN LEFT and continue west
0.7	45.1		jct NY 88 (flashing yellow light) TURN RIGHT and proceed north

0.5	45.6		NYS Thruway overpass SLOW DOWN
0.1	45.7	*	STOP 4 PULL OVER to the right just before RR overpass
			TURN AROUND AND HEAD BACK TO NY 96
0.7	46.4		jct NY 96 TURN RIGHT and continue west
2.5	48.9		RR tracks
5.9	54.8		jct NY 21
6.1	60.9		Finger Lakes Race Track on left
0.8	61.7		jct NY 332 CONTINUE WEST ON NY 96
1.4	63.1	*	STOP 5 Mud Creek PULL OVER to left side of the road-carefully
			CONTINUE WEST TO VICTOR, NEW YORK
1.8	64.9		signal light center of Victor
1.3	66.2		jct 251 TURN LEFT
0.2	66.4		RR tracks
4.0	70.4		jct NY 64 CONTINUE WEST on NY 251
0.1	70.5		RR tracks
3.9	74.4		jct NY 65 TURN LEFT heading south
2.1	76.5		Welcome to Honeoye Falls (sign) SLOW DOWN
0.6	77.1	*	STOP 6 Bridge over Honeoye Creek PARK PAST BRIDGE
			TURN RIGHT past bridge onto Maplewood Ave.
			TURN RIGHT onto Ulrich Lane
0.3	77.4	*	STOP 7 Sewage Treatment Plant
ADJUST			Start again at intersection of Ulrich Lane with Maplewood Ave. Head west on Maplewood Ave. (right turn from Ulrich Lane)
0.3	77.7		RR tracks
1.1	78.8		jct NY 15A CONTINUE WEST (straight ahead)
1.0	79.8		STOP sign at Works Rd. CONTINUE WEST
1.0	80.8		rock fences primarily of Cobleskill Fm. some stromatoporoids, rare favosite coral
0.2	81.0		jct Five Points CONTINUE STRAIGHT AHEAD:



1.0	82.0		jct US 15 TURN LEFT proceed to NY 5
4.5	87.5		jct NY 5 US 20 TURN RIGHT heading west towards Le Roy, N.Y.
1.3	88.8		entering Avon, N.Y.
1.0	89.8		RR tracks
0.5	90.3		Genesee River
5.8	96.1		Caledonia, N.Y. CONTINUE WEST on NY 5
2.4	98.5		RR tracks
0.6	99.1		RR tracks
0.8	99.9		entering Genesee County SLOW DOWN
0.7	100.6		jct Church Rd. (St Anthony's Church on NW corner) TURN RIGHT
0.2	100.8		RR (3 tracks)
0.7	101.5		RR tracks
0.1	101.6		jct Flint Hill Rd. TURN LEFT
0.2	101.8		jct Neid Rd. TURN RIGHT
0.4	102.2	*	STOP 8 Neid Road Quarry (Town of Le Roy Metal Refuse Disposal) TURN LEFT
0.1	102.3		leave quarry TURN RIGHT onto Neid Rd and head back
0.3	102.6		jct Flint Hill Rd TURN RIGHT
0.3	102.9		RR (3 tracks)
0.2	103.1		entrance to General Crushed Stone Co.-Le Roy plant--quarry in the Onondaga Fm.
0.1	103.2	*	STOP 9 brief stop-steam shovel used from 1906-1949-also small locomotive and car for carrying stone
0.2	103.4		quarries in the Onondaga Fm. on both sides of the road
0.6	104.0		jct Circular Hill Rd (Perry Rd on topo map) TURN RIGHT
1.0	105.0		RR tracks
0.7	105.7		Oatka Creek SLOW DOWN
0.1	105.8		jct Oatka Trail TURN LEFT
0.8	106.6		jct Parmelee Rd TURN LEFT
0.3	106.9	*	STOP 10 LAST STOP FIND PLACE TO PARK Roadcut NY 19
			TURN RIGHT onto NY 19 and head north to Interstate 490
1.8	108.7		ENTER Interstate 490 East (Rochester 20 miles)
18.0	126.7		NY 47 exits 1 mile
1.2	127.9		TURN RIGHT onto NY 47 to get back to US 15

OR

CONTINUE on Int 490 into Rochester

COMMENTS

Depending on the weather and level of streams, BOOTS may be needed for some stops.

CAMERAS may be useful-particularly since a few stops are threatened by progress and waste (literally).

Trip E

LATE GLACIAL AND POSTGLACIAL GEOLOGY OF THE GENESEE VALLEY IN LIVINGSTON COUNTY, NEW YORK:

A Preliminary Report

by

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and

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INTRODUCTION

Geologic and archaeologic investigations in the Genesee Valley have produced evidence of glacial drift blockage (moraine?) within the valley, followed by floodplain aggradation up to 95 feet above the modern river bed. The terraces may have been formed between 2500 and 4400 years ago between Avon and Mt. Morris, New York. The exact manner of emplacement of the abnormally thick till section in the valley is unclear, but the resulting postglacial fluvial aggradation and subsequent terracing appear to correlate in a general way with the periods of neoglacial climatic fluctuation discussed by Denton and Porter (1970).

PREVIOUS WORK

The Genesee Valley, as discussed by Fairchild (1909, 1928), has been described as a glacially enlarged valley, up to 2 miles wide near Geneseo with evidence of an interglacial or preglacial

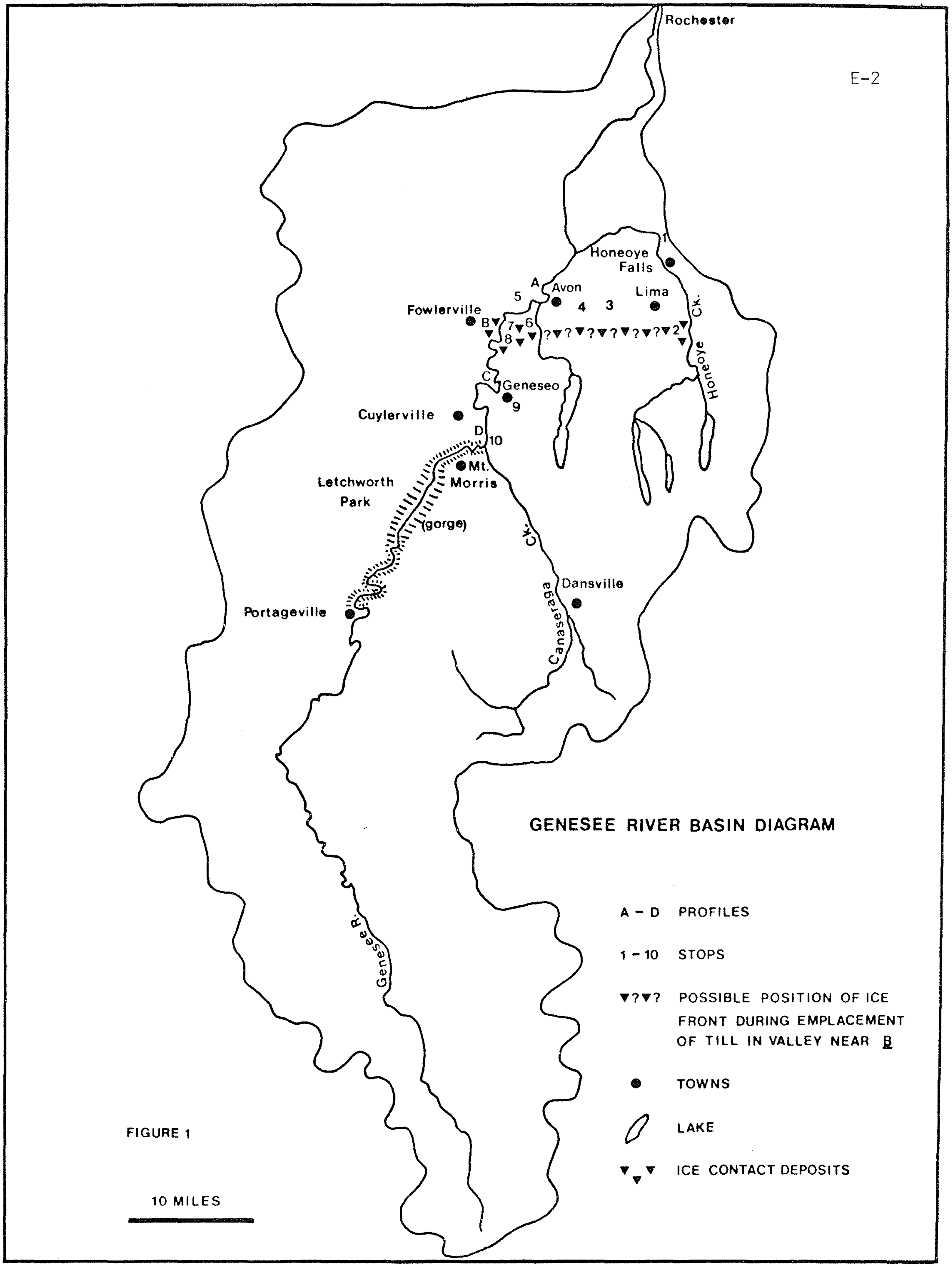

Rochester
Honeoye
Falls
1
A
Avon
Lima
5
4
3
Ck.
Fowlerville
B
7
6
8
2
Honeoye
C
Geneseo
9
Cuylerville
D
10
Mt.
Morris
Letchworth
Park
(gorge)
Ck.
Dansville
Canaseraga
Portageville
Genesee R.
GENESEE RIVER BASIN DIAGRAM
A – D PROFILES
1 – 10 STOPS
▼?▼? POSSIBLE POSITION OF ICE FRONT DURING EMPLACEMENT OF TILL IN VALLEY NEAR B
TOWNS
LAKE
ICE CONTACT DEPOSITS
10 MILES

FIGURE 1

buried channel north of Avon. A younger, postglacial gorge section through Letchworth Park (Figure 1) formed as a result of filling of an older valley near Portageville by morainal deposits. The Letchworth gorge may be more complex than Fairchild's description (1928, p. 179) because of the fact that some portions of the gorge are excavated in bedrock, whereas other sections are eroded in an interglacial(?), drift-filled valley which may also have drained to the north (R.A. Young, work in progress). Within the main Genesee Valley north of Mt. Morris there is ample documentation (Fairchild, 1909) of glacial modification by moraines, hanging deltas (stop 5, 6) ice marginal channels (stop 1), and lake sediments deposited in a complex series of oscillating lake stages (stop 3) following the retreat of the ice from the Valley Heads moraine near Dansville. The river course north of Avon on the north portion of the Rush quadrangle and across the Genesee Junction quadrangle is controlled by ice-depositional landforms and ice-sculptured terrain. Through this section the river is sinuous, with a floodplain as narrow as 1000 feet in several places.

Young and Rhodes (1971) presented evidence of a more complex postglacial history for the Genesee Valley between Mt. Morris and Geneseo as determined during the course of archaeologic excavations in terrace deposits south of Geneseo (work currently in progress under the direction of Dr. Wendell D. Rhodes).

In retrospect, this recent work, combined with the fresh exposure of till at the large slump (Figures 2, 3) along the

GENESEE VALLEY PROFILES A–D

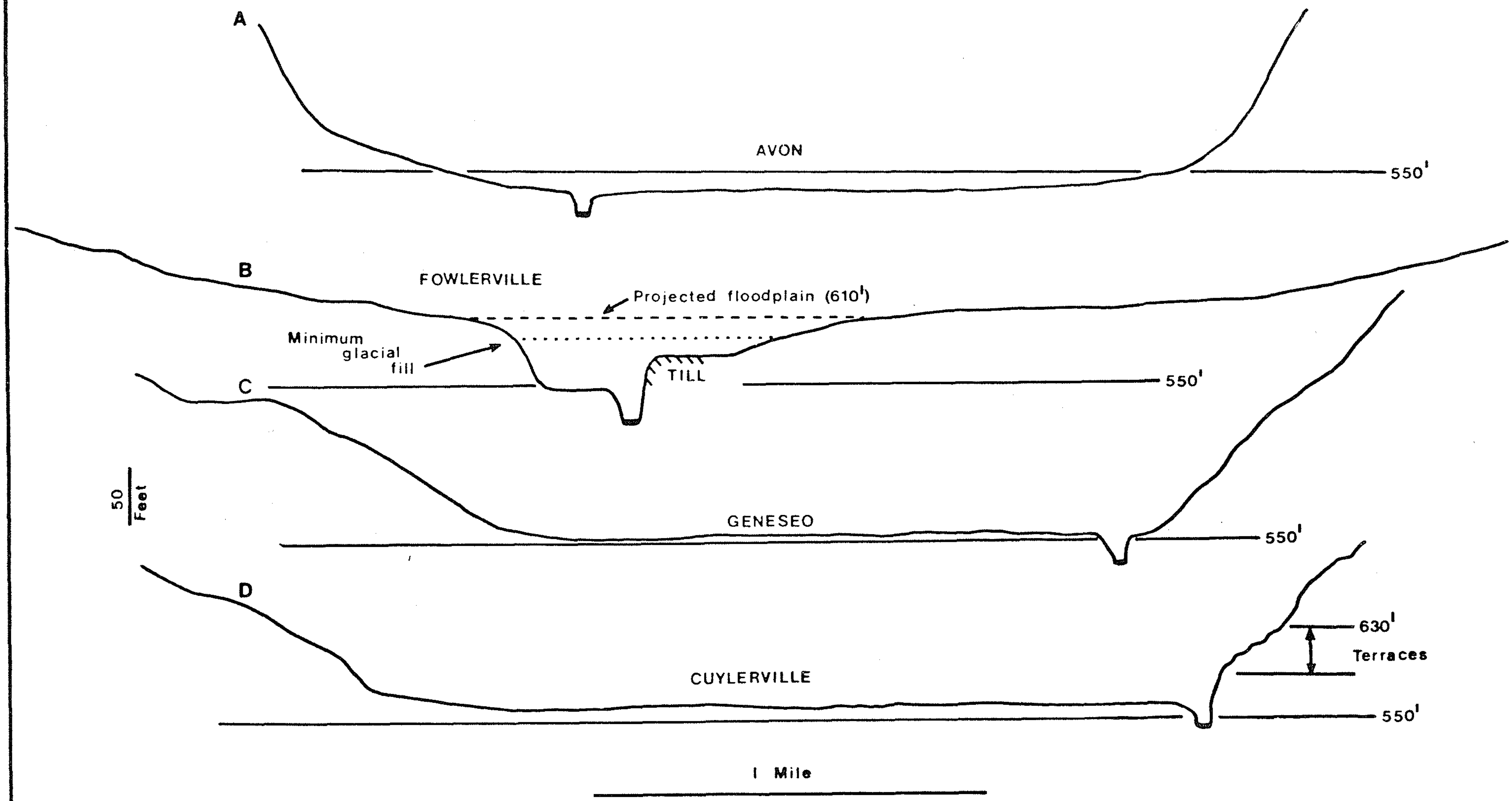


FIGURE 2

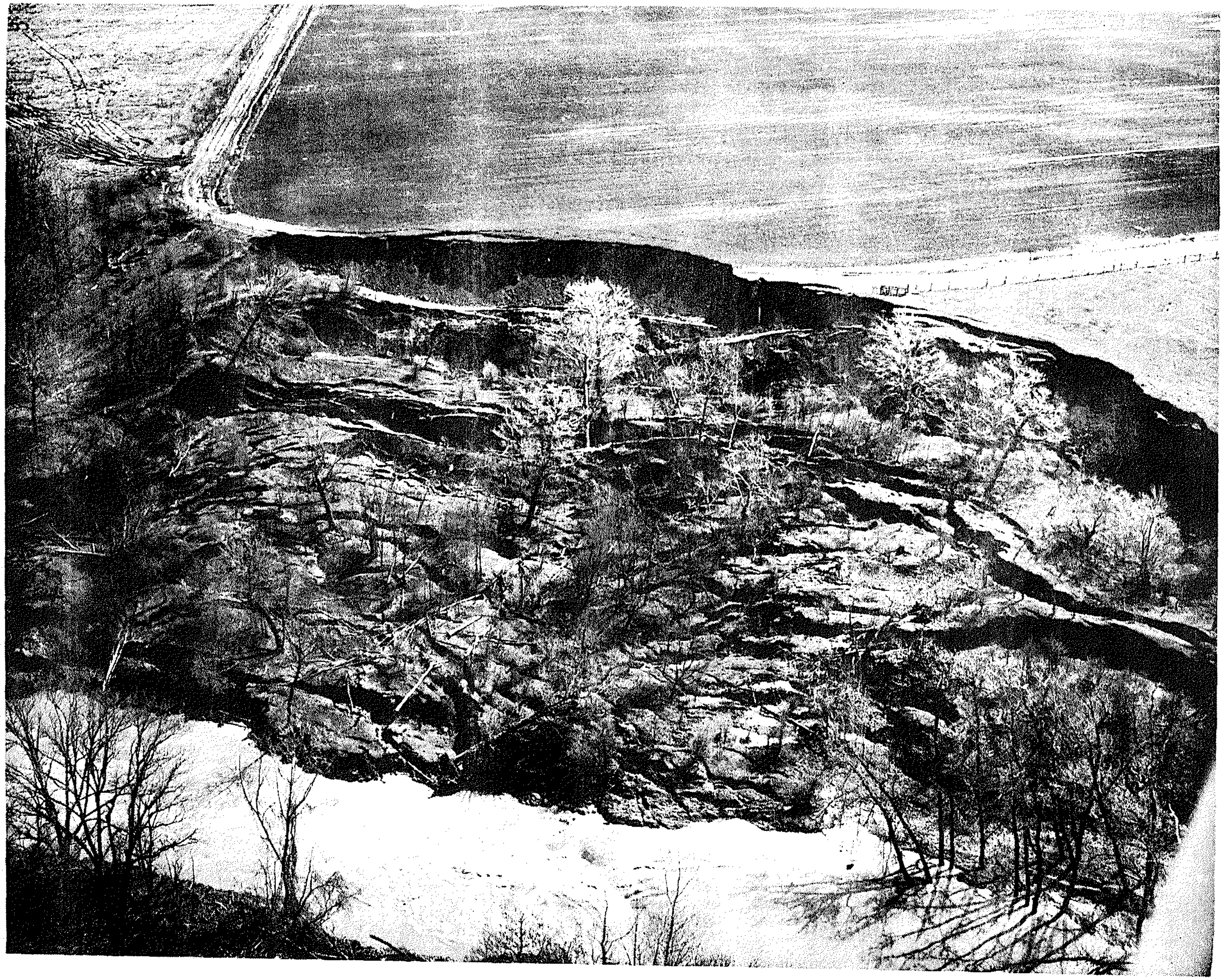


FIGURE 3. Large slump of April, 1973 on east bank of Genesee River at the end of Oxbow Lane, Town of Avon. Photo courtesy of Rochester Democrat and Chronicle, Burr Lewis photographer.

river between Avon and Geneseo, sheds light on some observations made by Fairchild concerning the final ice-marginal lake stages in the lower valley.

Beginning with Fairchild's description of the Lake Warren stage (880 feet), the late glacial history included lowering of the Warren waters down to 700 feet (Lake Dana) and the accompanying formation of the Rochester (Pinnacle Hills) moraine. This lake stage partially submerged the slightly older Mendon Kames complex. The last local lake stage filling the Genesee Valley was Lake Scottsville, confined to the Genesee Valley between the Pinnacle Hills moraine and Avon at an elevation of 540 feet. It has not previously been clear why Lake Scottsville did not extend further south up the Genesee Valley. The river channel is near 540 feet in elevation at Geneseo, and river sediments are known to overlie glacial lake sediments in many places, such as north of Avon (Fairchild, 1928, p. 147). Thus, one might expect the modern valley floodplain near Geneseo to be somewhat higher than the older glacial deposits which floored the valley during Lake Scottsville time. These observations can be reconciled by considering the significance of the till filling the valley between Geneseo and Avon.

GLACIAL VALLEY FILL AND POSTGLACIAL SEDIMENTATION

Figure 2 illustrates the anomalous nature of the valley cross-section near Avon as compared with the valley to the north and south. Section B, near the large slump that occurred in April, 1973 (Figure 3), is near the end of Oxbow Lane in the town of Avon. A 20-foot section of till is exposed at the back of the slump scarp. Till is also exposed near the Fowlerville bridge (stop 7) at 570 feet. The significance of this anomalously thick fill becomes clear if a comparison is made of the cross-sections on Figure 2. The most obvious conclusion is that the fill acted as a barrier, preventing further extension of Lake Scottsville to the south.

If the maximum floodplain level is projected from the highest terrace near Geneseo (Figure 2, D) northward to the area of section B (Figure 2), assuming a gradient similar to the present (20 feet per 9 miles), we obtain the level of the former alluvial fill (dashed line) at this location. The dotted line indicates the minimum probable elevation of the former till section eroded by the river (indicated by terracing). The 20-foot interval between the dashed and dotted line is, therefore, the probable maximum extent of alluvial fill that would have been required near section D to correlate with the thicker alluvial fill (terraces) south of Geneseo. In other words, assuming that till did not originally entirely fill the valley near profile B up to 610 feet and thereby directly cause all of the fluvial aggradation upstream, only about 20 feet of alluvium above the till would require a corresponding aggradation of the floodplain near Geneseo to 95 feet above the modern river bed (Figure 4). Such a thickness of alluvium is equivalent to the distance from the modern floodplain to the river bed.

The thick till deposit which fills the valley for a distance of 5 miles between Geneseo and Avon may represent a morainal fill in the valley in that section. Alternatively, constriction of ice flow due to narrowing of the bedrock valley profile in this area might have produced the anomalous fill by some obscure ice-depositional process.

The authors currently favor the morainal hypothesis. However, the only other evidence for a moraine at this latitude is an esker-kame-kettle complex 10 miles due east near Honeoye Creek (stop 2). Admittedly, it is possible that isolated eskers, kettles, or kames such as these could probably have developed at random locations along a slowly melting ice front without signifying the formation of a major recessional moraine.

A delta-like deposit north of the till filling at the outlet of Conesus Creek near Ashantee (stop 6) indicates either (1) a remnant of a former floodplain surface near 580 feet in the valley north of the till-filled section, or (2) a glacial lake delta built into the sequence of falling lake levels. If the feature is a delta, it would probably have to represent deposition in Lake Avon (pre-Warren low stage) near 580 feet. If the feature is merely an eroded floodplain remnant, consistent with the fill to the south, a higher proportion of gravel in the sediments discharged from Conesus Creek might account for the resistance to erosion of this portion of the valley fill.

TERRACES NEAR GENESEO

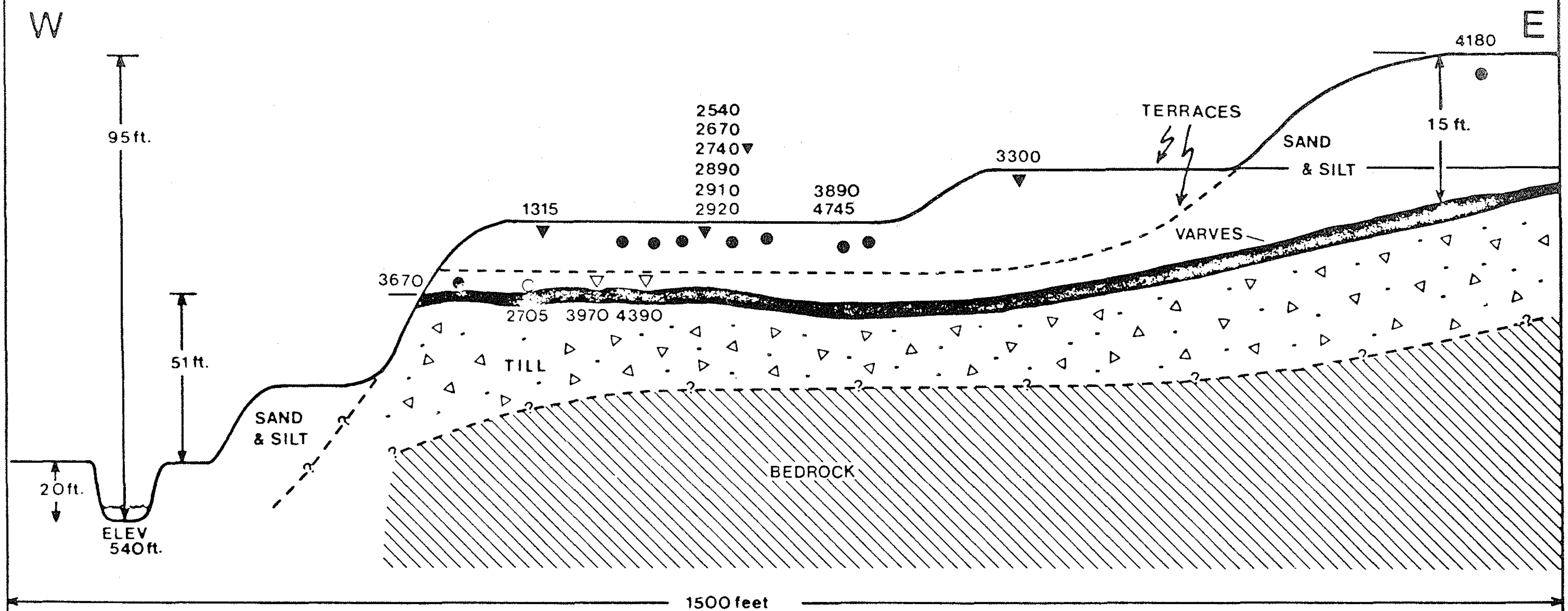
The terraces in the Genesee Valley (Figures 2 and 4) are portions of an alluvial fill built up to the approximate level of the till deposits (moraine?) between Geneseo and Avon. This fluvial aggradation might also have been influenced by the climatic changes and vegetation succession which followed deglaciation, and by the postglacial influx of sediments contributed by the drift and bedrock eroded from the Letchworth gorge immediately upstream.

It is also possible that a shallow lake existed in the Geneseo-Dansville portion of the valley before the river had cut through the till plug. The existence of such a lake would depend on the elevation of the former valley fill. Glacial varves beneath the terrace sands (Figure 4) indicate that the valley may have been nearly filled with glacial deposits, but precise reconstruction of the original postglacial cross profile is not possible. It does not appear that these varves (Figure 4) were deposited in a small shallow lake because the fine-grained nature of the varves beneath the terraces imply deeper, quieter water than would have been the case near the margin of a shallow lake.

Radiocarbon dates from archaeologic hearths within the sandy terraces (Figure 4) shed some light on the approximate time of floodplain aggradation and terrace formation, if certain assumptions are made. Charcoal from hearths taken from depths down to 3 feet imply that occupation of the sites was concurrent with floodplain deposition near river level. Floods are commonly within about 20 feet of the river bed, since deeper flooding over the entire floodplain would require unusual volumes of water, given the valley cross-sectional profile (as demonstrated by the flood of June, 1972).

GENESEE VALLEY NEAR MOUTH OF CANASERAGA CREEK

DIAGRAMMATIC AND COMPOSITE



(NOT TO SCALE)

●○ RADIOCARBON DATE >12 in.

▼▽ " " <12 in.

ALL DATES IN YEARS (B.P)
FROM ARCHAEOLOGICAL MATERIALS

OPEN SYMBOLS NOT IN PLANE OF DIAGRAM

FIGURE 4

Sedimentary structures, such as cross bedding, are uncommon in the terrace deposits. Thin persistent oxidized zones from 3 to 12 inches apart (Figure 5) are present throughout most of the excavations, except close to the underlying varves. One possible explanation of the oxide zones is that they are incipient soil horizons composed of leached colloidal oxides deposited by downward percolation of soil water between flood deposition intervals. However, it is difficult to imagine how such thin, uniform, oxide zones would have been preserved in well-drained sands and silts and still exhibit such regularity if normal, soil-forming processes have been continuously operating up to the present (downward migration of colloidal and dissolved material). In any event it appears that some type of repetitive sedimentation, weathering, and terracing were occurring on floodplains 30 to 75 feet above the modern floodplain when the sites were being occupied, probably under forest conditions. This means that the river bed was correspondingly higher at that time, and that the flooding was occurring near river level as overbank deposits.

The grain size characteristics of the terrace sediments, their physical location, the topography of the site, and the location of the excavations make slope-wash deposition an unlikely mechanism to explain the depth of burial of the artifacts and hearths. In addition, the material immediately upslope is till. The arrangement and positioning of many of the hearths and associated artifacts excavated from the terraces indicate that reworking of the river sediments by lateral river migration

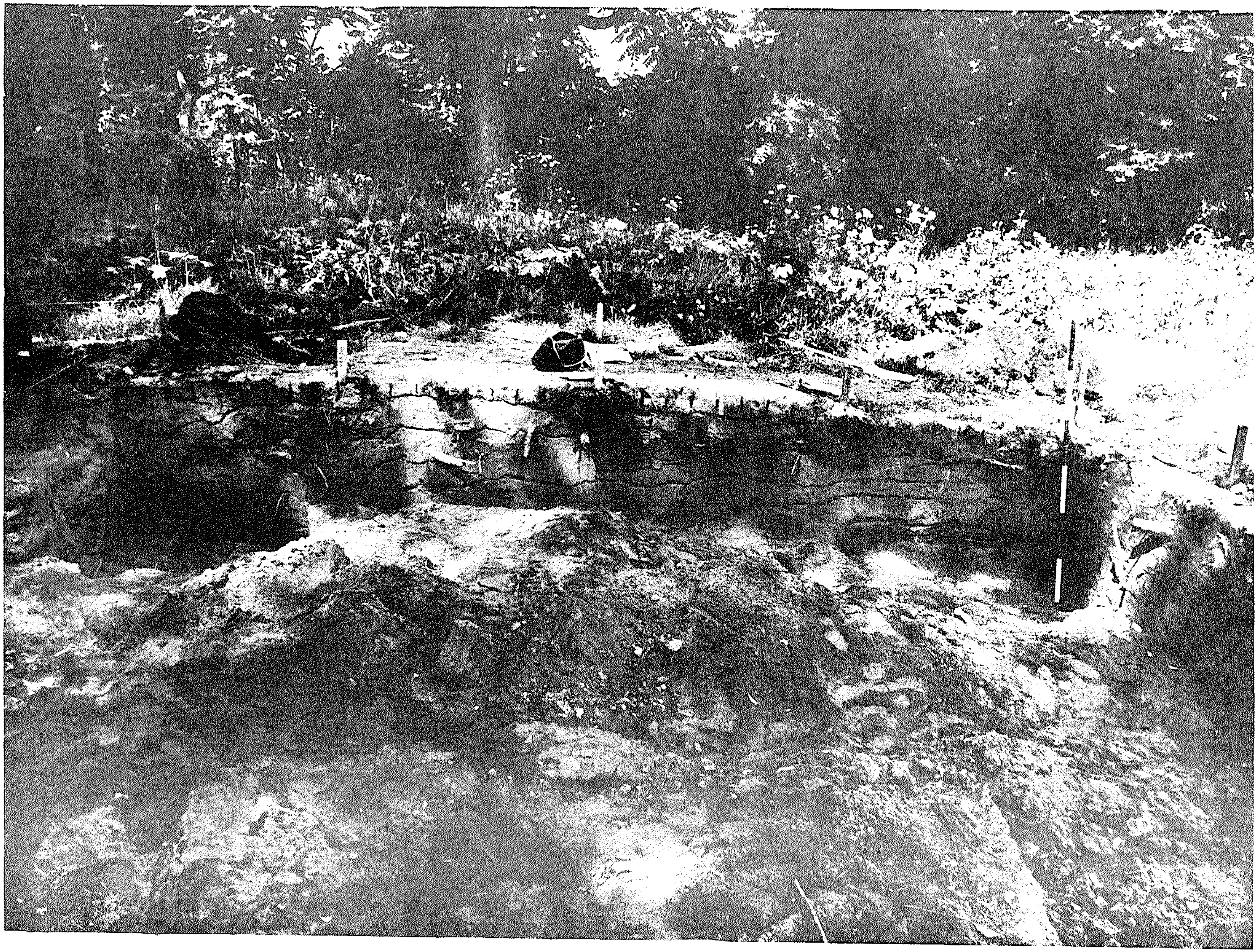


FIGURE 5. Excavation at the Macauley Complex near Geneseo, New York. Oxide horizons in the terrace sediments have been accentuated with the point of a trowel. Photo: Herbert Edelsteine.

did not occur subsequent to burial. However, lateral river migration and terracing could have completely removed some sediment and artifacts. This could then have been followed by renewed aggradation so that a complete record of archaeologic occupation is not preserved.

The distribution of dates on Figure 4 also illustrates that the oldest dates occur both in high and low terraces, whereas the intermediate dates are found in intermediate terraces. If the sites were repeatedly flooded at the time of occupancy, the distribution of dates suggests a period of maximum aggradation sometime between 4400 and 3900 years Before Present (BP), with oscillatory cut and fill cycles occurring over the interval from 3800 to 2500 BP.

All of the floodplain formation, terracing, and associated valley sedimentation would have to postdate Lake Warren (circa 11,000 BP), which covered the archaeologic sites (all below 640 feet). Post-terrace, random occupation of all the terrace levels is possible, but believed to be unlikely in view of the depth of burial by what are interpreted as a series of overbank flood deposits, and by the apparent nonrandom pattern of occupation with regard to elevation (terrace levels). In some cases the more deeply buried artifacts may be related to older terrace surfaces (floodplains) now completely buried rather than being closely related to the existing terrace profiles.

For the sake of argument, it is assumed that net aggradation occurred generally over the interval from 11,000 BP (post Lake Warren) to 4000 BP and that general (net) downcutting followed with some conspicuous aggradation from 2900 to 2500 BP. This would explain the topographically highest terrace dates near 4000 and the influx of intermediate dates on intermediate level terraces above the deeply buried 3670 BP date (Figure 4). More precise correlation of individual terraces based on radiocarbon dates is impossible due to probable overlap of dating errors and possible occupation of individual terrace levels for spans of tens or hundreds of years, as well as destruction of the exact terrace profiles by recent gully erosion.

SUMMARY AND CONCLUSIONS

If this tenuous sequence of events has any validity, it appears to fit the general climatic curve for neoglaciation maxima of Denton and Porter (1970). This is based on the assumption that cooler, wetter periods cause aggradation, whereas warmer, dryer periods cause erosion and terracing. The neoglacial maxima (cooler intervals) of Denton and Porter (1970) peak near 4700 and 2700 BP.

This hypothesis is given additional support by detailed studies over the same time interval in the Southwest by Karlstrom et al. (1973) as presented in an informal progress report. Such a comparison with the arid Southwest is made only because of a lack of similar, detailed studies in the eastern United States. The Mississippi Valley archaeologic and geologic chronology shows a similar generalized history involving 50 feet of alluviation in the last 7000 years, followed by terracing and downcutting (Griffin, 1968).

ADDENDUM

The following information was obtained during continuing studies of the Canaseraga Creek floodplain in June 1973.

Correlation of logs of wells near Dansville and near the mouth of Canaseraga Creek with seismic refraction surveys (Young, 1973) and shallow test borings (U.S. Army Engineers) in the center of the valley north of Sonyea indicate that the Genesee Valley floodplain between Mt. Morris and Dansville is underlain by uniformly thin (averaging 30 to 40 feet) fluvial sands, silts and gravels interbedded with lacustrine(?) clays and peat horizons which overlie thick "tough blue clay". The surficial sands and gravels thicken locally near Dansville where a delta was built northward into the valley. Wells near Dansville penetrate 180 feet of the "tough blue clay" which is interpreted as varved(?) lacustrine clay similar to that which is exposed at numerous locations along the Genesee River north and south of the Letchworth gorge.

A comparison of the Genesee Valley with cross-sections of the Cayuga Lake basin suggests that the Genesee Valley bedrock profile should be similar in cross section and depth, assuming that conditions controlling glacial erosion were comparable. This comparison is partially substantiated by well logs at Dansville and at Cayuga Lake (O.D. von Engeln, 1961, The Finger Lakes Region, p. 53) which indicate that both valleys are eroded in bedrock to depths probably in excess of 450 feet below the river floodplain and lake surface, respectively.

Considering their probable similar erosional development and glacial history, it is unclear why the Genesee Valley should be so completely filled with fine-grained lacustrine sediments. However, when viewed in light of the thick till filling the valley near Avon and the related fluvial aggradation (terraces) south of Geneseo, the thick section of fine-grained lake deposits could be explained as a result of the lengthy exist nce of glacial and postglacial lakes contained by the till plug (moraine?) near Avon. If these hypothetical lakes (gradually lowering levels) were maintained for several thousand years as suggested by the radiocarbon dates related to the overlying Genesee River terraces (Figure 4), sediment brought by Canaseraga Creek and the Genesee River into this restricted basin could account for the thick clay deposits.

The exposure in the accompanying photograph (Figure 6) is at the mouth of an unnamed creek on the east side of the valley two miles south of the archaeological site on Figure 4 (opposite Mt. Morris). Cross bedding and imbrication in these delta deposits above and below the varved clays (V) indicate an environment of laterally shifting channels alternating with lacustrine deposition. The varved clays could only have developed when the small stream discharged somewhat north or south of the exposed section. The elevation of the exposure is near 600 feet which puts it within 10 feet (vertically) of the six-foot section of varves beneath the terraces on Figure 4. In the delta deposits the varves are now approximately 30 to 40 feet above the modern floodplain.

Building out of the delta into a lake is indicated by the varves. Any streamflow to a lower floodplain level without such a lake present (above 600 feet) would have caused erosion rather than deposition as demonstrated by the small stream now incised into the delta.

All of the above information further substantiates a complex lacustrine and fluvial history for this portion of the Genesee Valley. Presumably, there was a gradual filling in of the lake(?) floor while the Genesee River was cutting through the till plug south of Avon. As the lake lowered and became a marsh or swamp, floodplain (fluvial) sedimentation processes reworked the uppermost lacustrine deposits and climatic influences may then have dominated the aggradation and downcutting (terracing) of the floodplain surface. Continued erosion of the main channel has resulted in a gradual lowering of the modern floodplain.

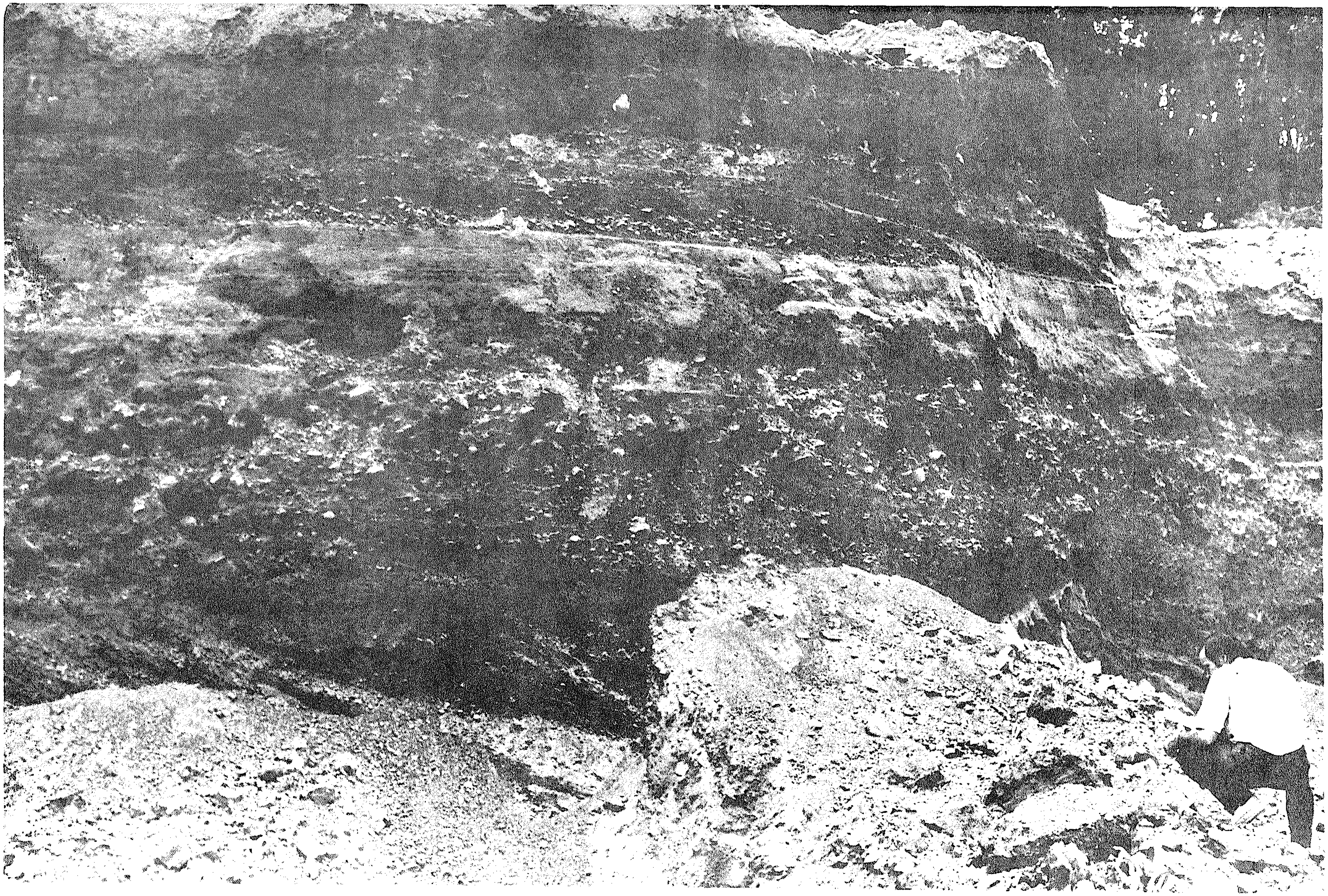


FIGURE 6. Exposure of delta gravels and sands interbedded with varved clays (V) on the east side of the Genesee Valley along Route 63, two miles south of Hampton Corners (opposite Mt. Morris). Elevation near 600 feet. Photographic reproduction by Roger Smith.

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FIELD TRIP ROAD LOG FOR GENESEE VALLEY

Glacial and Postglacial Geology

Mile	
0	Turn south on Mt. Hope Avenue. Proceed south along East Henrietta Road to Westfall Road
1.0	Turn east on Westfall Road and proceed to junction with Clover Road
4.5	Turn south on Clover Road, continue past Mendon Ponds Park (9.4 miles)
13.9	Turn east on Route 251 toward Mondon Center
14.1	STOP 1. After 2/10 mile turn south and cross ice marginal drainage channel
15.6	Proceed 1 1/2 miles south to Cheese Factory Road at border of second channel. Turn west on Cheese Factory Road following ice marginal channels to Sibleyville (make sharp right then left across Route 65). Cross Honeoye Creek on approach to Sibleyville, Honeoye Creek occupies ice marginal drainage at this point. Turn south from Sibleyville on Route 15A and proceed to Lima
20.0	Lima Turn east at Lima on Routes 5 & 20 to Doran Road (1.1 miles)
21.1	Doran Road - proceed south 0.6 miles to turnoff for Round Pond (dead end road to east)
21.6	STOP 2. View esker, kettles, and kames at Round Pond
23.2	Return to Lima and proceed west on Routes 5 & 20 to Oak Opening Road
24.9	STOP 3. Oak Opening Road follows Warren Shoreline north-south across Routes 5 & 20
25.4	STOP 4. Continue 1.5 miles to beach along wave eroded drumlin(?) on south side of highway

Mile

30.3 STOP 5. Proceed (4.9 miles) west on Routes 5 & 20 across Genesee Valley (past junction of Route 20) to gravel pit on west bank near large glacial drainage which discharged SE into Genesee Valley. View drainage features and gravels mapped as deltas by Fairchild (1909)

35.2 Return to Avon and proceed south on Route 39 to Ashantee (1.7 miles)

36.9 STOP 6. Pass through Ashantee and turn west (right) on Fowlerville Road. For 1/2 mile cross remnant of delta-like deposits at 580 feet at Conesus Outlet stream which might have been deposited into lake waters prior to the formation of Lake Scottsville at 540 feet. Alternatively it could represent the remnant of a higher floodplain in the Genesee Valley 40 feet above the modern floodplain (See discussion regarding Genesee Valley terraces)

39.6 STOP 7. Continue to bridge over river near Fowlerville to view valley profile and till outcrop

42.3 Return to Route 39, continue south to South Avon Road (1.8 miles)

44.1 Turn west on South Avon Road and proceed straight to river (3 miles) at landslide of April, 1973

47.1 STOP 8. Avon landslide of 1973
Return to Route 39, continue to Geneseo

55.4 STOP 9. Lunch at Department of Geological Sciences, Geneseo. View maps, aerial photographs, etc.

55.4 Continue south through Geneseo on Route 39 to Farm Road 1 mile south of Jones Bridge Road. (8.7 miles)

58.8 STOP 10. Turn west toward river through field to Archaeology site in Genesee River terraces near confluence with Canaseraga Creek

Trip F

THE PINNACLE HILLS AND THE MENDON KAME AREA: CONTRASTING MORAINAL DEPOSITS

by

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Department of Geosciences
Monroe Community College

INTRODUCTION

The Pinnacle Hills, fortunately, were voluminously described with many excellent photographs by Fairchild, (1923). In 1973 the Range still stands as a conspicuous east-west ridge extending from the town of Brighton, at about Hillside Avenue, four miles to the Genesee River at the University of Rochester campus, referred to as Oak Hill. But, for over thirty years the Range was butchered for sand and gravel, which was both a crime and blessing from the geological point of view (plates I-VI). First, it destroyed the original land form shapes which were subsequently covered with man-made structures drawing the shade on its original beauty. Secondly, it allowed study of its structure by a man with a brilliantly analytical mind, Herman L. Fairchild. It is an excellent example of morainal deposition at an ice front in a state of dynamic equilibrium, except for minor fluctuations.

The Mendon Kame area on the other hand, represents the result of a block of stagnant ice, probably detached and draped over drumlins and drumloidal hills, melting away with tunnels, crevasses, and perforation deposits spilling or squirting their included debris over a more or less square area leaving topographically high kames and esker segments with many kettles and a large central area of impounded drainage. There appears to be several wave-cut levels at around the ± 700' Lake Dana level, (Fairchild, 1923).

The author in no way pretends to be a Pleistocene expert, but an attempt is made to give a few possible interpretations of the many diverse forms found in the Mendon Kames area. Fairchild's work (1923) on the Pinnacle Range seems to need little in the way of additional interpretation.

THE PINNACLE HILLS

General Description:

Fairchild (1923) refers to the moraine as "The Pinnacle Hills or The Rochester Kame-Moraine." He divided it into three divisions based on form and composition. The "middle division" contains the "Pinnacle" or high point at 749' about 230' over the city plain. The eastern and central divisions show till capping and contorted layers on the north side indicating a re-advance of the ice.

The northern slopes of the range are irregular with steep ravines and spurs indicating ice contact with some erosion both natural and man-made.

There is a smaller recessional moraine to the north which contains more till indicating that perhaps the base of the Pinnacle Range is till although it is not (or was not) exposed in any cuts.

The lowest beds exposed were all horizontal sands and gravels. Blocks of Lockport dolomite occur on the apex of the Pinnacle and Cobbs Hill. They are angular and fresh indicating a short readvance, since Lockport is found only a few miles north.

The western division contains mound-and-basin or eggs-in-a-basket topography which is excellently displayed in Mt. Hope Cemetary and Highland Park. These deposits are similar to many on the west side of the Mendon Kame area.

Origin:

The greater part of the Pinnacle moraine is not till but stratified sands and gravels. The dip is southerly with southwest slightly more abundant. The last sentence, along with the sub-lacustrine outwash slope on the south side seems to negate the interlobate hypothesis of origin (Taylor, 1924). If there was a southern lobe it would have scraped off the sub-lacustrine slope and deposited northerly dipping sediments. Fairchild rejected the hypothesis in a footnote (1923, p. 165).

Most of this discussion is taken directly from Fairchild (1923), but the author questions one opinon on page 167 where Fairchild states:

> "Probably most, or all of the glacial drainage was subglacial, issuing from tunnels beneath the ice sheet."

It is hard to imagine a melting ice front having only subglacial drainage. The presence of ice contact kames on the eastern end of the moraine and eggs-in-basket kames with no possibility of their being scattered about by a few large streams, mitigate against this hypothesis. Also, the western end of the range shows no readvance, at least not on the top with the eggs-in-basket kames intact. There should be some evidence of eskerine deposits with all those sub-glacial tunnels.

According to Fairchild (1923), the Genesee River channel was cut northward to drain a small pro-glacial lake (Lake Scottsville). The Pinnacle Moraine was built into Lake Dana with a surface elevation of ± 700', (Fairchild, 1926). As Lake Dana was drained down through an eastward outlet toward the Mohawk-Hudson the waters south of the moraine and west of the East Henrietta Ridge were left as Lake Scottsville extending southward towards Avon. The lake level was at 540'. Since the waters of Lake Dawson, north of the moraine were at about 480' the post-glacial Genesee channel was cut though at the lowest point in the moraine where it is presently situated. Although not mentioned by Fairchild it is still (the Genesee River) at about the same elevation (512') due to the temporary base-level provided by the Lockport dolomite bench.

THE MENDON KAME AREA

General Description:

The Mendon Kame area is unusual in that it consists of stagnant ice features in an anomalous topographic setting. Usually ice stagnates by a block of ice melting down between hills, ridges , or in a valley and becomes separated from the main ice mass by the topographic highs. By contrast, the Mendon area is "setting up" above the surrounding terraine and contains some of the highest hills, with radial drainage away from the deposits.

The area is divided topographically into three north-south zones (fig. 1). The central zone is characterized by low ground with impounded drainage producing three "ponds" and a few scattered kames and kame clusters among swampy areas. The east and west zones, although quite different in detail, contain kames, eskers and eskerine segments with kettles and various puzzeling stratified drift areas.

General Description of Kinds of Deposits:

Eskers:

Giles (Giles, 1918) in a paper describing the eskers in the vicinity of Rochester, New York went into a long and detailed description of eskers all over the northern hemisphere replete with pros and cons about esker origin. His main conclusion was that most eskers are sub-glacial in origin. On page 217 Giles described the east esker as: "probably the finest esker in western New York." On the other hand, Fairchild (1926, p. 207), stated: "The eskers in the two ranges of kames are so irregular in form and so confused with or surrounded by the kames that they are not readily recognized."

Both Giles and Fairchild were of the opinion that the kames surrounding the eskers were probably products of the same stream. Unless they are directly connected to an esker segment, this, to the author, seems like a physical impossibility.

Kames:

There are, in the Mendon Ponds area, kames with great variation in size, shape, and location. Again Giles and Fairchild only recognized "eggs-in-a-basket" type kames formed at the debouchure of the subglacial stream along re-entrants as the ice wasted away. Since kames are so diverse in size, shape, and origin, I will discuss them later under "Origin."

Kettles-(not "deposits" but intimately related):

Kettles are found intermixed with the kames and eskers, especially bordering the esker, with "Devil's Bathtub" (end of walk along wesk esker-stop #2), surrounded by the southernmost esker-fan of the west esker the most famous, but certainly not the largest. Some are dry, others "ponds" according to the water table level.

Drumlins:

No drumlins outcrop in the park in a recognizable form although there may be several buried ones. Fairchild (1926) called the hill between Hundred Acre Pond and Deep Pond a "diminutive drumlin." The shape, size, and orientation make it appear more like a kame with ice-contact steepness, especially on the west side bordering Deep Pond.

There are many drumlins and drumloidal hills surrounding the area, especially to the southwest in an area enclosed by Clover Street and Sheldon Road.

ORIGIN OF MENDON PONDS PARK AND SURROUNDING STAGNANT ICE FEATURES

General Statement:

The author undertook this brief report with very limited time available because any field trip in the Rochester area would be missing something if a trip to the area was not included; and because a few traverses through the park and new gravel pits surrounding the park raised more questions than were answered in the literature.

The first and most striking characteristic of the park is its elevation above the surrounding drumloidal till plain. The only logical explanation seems to require a stagnant and eventually detached very dirty ice block draped over drumlins and drumloidal hills with its original southern terminus marking the ice-marginal drainage channel of Lake Warren II to the south (fig. 1).

The trend of the drumlins is northeast toward the Irondequoit Bay area. This may have been the source of the englacial debris needed for the formation of the high level melt-water deposits. It also may explain the abrupt ending of the eastern end of the Pinnacle Hills.

The debris was left at Mendon Ponds, leaving cleaner ice to rapidly retreat north to the Rochester parallel.

Another strange feature was the sloping away from the area in many directions of what appears to be outwash grading into swell and swale topography. John H. Cook (Cook, 1946a) described a similar relationship in the Hudson Valley area in which streamlined forms were apparently produced by undermelting. In figure 2 I've attempted to show a possible similar relationship along the west side of Mendon Ponds. Slight ice movement of the clean block would produce more streamlining. Undermelting and perforation deposits can form because water is densest at 3.9°C and therefore sinks and has heat energy to expend melting ice (Cook, 1946b).

This process would stop if an impervious clay layer were deposited. It would insulate the ice below from further melting. Since N.Y. State tills are usually high in clay content, perforation probably becomes suspended in most instances (Holmes, 1947).

The diversity of form, shape and distribution of the kames, eskers, kettles and outwash calls for a polygenetic origin. The central zone was probably higher and cleaner, or just higher, and the superglacial and englacial debris was washed off to the sides contributing to the deposits of the east and west zones.

The few kames and compound kames found south of Hundred Acre Pond were probably formed early, by pothole drilling. If the east and west zones were insulated by superglacial drift the cleaner central zone would melt away leaving little trace (figs. 3 & 4).

Specific Deposits

Eskers

The most glamorous deposits in Mendon Ponds are the two segmented eskers with their railroad embankment appearance in the woods where they can be seen and Indian trails and bridal paths along their crests.

The West Esker

The esker on the west side of the park is divided into three traceable segments each ending in an esker fan or cone. Throughout much of its length it is bordered by large kettles that in places show ice-contact kames on the opposite side. It varies in height from 5 or 10 feet to over 100 feet. The origin, at first glance, seems to be a simple melting "back" that is, northward, with a fan or cone deposited at each prolonged "stand" of the ice (fig. 5). This may well be the way it was formed, but if the ice block was detached the northern most segment that ends abruptly north of the thruway, may have formed contemporaneously with the two southern segments, spilling its large cone termination into water (or partly under ice. fig. 2). Stop #1. The large kettles that parallel the esker terminate with ice-contact steepness with a mixture of ice-contact kames and smaller kettles on the opposite side. The sharp break in slope at the top of kettles and irregular gradation to swell and swale may be due to some variation of the conditions illustrated in figure 2.

The East Esker-Kame-Kettle Complex

The continuous nature of "the esker" described by Giles as "not being in any place discontinuous" (Giles, 1918) for 2 1/2 miles completely baffled the author in the field. Fairchild's description (Fairchild, 1926), quoted above, concerning their irregular and confused nature is more accurate.

The area bounded by Canfield Road on the north and Pond Road on the south, the swampy area on the west and Pittsford Mendon Road on the east, contains an extremely complex mixture of kames, kettles, esker segments and eskerine ridges. The origin of the many features seems most likely to be polygenetic, not the product of a single stream as postulated by Fairchild (1926), although he does mention that the esker is "confused by subsequent kame construction."

The ice covering this area must have been more highly fractured and covered with suspended perforation deposits, perhaps due to a more irregular till basement. John H. Cook, (1946b), argues the case in favor of much "kame" construction being due to perforation deposits working their way down through the ice. Chauncey D. Holmes (1947) counters with the argument that, in New York State at least, they would become suspended by the insulating effect of a layer of clay which would leave them suspended in the ice mass. Holmes considers pot-hole action to be responsible for most individual kames.

This eastern area of the park contains such a jumbled up mixture of deposits that all the processes discussed by Cook and Holmes, along with subglacial esker formation, could be responsible in different individual depositional forms - Stop #5. The esker segments, kettles, and some ice-contact kames indicates much fracturing and deposition in, around, and under ice blocks. On the other hand, many small "eggs-in-a-basket" kames indicate no ice-contact and must have been poured into the water from small crevasses and perforation deposits as the final melting of the stagnant ice occurred - Stop #3. These last deposits may be found in between, on top of, or contiguous to, any of the previous deposits (fig. 6). Where two perforation deposits are connected by a filled crevasse a saddle would be found connecting two kames.

The area north of Canfield Road and east of Wilmarth Road is now being quarried for sand and gravel revealing an interesting structure. Stop #4. The section on the east and southeast appears to be kame-kettle topography similar to that south of Canfield Road, but is being cut into for private home construction and appears to be mostly sandy in consistency.

The quarry reveals torrential bedding, some zones so coarse-grained that they could almost be called catastrophic, to a depth of around 100' to ± 700' above sea level. There is no water except in the deepest excavation which may be near the top of a drumlin. (This deep water table is found in all of the new excavations in topographic high areas, indicating that the gravels do not hold water for long, or it is shed off their grass-covered slopes.) There appears to be a till capping, although it has been farmed and bull-dozed considerably and may be a man-made deception. The bedding has apparent dips in all directions indicating that this large deposit may have been draped over a drumlin or drumloidal hill.

A similar but smaller deposit occurs 3/10's of a mile east of Round Pond (which is the highest elevation in the park at 820'+.) This one has many branches like a giant amoeba. A possible explanation for these large hill-mantled kames is that with down-melting the tops of the hills were exposed allowing the entrance of gravel-charged water which subsequently worked its way down around the hills by convection melting (fig. 7.)

South of Woodchuck Hollow a pit was cut (and is being filled for reclamation-not a land-fill) showing torrential bedding with a "catastrophic zone" as revealed at different horizons in all the new cuts. Due to their great permeability the very coarse gravels are mostly cemented with lime leached out of the "rock flour".

Across the road (north of Pond Road, east of Pittsford Mendon Center Road), several large kames are being dissected and also show "catastrophic zones." (Stop #6). These cobble-sized deposits are so prevalent it makes one think there must have been one or several mini-alti-thermal periods.

Another "catastrophic" zone is found south of the park north of the ice-drainage channel in Russo's pit and appears to overlie pre-glacial Genesee River sediments. This unusual deposit consists only of pebbles, cobbles, and coarse sand as though flushed clean of all other size grades. It is also truncated by an ice-marginal drainage channel which makes it even more interesting.

A possible explanation for these relationships may be found by considering the two deglaciations of Lake Warren I and Lake Warren II (Fairchild, 1932). During the deglaciation of Lake Warren I the catastrophic layers could have been formed at an earlier, higher level, ice-marginal drainage channel. During the deglaciation of Lake Warren II, at a slightly different location of the ice-front, the second, deeper, channel could have been cut truncating the first.

If time is available a look at the catastrophic bedding on top of the pre-glacial Genesee River with the above described possible relations could be made (Stop #7). This is located south of Bulls Sawmill Road.

The above descriptions and interpretations are based on a study of the available literature, study of the 7 1/2 minute contour maps (not available to Giles and Fairchild) with a five foot contour, and a few days traversing the area to get a closer look at the tree-covered deposits.

The author takes full responsiblity for any interpretations that may seem, to the glacial expert, as wildly illogical.

ACKNOWLEDGEMENTS

The writer would like to thank Richard D. Hamell for help in the tedious "kame-climbing" and gravel-pit digging in the field and Thomas X. Grasso for critically reading the manuscript.

The following sketch diagrams are an attempt to put into visual perspective the ideas in the text. Figs 9-10-11 were added later to explain STOP #3. Maps - fig 1 - at the end.

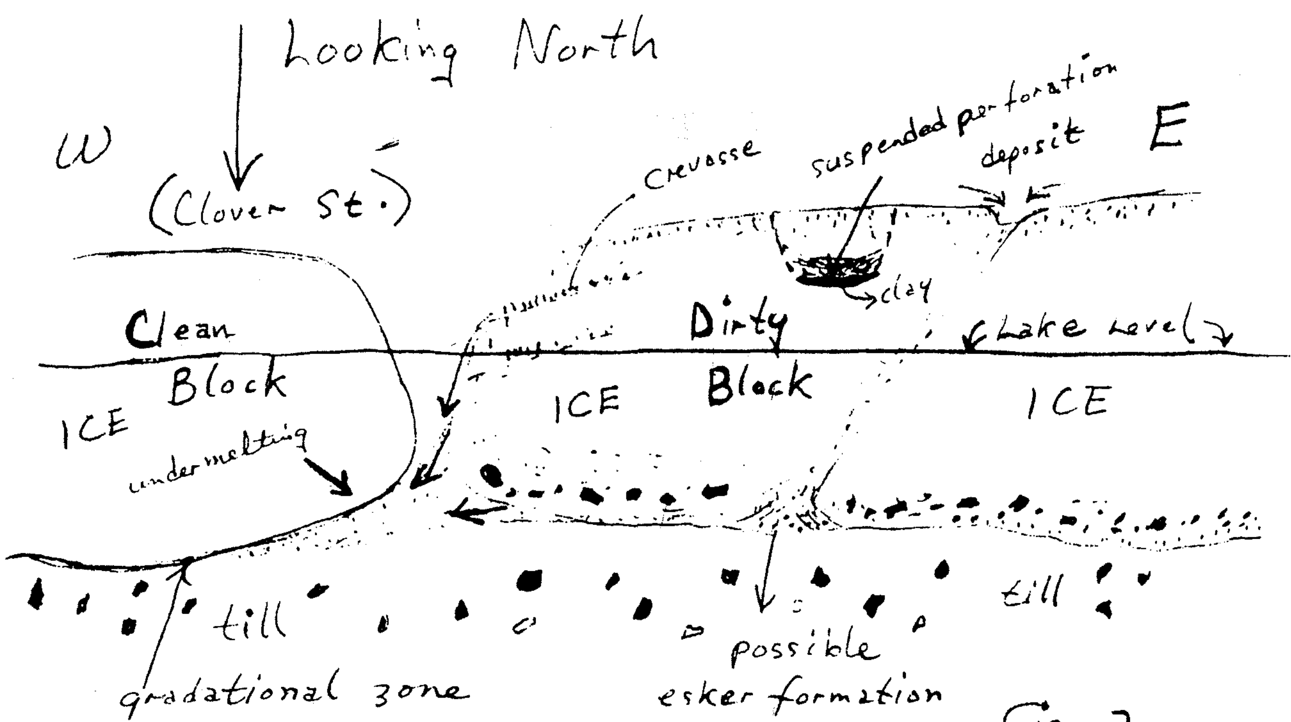


fig. 2

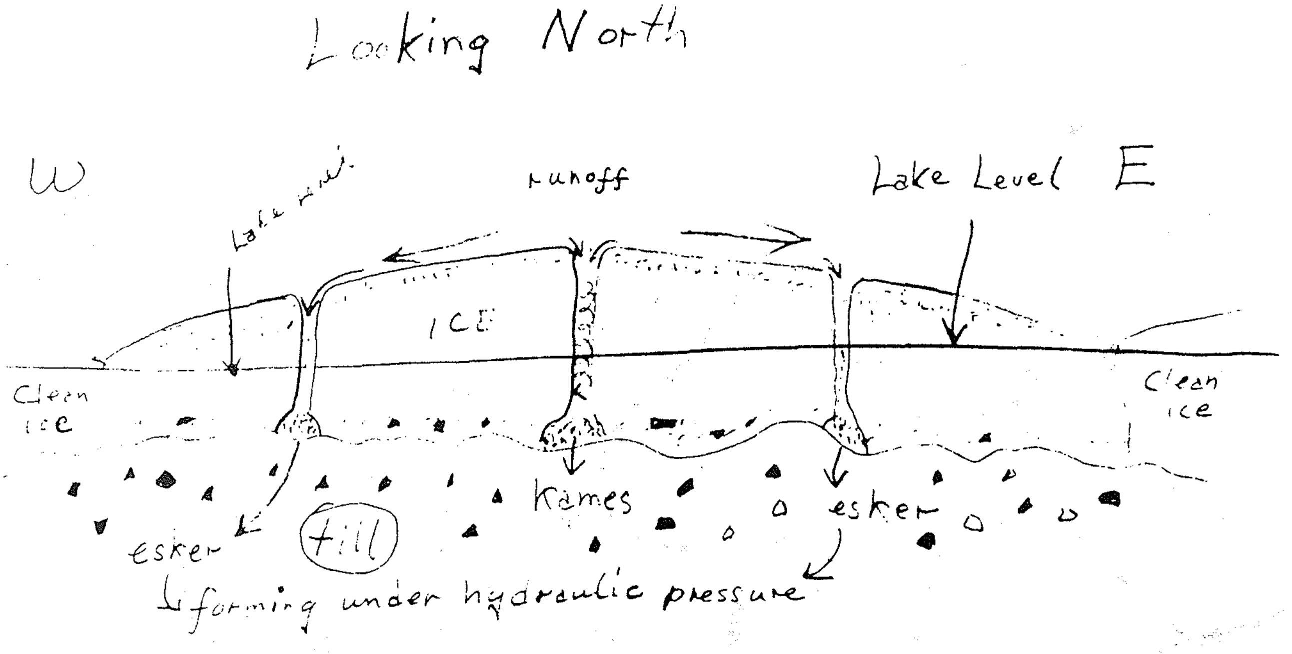

Looking North
W
runoff
Lake Level
E
Lake level
ICE
Clean ice
Clean ice
Kames
esker
esker
till
forming under hydraulic pressure

fig. 3

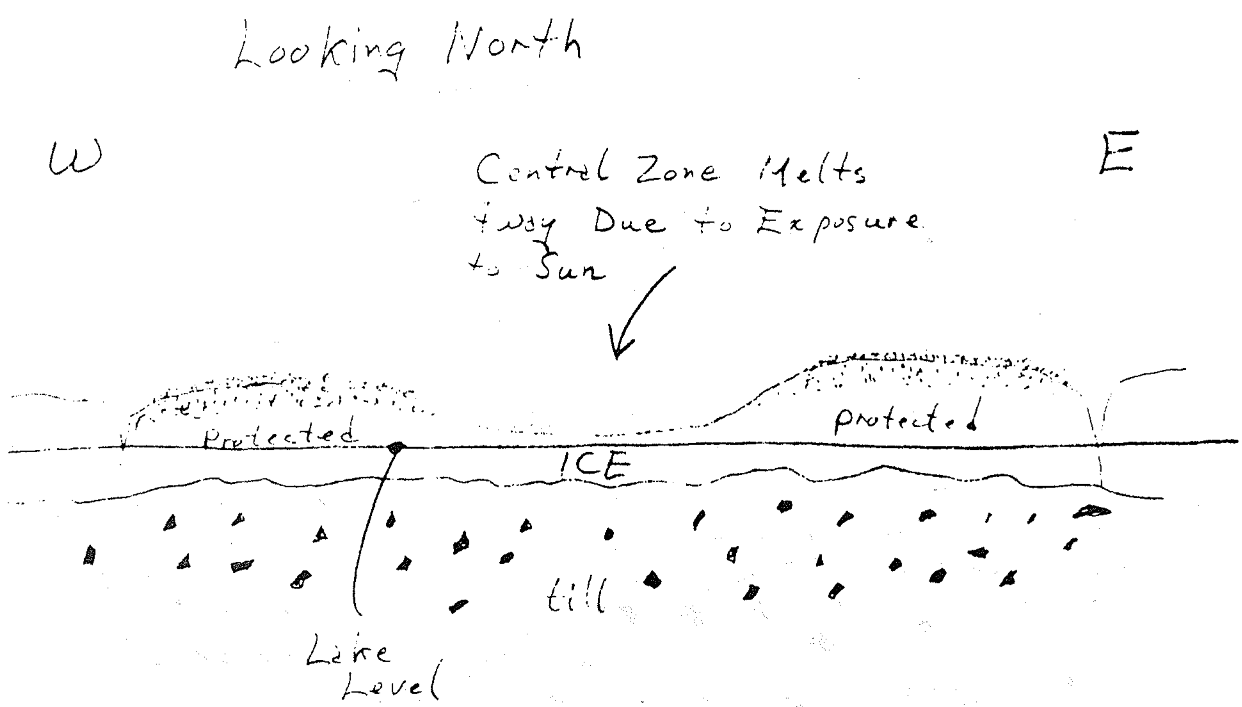

Looking North
W
E
Central Zone Melts Away Due to Exposure to Sun
Protected
protected
ICE
till
Lake Level

fig. 4

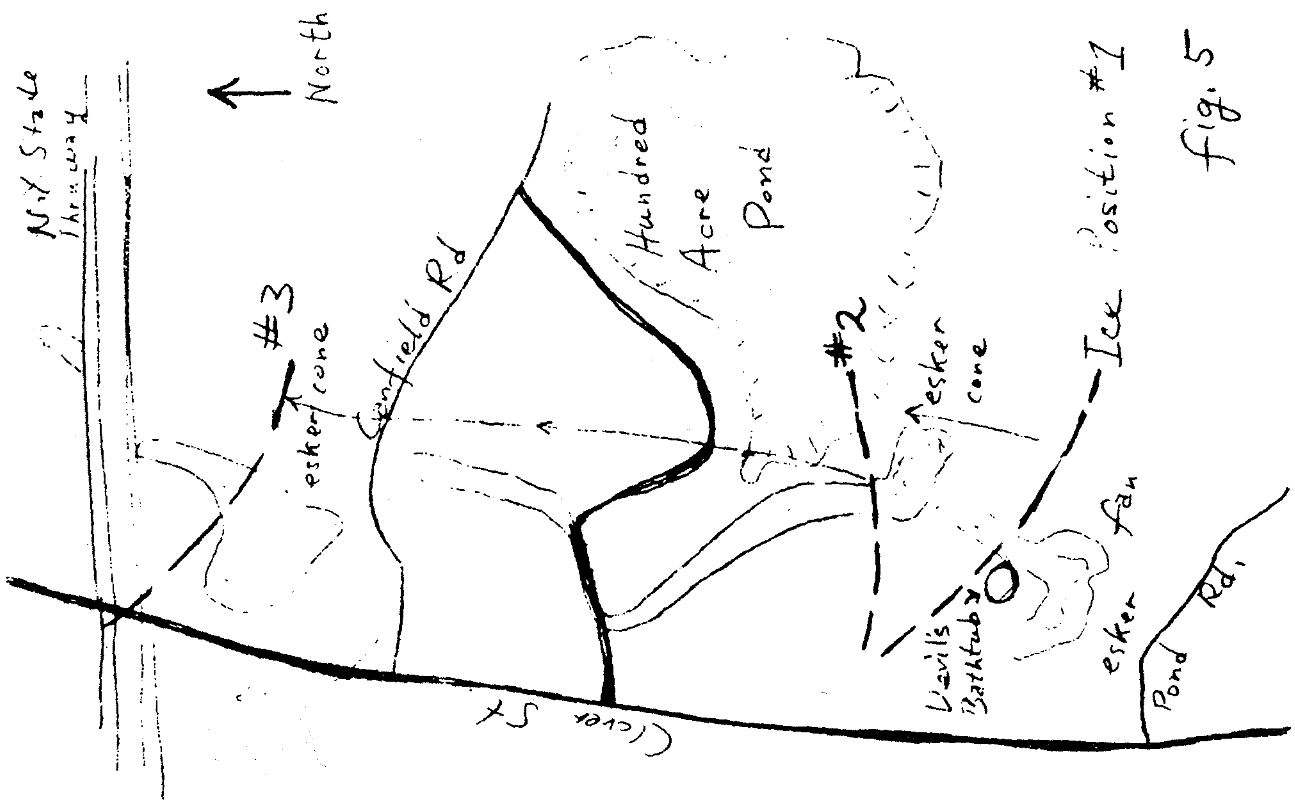

N.Y. State Thruway
North
Hundred Acre Pond
#3
esker cone
Canfield Rd
#2
esker cone
Ice Position #1
fan
esker
Devils Bathtub
Pond Rd.
Clover St

fig. 5

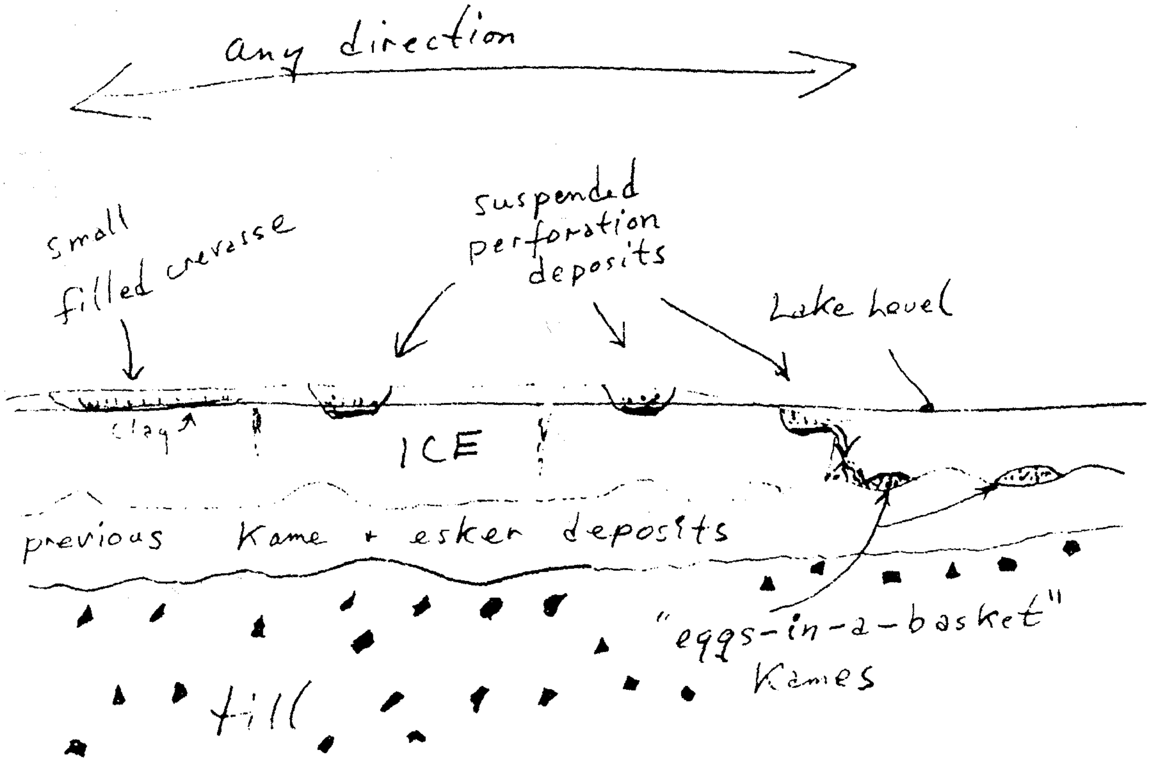

any direction
small filled crevasse
suspended perforation deposits
Lake Level
clay
ICE
previous Kame + esker deposits
"eggs-in-a-basket" Kames
till

fig-6

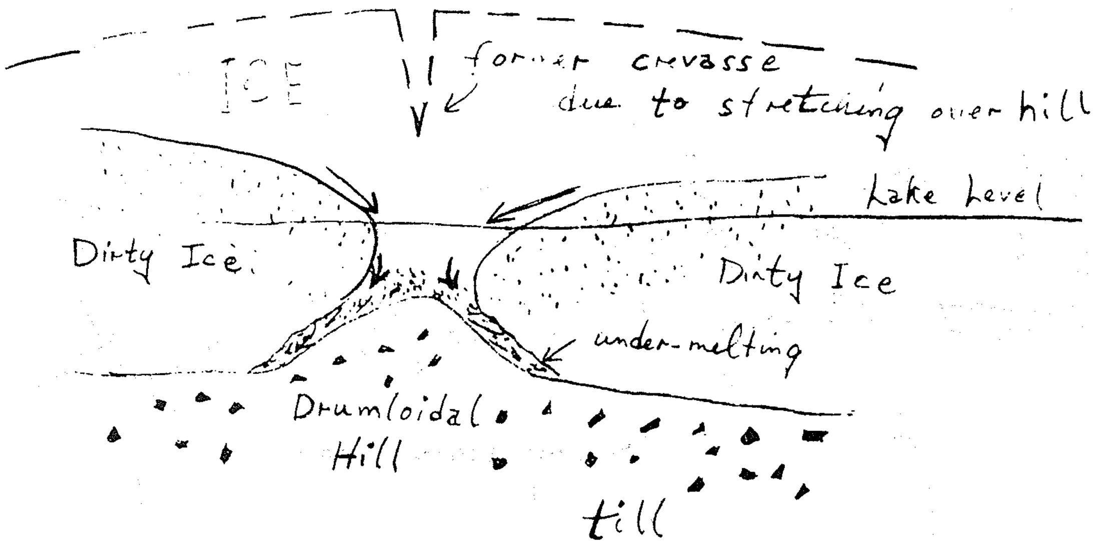

ICE
former crevasse due to stretching over hill
Lake Level
Dirty Ice
Dirty Ice
under-melting
Drumloidal Hill
till

fig. 7

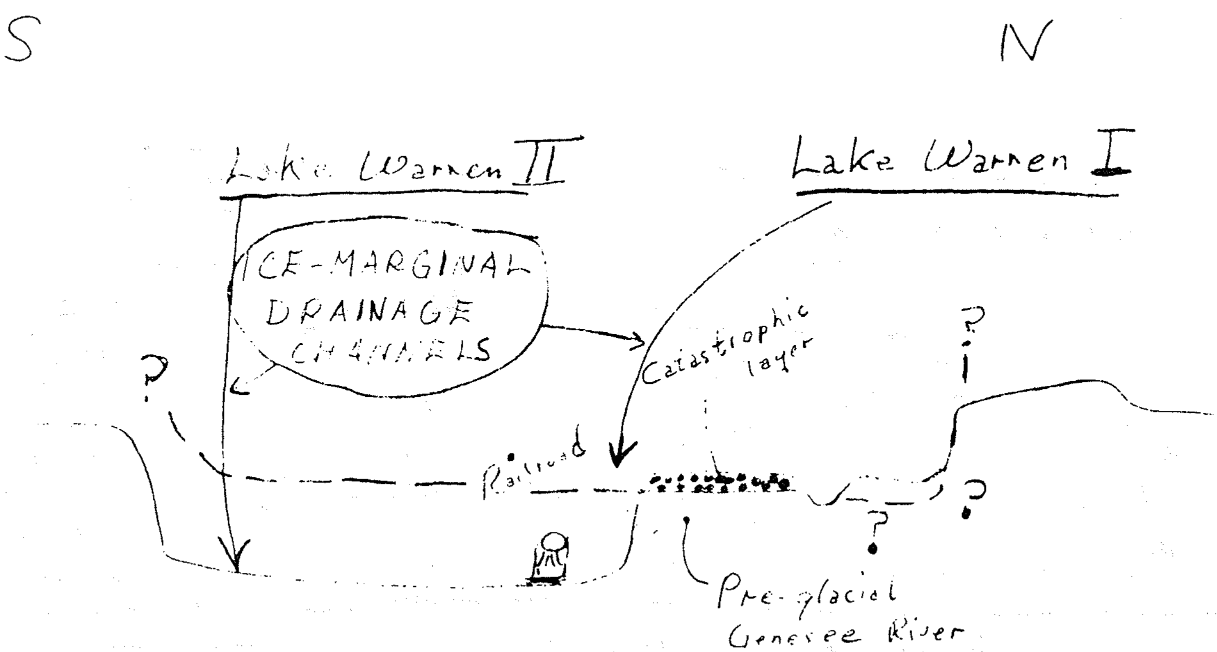
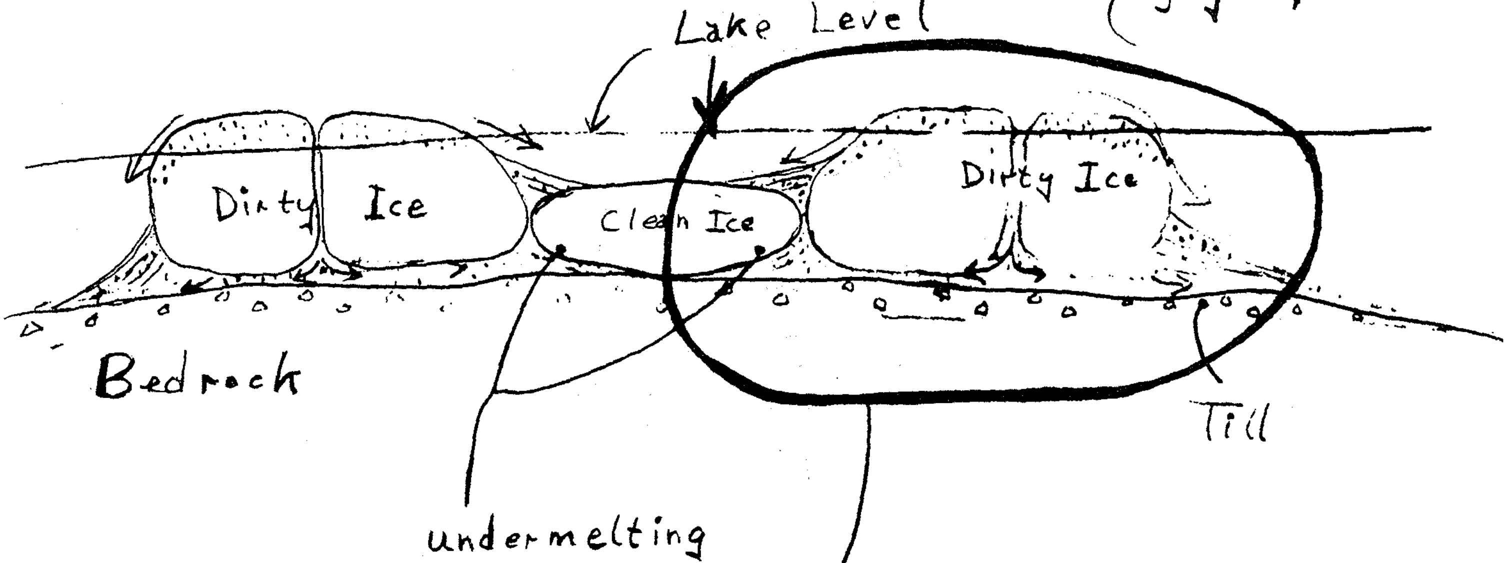

S
N
Lake Warren II
Lake Warren I
ICE-MARGINAL DRAINAGE CHANNELS
Catastrophic layer
Railroad
Pre-glacial Genesee River

fig. 8

Looking North - (Mendon Ponds Park)

fig. 9

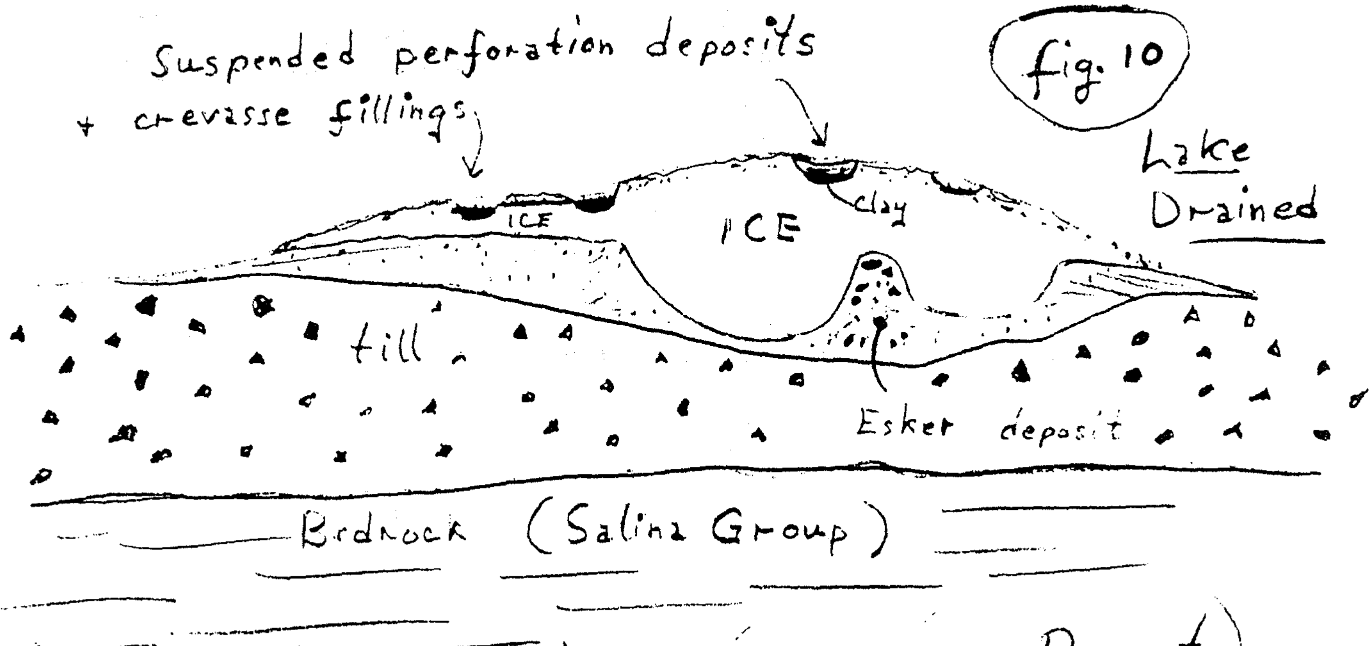


STOP #3

figs 9, 10, 11

Later Stage - (enlarged inset)

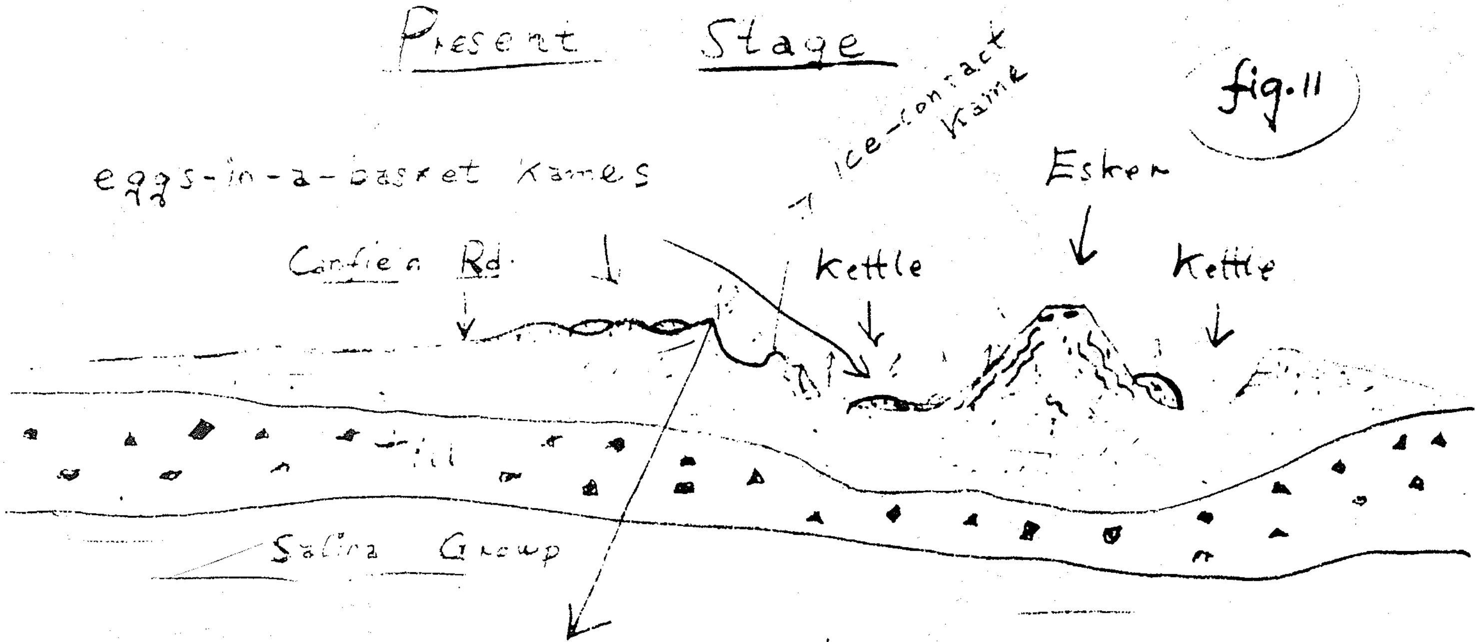
fig. 10



(next page → Present)

Present Stage

fig. 11



sharp break between:
ice-contact (right, in kettle-esker area)
features ~and~
non-ice contact eggs-in-a-basket
kames dumped wherever superglacial
debris was concentrated as seen
at STOP #3

Fig. 1a

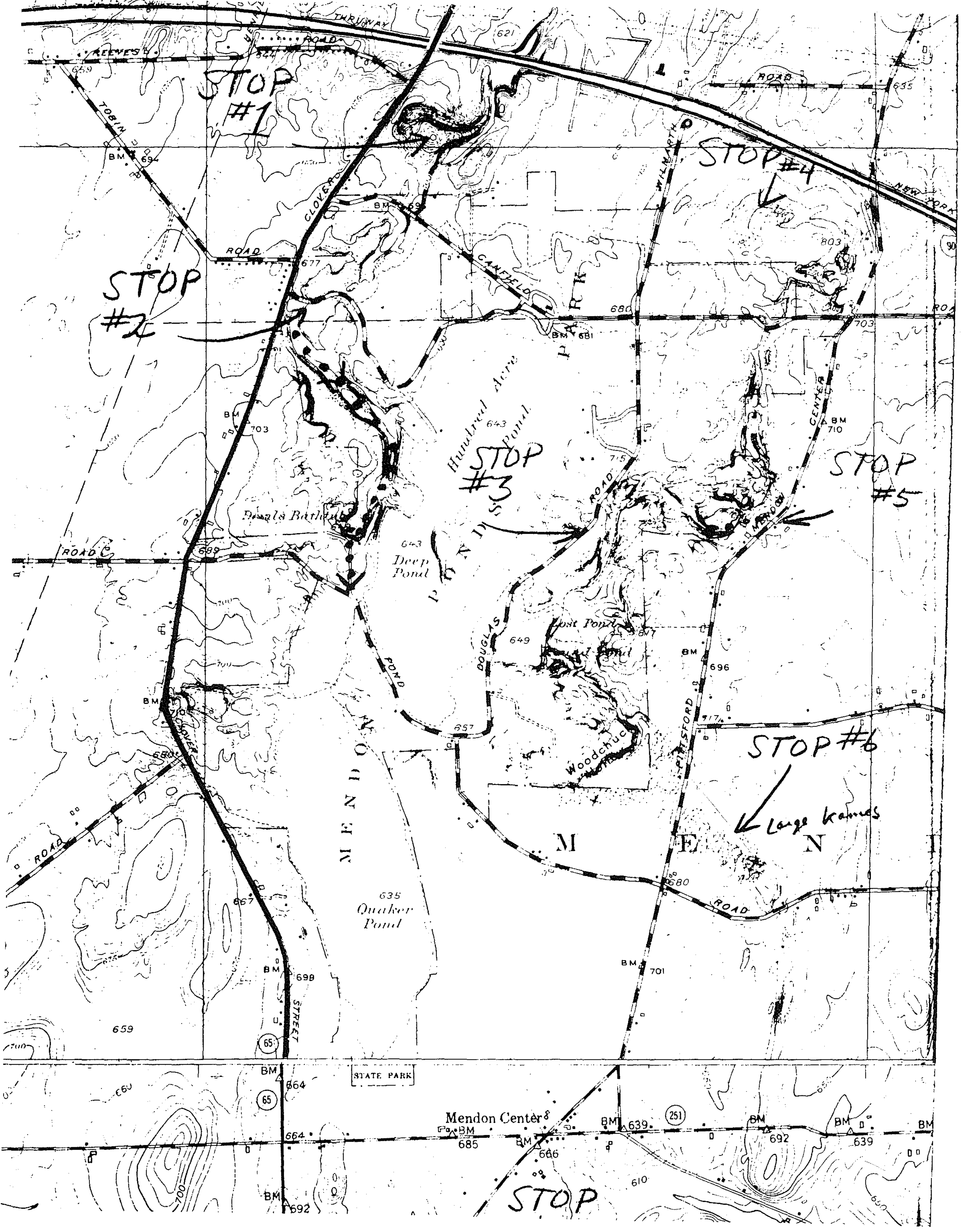
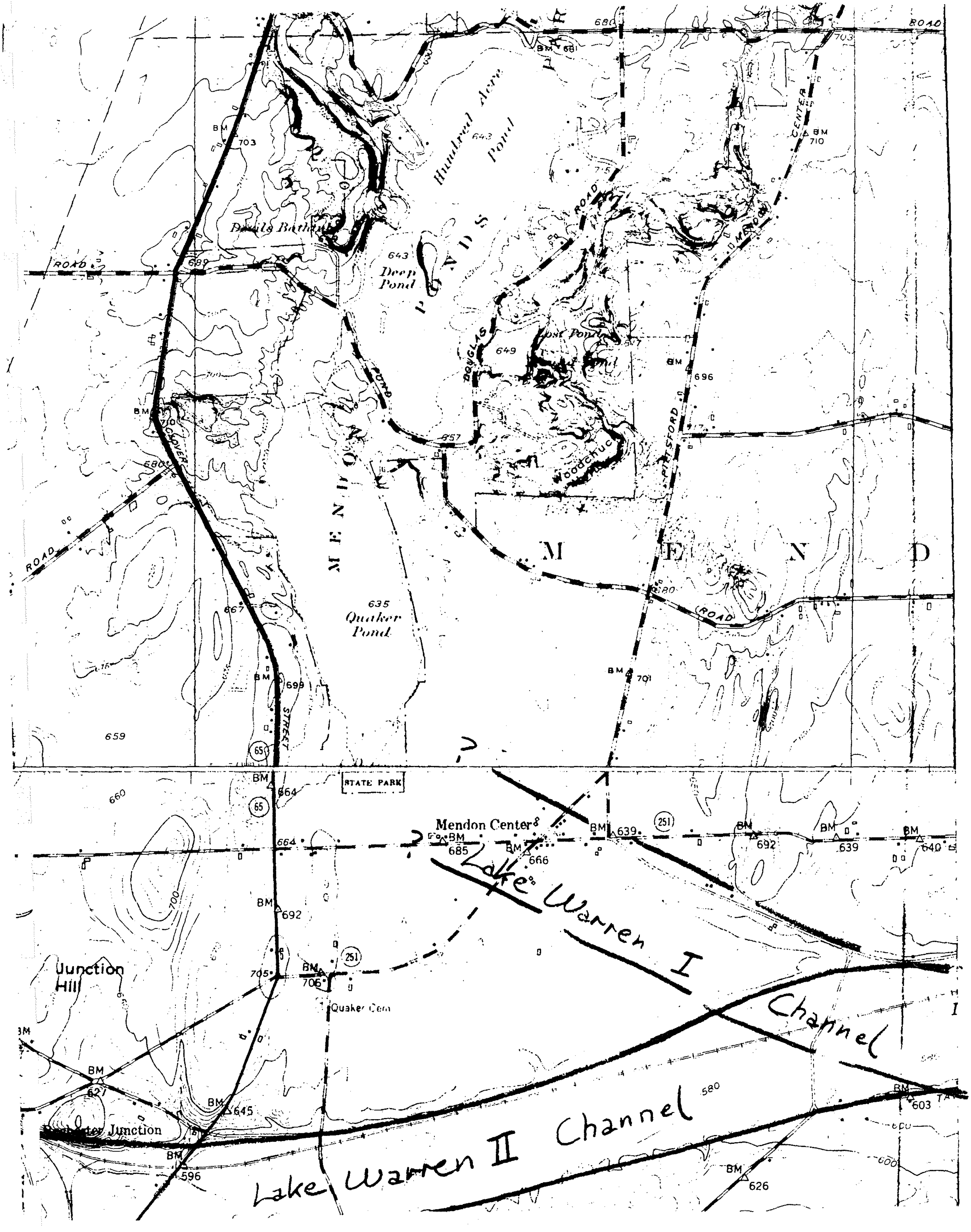

THRUWAY
REEVES
ROAD
621
659
STOP #1
TOBIN
BM 694
CLOVER
BM 691
ROAD
677
CANFIELD
STOP #2
PARK
680
BM 681
WILMARTH
STOP #4
NEW YORK
803
703
635
Hundred Acre Pond
643
STOP #3
715
STOP #5
CENTER
BM 710
BM 703
ROAD
688
643
Deep Pond
PONDS
DOUGLAS
649
Lost Pond
BM 696
717
POND
657
STOP #6
Large kames
Woodchuck
PITTSFORD
M E N
MENDON
680
ROAD
635
Quaker Pond
667
BM 699
STREET
659
65
BM 701
STATE PARK
BM 664
Mendon Center
BM 685
BM 686
BM 639
251
BM 692
639
664
610
BM 692
STOP
700

Fig. 1b



Hundred Acre Pond
643
Devils Bathtub
Deep Pond
PONDS
MENDON
Quaker Pond
635
Woodchuck
DOUGLAS
POND
CLOVER
STREET
PITTSFORD
CENTER
MENDON
ROAD
M E N D
STATE PARK
Mendon Center
Junction Hill
Quaker Cem
Junction
Lake Warren I Channel
Lake Warren II Channel

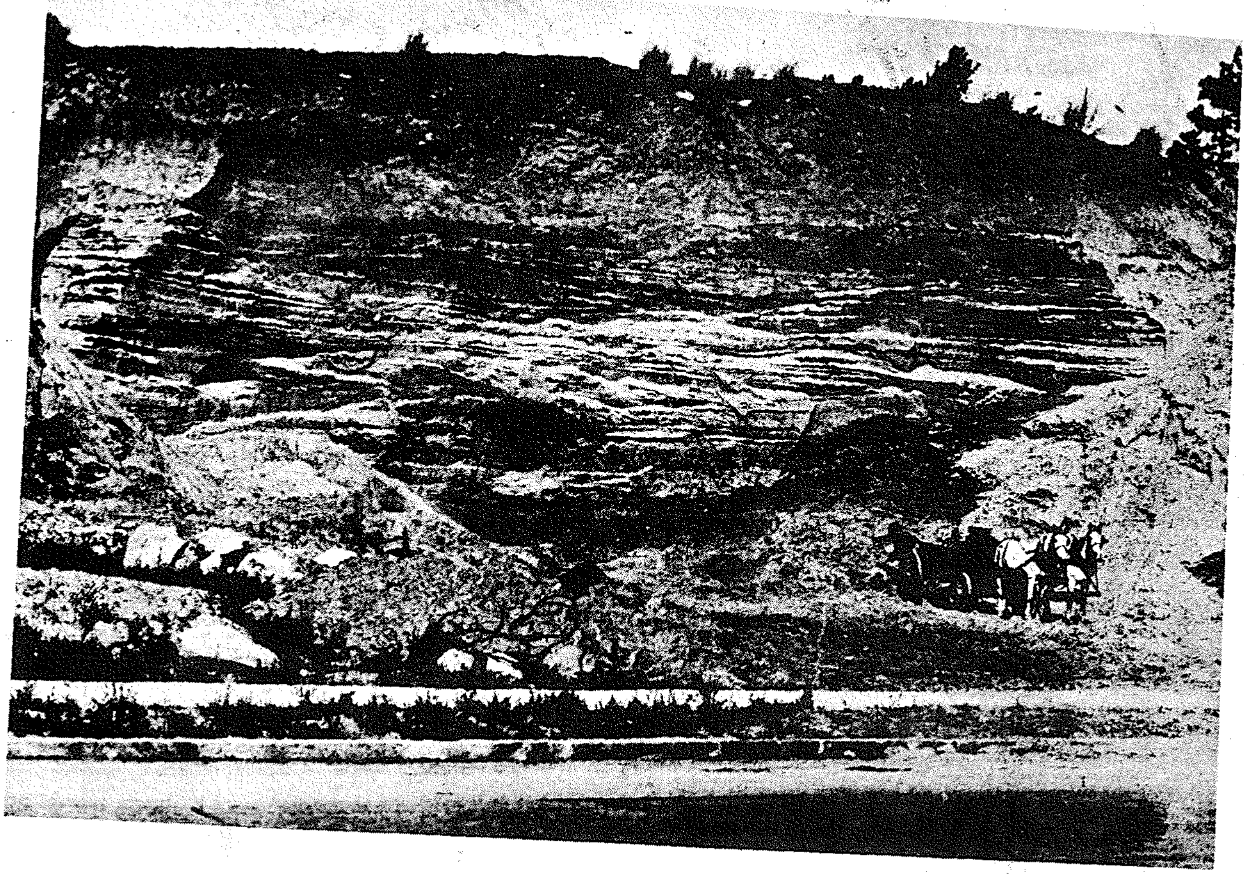


Plate I

Till capping lake sand. Near Winton Road, looking west in 1922. (Fairchild, 1923).

Plate II

Cobbs Hill. North side of Hill by Erie Canal widewaters east end of pit, looking southeast, in 1903. (Fairchild, 1923).

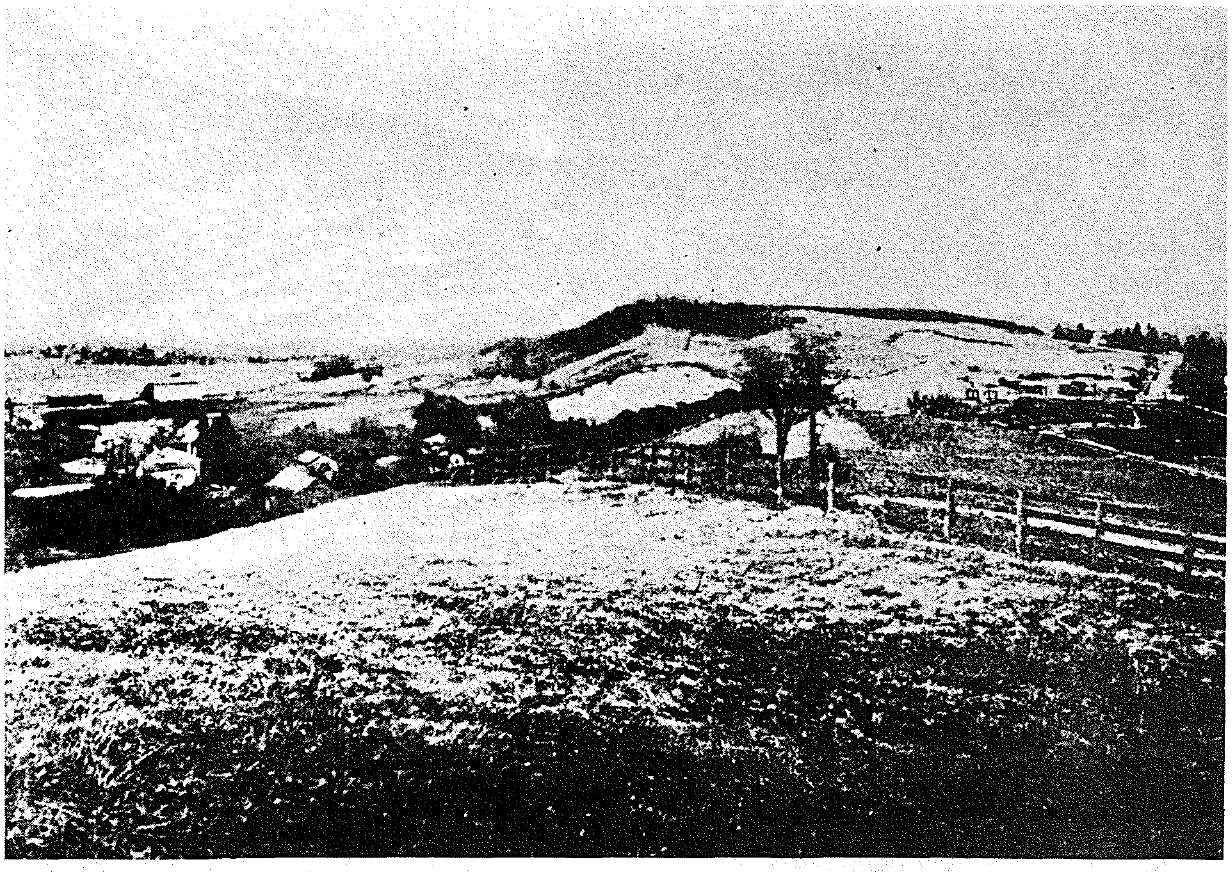


Plate III

Cobbs Hill. Looking east from Klinck Knoll on Pinnacle Hill in 1895. (Fairchild, 1923).

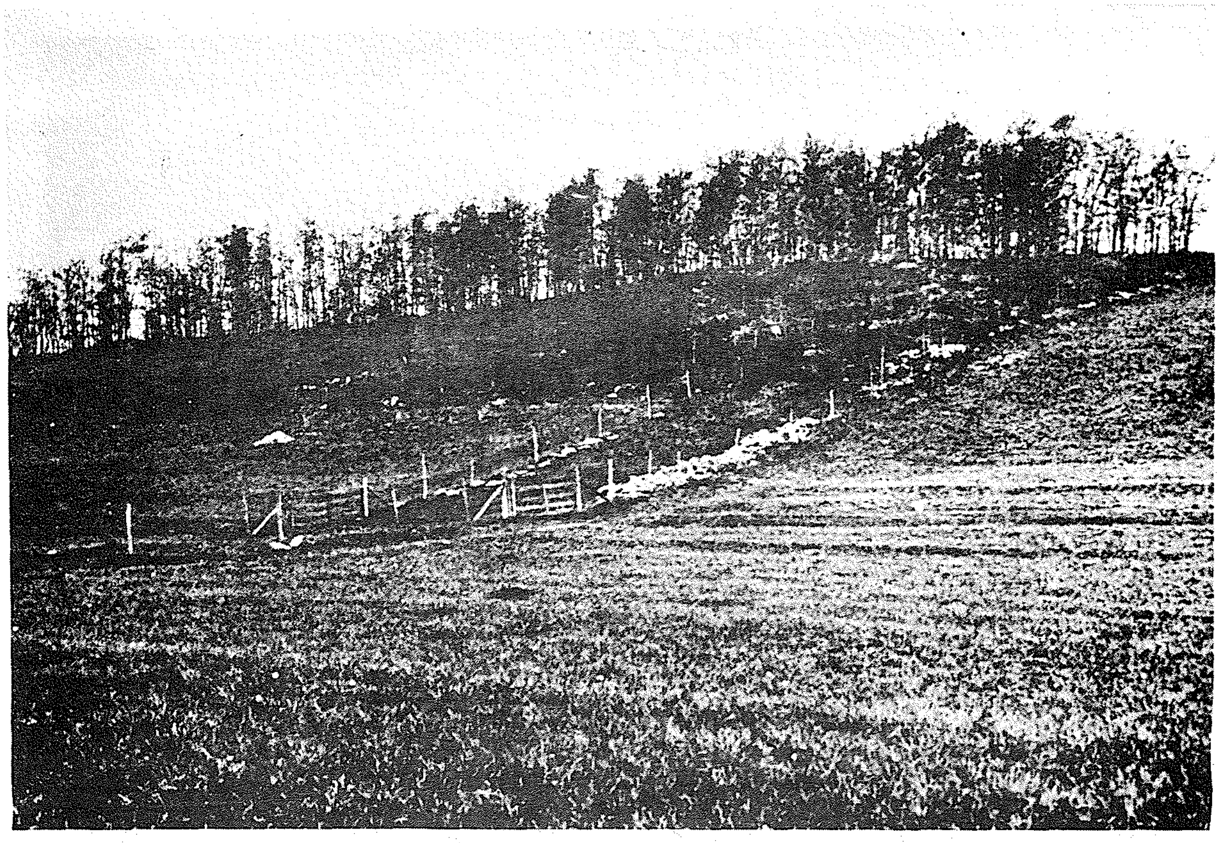


Plate IV

Cobbs Hill. Looking northwest from south ridge in 1903. (Fairchild, 1923).

Plate V

Section at South Clinton Street. View of west slope of the Pinnacle looking west, in 1895. (Fairchild, 1923).

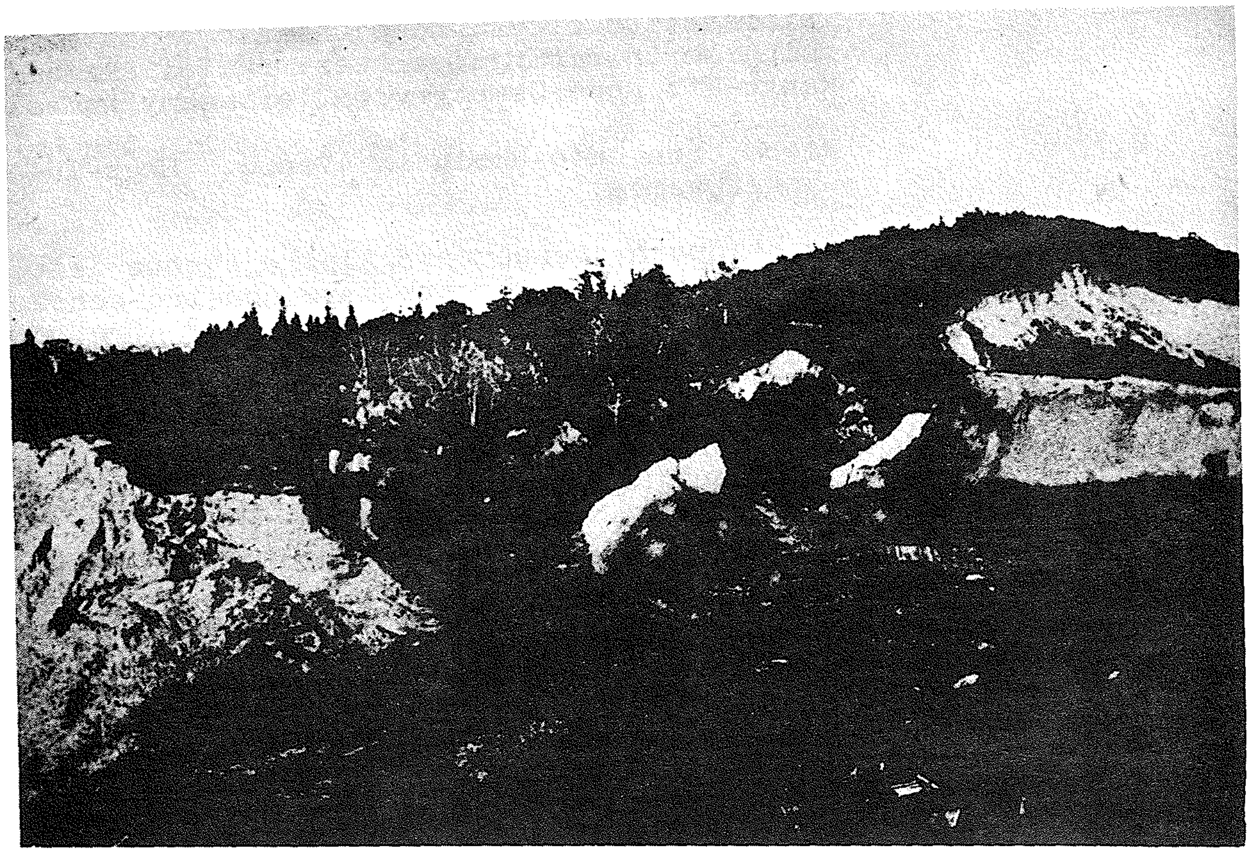


Plate VI

Section at South Clinton Street. View looking north of east toward the Pinnacle, in 1894. (Fairchild, 1923).

TRIP LOG

Miles-Cumulative	
-0-	Intersection of Mt. Hope and Elmwood Avenues going North rising over west end of Pinnacle Range-Mt. Hope Cemetery on left-many kames.
0.7	Right turn onto Robinson Avenue. Eggs-in-a-basket kames.
1.0	Cross South Avenue onto Alpine Avenue left then right through park more non-ice-contact kames.
1.5	Right turn on South Goodman Street.
1.7	Left turn on Highlnad Avenue. Driving along sub-lacustrine outwash slope.
2.2	Cross Clinton Avenue South pit on left.
2.4	Stop bus just before Winslow Avenue. Kame appears to ice-contact on north outwash slope.
3.0	Light at intersection of Highland Avenue and Monroe Avenue.
3.1	Cross on Highland Avenue. Take left fork up Cobbs Hill, circle Reservoir overlooking Rochester till plain to north and Lake Dana basin to south (if clear, may see Bristol Hill-south shore of Lake Dana) Pinnacle Hill high point to west with T.V. towers.
4.0	Back down to Highland Avenue. West to intersection of Monroe and Highland Avenues.
4.1	Take sharp left going southwest Monroe Ave.
5.0	Cross Winton Road.
5.9	Cross Westfall Road.

6.4	Right turn going south on North Clover Street (Rt. 65S).
7.1	Cross French Road.
7.7	Cross Barge canal.
8.0	Cross Jefferson Road west to Clover Street outh (still going south) climbing up Salina Group.
8.7	Cross Stone Road-notice swell and swale topography-both sides.
9.3	Cross Calkins Road.
9.7	Notice Drumlins on both sides of road.
11.1	Cross thruway. Notice collection off erratics on house below on right.
11.4	Stop #1. Clover Sand & Gravel Co. Large cut in esker cone showing torrential bedding.
12.1	Left turn into second park entrance, Hopkins Point Road. Pull off to right, get out of bus for walk on esker. Stop #2, bus will pick us up at base of Devil's Bathtub parking lot on Pond Road.
	BUS: (circle around to left, left on Canfield Road, left on Clover Street, left at third entrance to park-Pond Road-stop at bottom of Devil's Bathtub parking lot.)
15.5	Continue SE on Pond Road-west on Pond Road; north on Douglas Road-pull off to right by telephone booth.
17.0	Stop #3. Look at eggs-in-a-basket kames (non-ice-contact) and edge of kettle with sharp break in slope-(ice-contact). Get back on bus. Continue north on Douglas Road.
17.7	Cross Canfield Road.

18.1	Stop #4. Stop at entrance to Shafer's Pit in large-till-capped? kame, probably draped over drumlin. Get back on bus.
18.7	BUS: Proceed north to turn-around. Pick us up at entrance.
19.0	South on Wilmarth Road to Canfield Road, turn left on Canfield Road.
19.7	Turn right (south) on Mendon Center Road.
20.4	Stop #5. Pull off to right for walk on esker segment in east side of park. Get back on bus.
	Proceed south to entrance of Spezio's pit in kames east of Mendon Center Road, north of Pond Road.
21.1	Stop #6. View of dissected ice-contact kames.
21.3	Cross Pond Road going south. Proceed south on Mendon Center Road.
21.8	Left turn on Bulls Sawmill Road.
22.0	Cross Rush-Mendon Road (Route 251).
22.9	Stop #7-Optional. Right turn in Russo's pit. Look at catastrophic bedding overlying pre-glacial Genesee River (?), truncated by ice-marginal drainage channel of Lake Warren II, get on bus for trip back to motel.
±25 miles	Left on Bulls Sawmill Road.
	Left on Route 251 going west.
	Right on Route 15 going north back to motel.
TOTAL:	± 50 miles-END OF TRIP.

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Trip G

PLEISTOCENE AND HOLOCENE SEDIMENTS AT HAMLIN BEACH STATE PARK, NEW YORK

Robert W. Adams
State University College at Brockport

Erosion and sedimentation along the Lake Ontario shore at Hamlin Beach State Park, ten miles north of Brockport, New York, have exposed and produced numerous sedimentological features. The purpose of this trip is to examine Pleistocene and Holocene deposits in order to observe the variety of materials and structures present and to discuss their possible origins. The high water level condition of Lake Ontario and periodic lake storms have created new exposures of Pleistocene deposits and have removed or made inaccessible other exposures. This situation is not expected to change prior to the field trip and therefore specific localities cannot be designated in this summary. The general types of material which we may reasonably expect to examine are outlined below. It is hoped that the experience of the participants and discussions on the "outcrop" will aid in the interpretation of the Pleistocene features.

Shoreline Sedimentation

The sandv beaches at Hamlin Beach State Park have been modified greatly by the high water conditions. Much of the sand has been removed, leaving a "lag concentrate" of coarser material with abundant sand-size heavy minerals. The lack of a substantial replenishing sand source to the west of this area (dominant longshore currents are from the west) inhibits the reformation of a sand beach. In the past this has necessitated groin construction for traping the sand moved by longshore drift, trucking-in sand to maintain the beaches, and snow-fencing during the winter season to inhibit the removal of sand by wind.

Under normal conditions the subdivisions of a beach (shoreface, berm crest, and backshore) can be found and examined at the Park. The presence of a wide range of clast size (silt to boulders), clasts of contrasting composition and derivation (igneous, metamorphic and sedimentary), and variable wind and water conditions together provide for the development of a host of sedimentary textures and structures. Examination of these sedimentation features provides an opportunity to observe sedimentation phenomena and to develop and discuss principles of physical stratigraphy and sedimentology.

Heavy mineral concentrates as layers up to one-inch thick were common in the beach area during normal conditions and have increased in proportion and thickness in the last year. Black magnetite-rich and pink to red garnet-rich bands dominate the beach deposits. Hornblende and hypersthene are very common in the concentrates. This material provides excellent teaching examples for optical mineralogy and sedimentary petrography.

Pleistocene Sediments

The shoreline within the Park extends from eastern, low, marshy areas westward to bluffs dominated by a prominent topographic high, locally called Devil's Nose, extending approximately eighty feet above lake level. Exposures of sediments along the shoreline has revealed materials which lake the characteristics of recent beach sedimentation. Individual sedimentation units are composed of clay, silt, sand, or boulder gravels and are probably late Pleistocene. A minor proportion of the material is cemented into a boulder conglomerate which upon being eroded by wave attack has formed "sea" caves, arches, and stacks. The documentation and analysis of the sedimentary units is an on-going project by the staff and students, Department of The Earth Sciences, State University College at Brockport.

This field trip will traverse the shoreline along the northwest portion of the Park. Exposures of the pre-recent vary from low wave-cut benches to high, vertical bluffs resulting from lake storm undercutting and subsequent collapse of the bluffs. The group will examine as many features of the Pleistocene as possible and a summary of facts and conjecture will be presented at the end of the trip.

Trip H

MINERAL COLLECTING AT PENFIELD QUARRY

BY

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ABSTRACT

Penfield Quarry, Penfield, N.Y., is in the dense gray Lockport Dolomite and is operated by Dolomite Products as a source of material for road construction. A large variety of nicely crystallized minerals occur in solution vugs as well as cavities associated with corals in the upper portions of the formation. Some of the finest specimens to come from this locality are variously colored fluorite cubes, very clear gypsum, reddish brown sphalerite crystals, celestite crystals, and vugs lined with dolomite and calcite crystals. The origin of these minerals is a subject that can lead to lively discussions.

Lockport Dolomite

The Lockport Dolomite is a hard, dense, fine grained dolomitic limestone of Middle Silurian age. It is quarried and crushed by the Dolomite Products Company for use in road construction. Its resistance to erosion has led to the formation of an escarpment that is a rather prominent feature running west from Rochester to Niagara Falls where it forms the crest of the falls. From there it runs west through Ontario and Michigan. In places it is argillaceous. It is also very petroliferous and has a strong odor of crude oil when broken. Black encrustations and blobs of natural asphaltum are abundant. At Rochester the Lockport Dolomite has a total thickness of approximately 180 feet. Fossil corals are commonly found in some layers but are not easily removed from their matrix. Solution has produced cavities and stylolites which in turn have served as hosts for much of the mineralization.

Mineralization

In spite of numerous outcrops and extensive quarrying of the Lockport Dolomite, there are only certain localities that offer the variety of minerals and well developed crystals found at the Penfield Quarry. The best known of these are the Royalton Stone Quarry east of Gasport on route 31, Frontier Quarry southwest of Lockport, the piles of rubble taken from the Barge Canal excavation at the east edge of the Monroe County Airport and just west of Lockport, and the Walworth Quarry east of Rochester. The minerals described below occur as crystals and encrustations lining the inner surfaces of the solution vugs, fissures, and corals found in the Lockport Dolomite. One reason that the mineral specimens from these localities have been very popular among collectors is the fact that they have formed as crystals growing rather freely into solutions that filled these spaces. The sequence of crystallization among the minerals has resulted in particularly interesting relationships. For instance, calcite crystals are commonly found on top of the dolomite crystals whereas dolomite crystals are commonly found embedded in clear gypsum. The availability and quality of the minerals at the Penfield Quarry vary considerably with time as the quarry workings traverse certain zones.

Anhydrite $CaSO_4$ Orthorhombic mmm

Light blue masses often found completely filling vugs and enveloping other minerals, commonly mixed with fine grained white gypsum. These masses are often found to be somewhat foliated. The gypsum may be an alteration of the anhydrite.

Aragonite $CaCO_3$ Orthorhombic mmm

Sometimes found as white crusts.

Barite $BaSO_4$ Orthorhombic mmm

Distinguished from the more common celestite with certainty only by flame tests or X-ray diffraction. It has an occurrence similar to that of celestite.

Calcite $CaCO_3$ Trigonal $\bar{3}$ 2/m

Scalenohedral crystals (dog tooth) are sometimes found as large as 15 centimeters; more commonly 2-5 centimeters. Also occurs as beautiful micro-crystals of rhombohedral habit and unusual clarity associated with marcasite on the dolomite. Scalenohedral crystals commonly occur on the dolomite oriented in such a way as to permit firmly attached doubly terminated specimens. Best large specimens are found in dolomite-lined vugs with little else present.

Celestite $SrSO_4$ Orthorhombic mmm

Light blue to white to colorless, translucent to transparent, elongate crystals. A light blue color is fairly indicative of celestite. The colorless crystals may be barite. Often found enveloped by gypsum; beautiful specimens with celestite penetrating transparent gypsum can be found. Crystal size from millimeters to approximately 0.3 meters.

Dolomite $CaMg(CO_3)_2$ Trigonal $\bar{3}$

Nice translucent white rhombohedral crystals with curved faces lining cavities are a certain find for anyone visiting Penfield Quarry. Crystals are commonly 0.5 - 1 centimeter in size and situated so as to show faces. Smaller colorless transparent rhombohedrons may also be observed with a lens and distinguished from calcite by acid.

Fluorite CaF_2 Isometric m3m

The most prized specimens from Penfield Quarry are those with free-standing fluorite cubes. They range in size from less than a millimeter to approximately 10 centimeters on a side, though most are in the 1 - 2 centimeter range. Color ranges from colorless to yellow to green to blue to purple making these especially attractive specimens. Many of the examples exhibit especially fine banding which can be seen in three dimensions within the crystals. The best crystals are found free-standing in vugs lined with white dolomite crystals which make the fluorite colors stand out vividly.

Galena PbS Isometric m3m

Rare. Occurs imbedded in the gray dolomite rock, more rarely as free standing cubes in cavities.

Gypsum $CaSO_4 \cdot 2H_2O$ Monoclinic 2/m

Occurs as fine grained white masses as well as the selenite variety of unusual clarity. Some selenite masses are as large as 0.3 meter in length. Occasionally crystal faces can be found. Selenite commonly envelops other crystals, notably celestite and dolomite producing quite nice specimens. Both varieties of gypsum commonly fill entire cavities.

Marcasite FeS_2 Orthorhombic mmm

Small cockscomb masses and singly or doubly terminated crystals usually less than 3 millimeters in length. Most are tarnished to a brilliant iridescent blue; some are pale bronze-yellow. Usually found on dolomite crystals and sometimes imbedded in gypsum.

Pyrite FeS_2 Isometric $2/m\ \bar{3}$

Small cubes and pyritohedrons less than 2 millimeters. Other forms may be present as well. Usually brass-yellow, sometimes tarnished iridescent blue. Usually found on dolomite crystals with little else near except marcasite and colorless rhombs of calcite.

Quartz SiO_2 Trigonal 32

Skeletal masses of drusy micro-crystals. Distinguishable in hand specimens from similar masses of dolomite by sparkle and from similar masses of calcite by acid test. Hardness is not applicable because the individual crystals are of the order of tenths of a millimeter. With a hand lens and a careful eye, identification based on crystal forms is possible in some cases. All three minerals may occur together.

Sphalerite (ZnFe)S Isometric $\bar{4}3m$

Variable in color from light yellow to red to dark brown depending on iron content. Occurs as veinlets in the dolomite rock and as curved, thick, fan-shaped crystals that are free-standing in the vugs. The crystals are often a centimeter or more across.

Strontianite $SrCO_3$ Orthorhombic mmm

Sometimes found associated with celestite.

Sulphur S Orthorhombic mmm

Occurs rarely as surface coatings and masses and as micro-crystals.

Origin of the Mineralization

The mineralization in the Lockport Dolomite has all of the characteristics of the Mississippi Valley type of deposit. Ohle (1959) describes these:

1. Absence of outcrops of igneous rocks that are potential sources of the ore solutions,

2. Simple mineralogy,

3. Low precious metal content,

4. Occurrence in limestone or dolomite,

5. Bedded replacements and veins,

6. Location in passive structural regions (regions that have not undergone strong mountain building activity),

7. Relation to positive structures (these include such features as gentle uplifts and arches),

8. Evidence of solution activity.

There are many deposits in this country and around the world that have these characteristics and are classified as the Mississippi type. Of these, the one that is perhaps most like the mineralization in the Lockport Dolomite is the Tri-State district (Oklahoma, Missouri, Kansas). Specimens from the Tri-State district consist of well crystallized dolomite, sphalerite, galena, marcasite, pyrite, calcite, and drusy quartz filling solution cavities and associated with corals in dolomitized limestone. Many of the relationships are the same. For instance, well formed crystals of sphalerite, marcasite, pyrite, galena and calcite occur on dolomite crystals.

There has been very little work concerning the origin of the mineralization in the Lockport Dolomite. However, there have been extensive studies done on the other Mississippi Valley deposits, especially those in the Tri-State district. These have led to a controversy that still continues today. Ohle (1959) gives the following proposed origins:

1. Original deposition

2. Original scattered deposition with modification by regional metamorphism

3. Original scattered deposition with modification by circulating ground water moving up

4. Original scattered deposition with modification by circulating ground water moving down

5. Deposition from fluids of igneous derivation with hydrothermal or gas transport either with volatile aid or simply as metallic vapor.

He dismisses the first because it could not account for veins and beds of galena and sphalerite inches thick. He dismisses the second explanation because it would call for deposits in the Precambrian rocks that were the source of the lead and zinc. No such potential source has been found in the exposed Precambrian rocks. He questions 3 and 4 on the grounds that in southeast Missouri faulting has cut up the areas in such a way as to reduce the size of the potential metal "gathering ground". He questions just how efficient ground water can be in leaching metals from limestone. Observations of present-day leaching indicate that it is quite limited. He also questions the mechanisms that cause precipitation. Organic matter has been suggested but there are deposits where no organic matter is found. Another objection to ground water emplacement is the depth of some of the deposits, 1500 feet in Missouri, 2000 feet in Tennessee, 5000 feet in Kansas.

In spite of these objections, the ground water hypothesis cannot be rejected. Deep circulating ground water could become quite warm and have many of the characteristics of hydrothermal mineralizing solutions of igneous derivation. The fifth hypothesis, mineralization by hydrothermal solutions of igneous origin, can explain such features as variation in mineral composition from area to area and pressure motivation for circulation. If these deposits do have such an origin, they should be classified as epithermal or telethermal since they exist at such large distances from any known igneous source for the minerals. A puzzling aspect of a hydrothermal origin is the extensive areas that have virtually identical mineralization, in some cases hundreds of miles across. This implies either a large area of igneous activity at depth that is able to produce solutions of remarkably uniform composition over a large area or it requires extensive circulation in the sedimentary rocks themselves.

Bastin and Behre (1939) and Bateman (1955) give evidence for a hydrothermal origin of the Tri-State deposits:

1. Bubble inclusions in sphalerite and galena contain 12 to 25 grams of NaCl per 100 cc of water as compared with an average of 3.5 grams per 100 cc in sea water. This seems inconsistent with concentration of the minerals by fresh ground water if the trapped inclusions represent the mineralizing solutions.

2. The bubble inclusions have been used to determine that the temperature of crystallization was 115° to 135°C. In this determination it is assumed that the mineralizing solution was trapped in the bubble as the crystal formed and that the liquid completely filled the bubble. As the crystal cooled the volume of the liquid decreased and its capacity for keeping gases in solution decreased, thus gas separated from the liquid inside the bubble inclusion. The process can presumably be reversed simply by heating the crystal and watching the gas disappear. This was done by observing crystals of sphalerite on a hot stage under a microscope. When the gas disappeared, it was assumed to be at the temperature at which the crystal formed. The temperatures determined by this method are considerably in excess of the temperatures that would result from deep burial in a region having a normal geothermal gradient.

3. The presence of the mineral enargite has been interpreted to indicate a hydrothermal origin.

More recently there have been studies by Hagni and Grawe (1964) on mineral paragenesis in Tri-State ores from which they conclude that the deposits are due to ground water circulation and by Erickson (1965) of bubble inclusions in calcite from which he concludes that his results are consistent with either a hydrothermal origin or a ground water origin.

Platt (1949) investigated the mineralization in the Lockport Dolomite. He favored an origin by ground water concentration of indigenous minerals. He cites as evidence the presence of impervious shales above and below the Lockport and the absence of mineralization in formations above and below the Lockport. He also made spectrographic analyses that showed both lead and zinc present throughout the dolomite in concentrations that could serve as a source for the galena and sphalerite.

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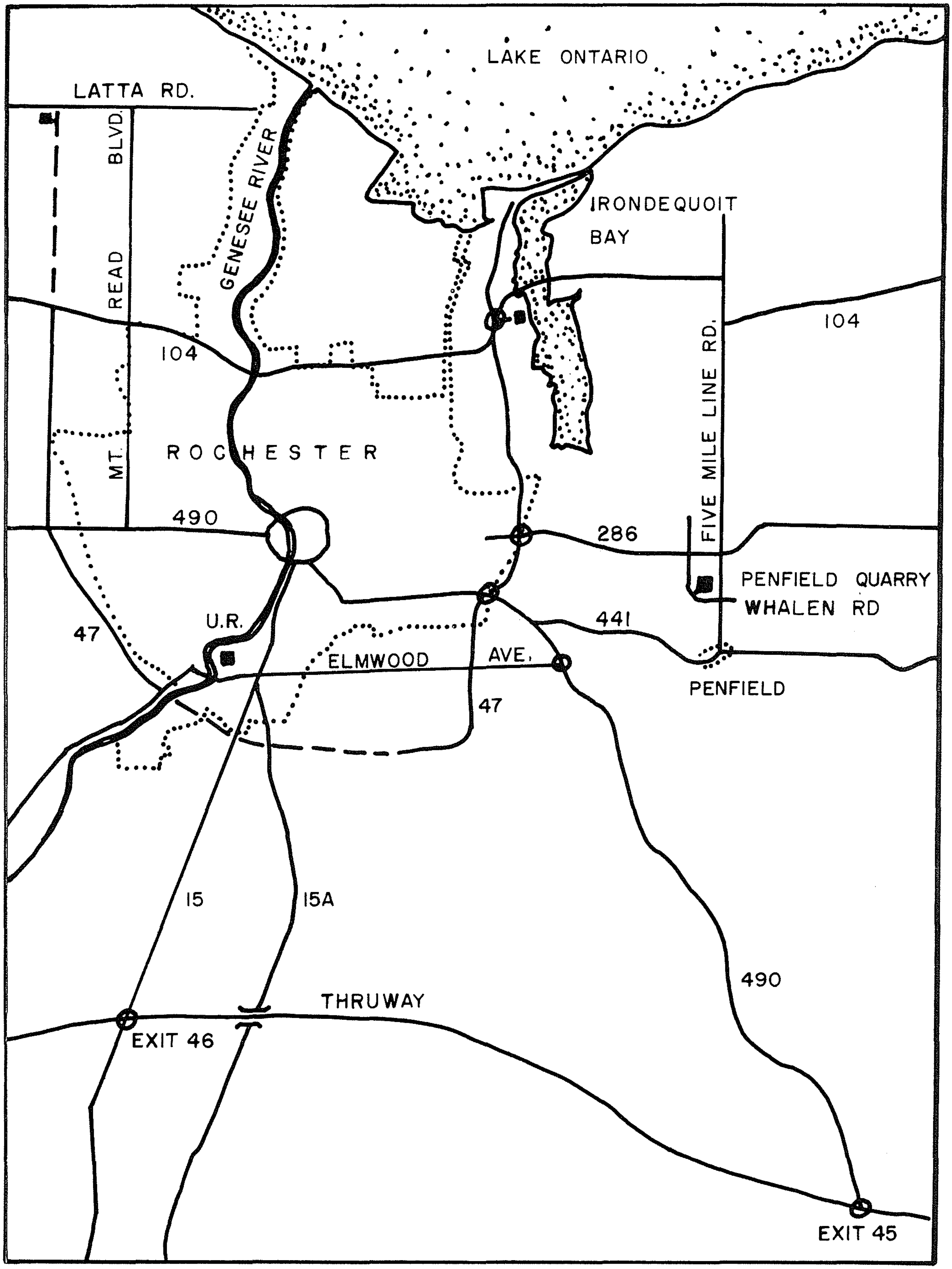
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LATTA RD.
MT. READ BLVD.
GENESEE RIVER
IRONDEQUOIT BAY
104
104
ROCHESTER
490
286
FIVE MILE LINE RD.
PENFIELD QUARRY
WHALEN RD
441
U.R.
47
ELMWOOD AVE.
PENFIELD
47
15
15A
490
THRUWAY
EXIT 46
EXIT 45

TRIP I

STRATIGRAPHY OF THE GENESEE GORGE AT ROCHESTER

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INTRODUCTION

The Genesee River, in its northward flow to Lake Ontario, plunges over the Niagara or Lockport Escarpment at Rochester. Diverted from its preglacial outlet through Irondequoit Bay, the Genesee River, since the last ice retreat (8,000 years ago) has carved a post glacial gorge exhibiting a nearly complete exposure of Upper Ordovician to Middle Silurian rocks. Formations of the same age are superbly exposed in the Niagara Gorge and a comparison of the two sections reveals a Lower and Middle Silurian section ideally suited for the illustration of complex facies changes and/or disconformities.

ORDOVICIAN SYSTEM

Upper Ordovician

<u>Queenston Formation</u> - The lowest exposure in the gorge is about 55 feet of unfossiliferous, thin bedded, red shale and siltstone with some red sandstone layers near the top. This consortium of red shale, siltstone, and sandstone is the Queenston Formation. White bloches in the shale and thin green shale layers following the bedding or joint planes, occur throughout the unit. These discolorations are thought to represent the percolation of ground water altering the red ferric oxide stain on the detrital fragments to the ferrous state.

Although only the upper 55 feet are exposed here, the Queenston totals nearly 1000 feet thick and underlies much of the Lake Ontario basin.

Named by Grabau (1908), the Queenston, to the southeast, becomes more sandy and silty, and in Pennsylvania is referred to as the Juniata Formation.

The Queenston and Juniata represent detrital deposits of a huge deltaic complex that spread westward across the Allegheny Basin as a consequence of the Taconic Orogeny (Middle Ordovician to Early Silurian)

SILURIAN SYSTEM

The Silurian System of New York begins with a deltaic sequence (Medina Group), succeeded by a complex marine transgression (Clinton and Lockport Groups), and ends with a sequence of hyper-saline deposits and eurypterid-bearing lagoonal carbonates (Salina Group). The Salina Group as presently defined includes, in its upper part, the Bertie Group of older reports.

This framework has resulted in a threefold subdivision of the Silurian into the following series: Medinan (lower), Niagaran (middle), Cayugan (upper). Only the Niagaran was thought to be fossiliferous enough to permit correlation outside of New York State. Since the paleontalogical recognition of the other series away from New York was difficult, Berry and Boucot (1970) suggested that the New York terminology be restricted to this state and adjacent areas, and that future attempts using the New York section for correlation be abandoned. Furthermore, they state that the North American graptolite and shelly faunal succession is similar to that of the British Isles, Scandinavia and Czechoslovakia; enough so to make the European series, (Llandovery, Wenlock, Ludlow and Pridoli) recognizable in North America and subdivided into Lower and Upper Silurian. Therefore these series names should replace Medinan, Niagaran and Cayugan.

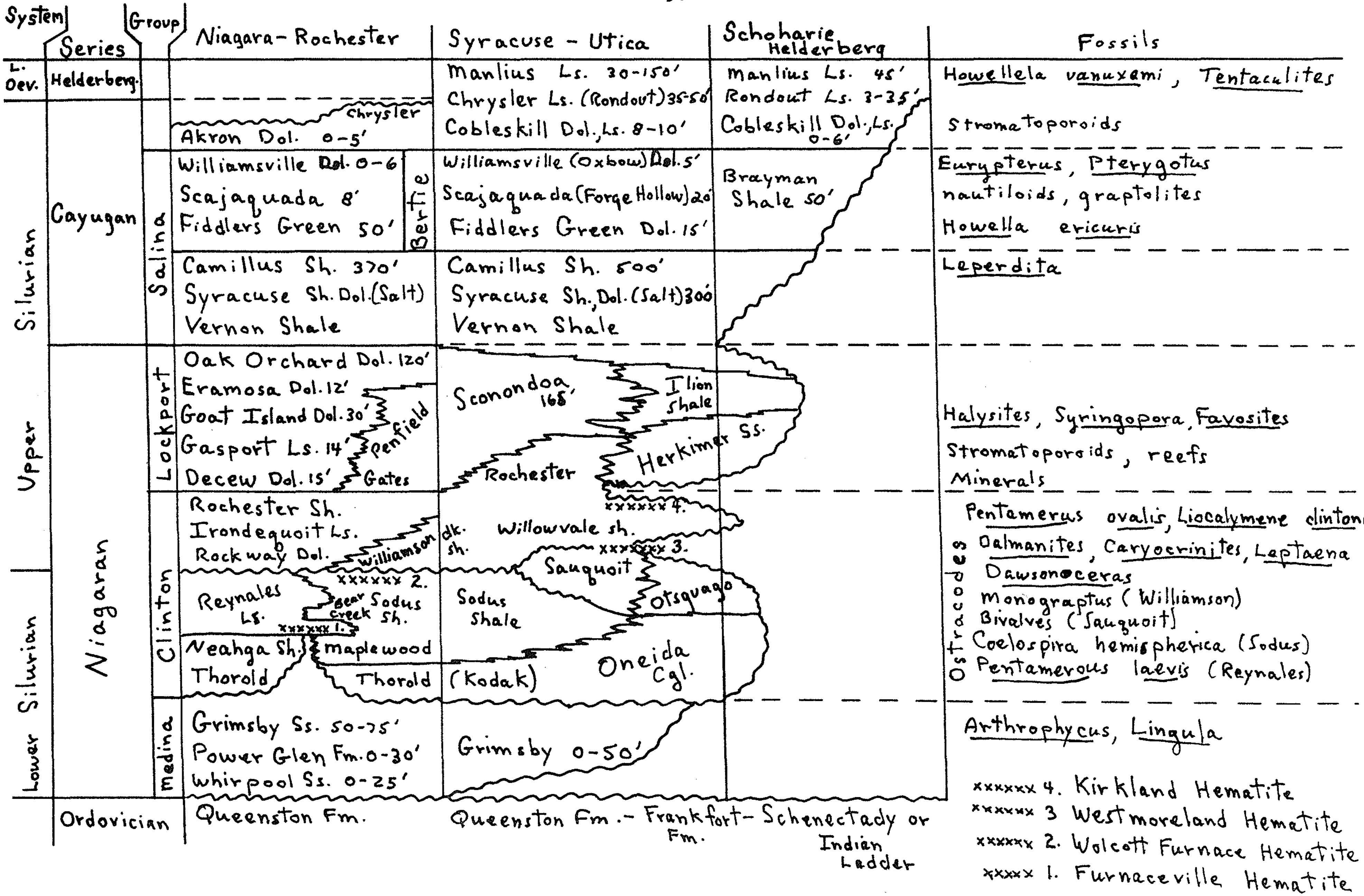
Many refinements in the correlation and subdivision of the New York Silurian have been accomplished in recent years. The major obstacles that impeded the study of the New York Silurian were the numerous disconformities, the lack of fossils in many units, and the change of facies eastward, toward the source area, into coarse clastics or red beds. These have been largely overcome by careful tracing of physical units using numerous closely spaced sections, more precise paleontological sampling and the widespread use of ostracodes and conodonts for correlation. This has yielded greater time stratigraphic control, thereby making Niagaran and Cayugan correlations more reliable outside the standard section. This usage has been adopted here.

Table 1 shows the relationships of the New York and European Series along with the graptolite, ostracode and conodont zones. Table 2 is a generalized chart of the Silurian section of New York (unpublished Silurian Correlation Chart - courtesy L. V. Rickard; Berry & Boucot 1970).

Table 1

Old American Standard: Syst.	Series	Rock Unit	Present European Standard: System	Series	Graptolite zones	Conodont Zones	Present American Standard: System	Series	Rock Unit	Ostracode Zones	Conodont Zones
Lower Devonian			Upper Silurian	Downtonian (Pridolian)	Monograptus transgrediens	Spathognathodus steinhornensis eosteinhornensis	Upper Silurian	Cayugan	Rondout Fm.	?	Spathognathodus S. sp. cf S. canadensis
					Monograptus ultimus				Salina Group		Spathognathodus snajdri
Upper Silurian	Cayugan	Akron—Rondout		Ludlovian	monograptus thuringicus	Spathognathodus crispus		Niagaran	Lockport Group		Polygnathoides siluricus
		Bertie Group			Saetograptus leintwardinensis	Polygnathoides siluricus					
		Salina Group			Pristiograptus tumescens						
					Cyrtograptus scanicus						
Middle Silurian	Niagaran	Lockport Group			Neodiversograptus nissoni	A. ploeckensis O. crassa				Drepanellina clarki	
				Wenlockian	Pristiograptus ludensis	Spathognathodus sagitta sagitta				Paraechmina spinosa	Spathognathodus sagitta sagitta
					Cyrtograptus lundgreni						
		Clinton Group			Cyrtograptus ellesae				Clinton Group		
					Cyrtograptus linnarsoni	Kockella patula					Kockella patula
					Cyrtograptus rigidus						
					Monograptus riccartonensis						
					Cyrtograptus murchisoni						
					Cytrograptus centrifugus	Pterospathodus amorphognathoides				mastigobolbina typa	Pterospathodus amorphognathoides
			Lower Silurian	Llandoverian	Monoclimacis crenulata		Lower Silurian				Spathognathodus celloni
					Monoclimacis griestoniensis	Spathognathodus celloni ?				mastigobolbina lata	
					Monograptus crispus						
					Monograptus turriculatus						
					Monograptus sedgwickii					Z. decora	
					Monograptus convolutus					Zygobolba excavata	Icriodina irregularis
					Monograptus gregarius						
					Monograptus cyphus						
Lower Silurian	Medinan	Medina Group			Orthograptus vesiculosus				Medina Grp.	?	Panderodus simplex
					Akidograptus acceminatus						
					Glyptograptus persculptus						

Table II
Generalized Silurian Section
West - Central - East New York



LOWER SILURIAN - MEDINA GROUP

Grimsby Formation - Extensively quarried for building stone and curbing, the Grimsby Formation or Red Medina Sandstone of older reports, is one of the more prominent units of the Lake Ontario Plain. Named by Williams (1919) it forms a minor escarpment west of Rochester and north of the well pronounced Lockport or Niagaran Cuesta.

In the Niagara Gorge the Queenston and Grimsby Formations are separated by nearly 60 feet of strata; 22 feet of white crossbedded Whirlpool Sandstone (Grabau 1909) or White Medina of earlier workers, followed by 48 feet of Power Glen Formation (Bolton 1953, 1957) of interbedded gray shales and siltstones. Traced eastward these two units pass laterally into the lower Grimsby.

Fisher (1966) has recognized three facies within the Grimsby in Orleans and Niagaran Counties west of Rochester. Facies "a", the lowest one, is a marine intertidal facies of pink and mottled siltstone containing abundant Lingula cuneata. It passes eastward into facies "b" east of Medina. The middle "b" facies is a thick bedded red sandstone with large scale crossbedding and the worm burrow Arthrophycus allegheniensis. It is this facies that has supplied most of the building stone and is probably supratidal in origin. The upper facies "c" is a crimson red, crumbly, shale containing a few greenish-gray shale beds indicative of a lagoonal environment.

The Grimsby Formation in the Genesee Gorge is a tripartite unit about 55 feet thick containing Arthrophycus allegheniensis. The lower 20 feet and upper 15 feet are coarse, heavy bedded, red siltstones and sandstones with minor amounts of shale. Large scale crossbedding and ripple marks can be found in both divisions. In addition, the upper portion contains blotches, and thin layers of light green to white color. These two subdivisions could be representatives of facies "b". The middle 20 feet is a mixture of thin bedded, red and gray, ripple marked sanstones and siltstones, with prominent interbeds of red and green shale. The middle portion could be a slightly coarser equivalent of facies "c" to the west.

CLINTON GROUP

Lardner Vanuxen (1839, 1842) was the first to use the Clinton as a group name. It is the most fossiliferous widespread Silurian unit and as such has been worked on extensively in an attempt to unravel the complex stratigraphic relationships. In this regard the works of Chadwick (1918); Sanford (1935, 1936); Ulrich and Bassler (1923); and especially Gillette (1947), have been important. Gillette's study of the Clinton Group certainly is the most comprehensive and therefore should form the base for all future research on the Clinton.

Refinements in Clinton correlation, petrology and biostratigraphy have been worked out in Western New York by Rexroad and Rickard (1965) and Kilgour (1963, 1966) and in Eastern New York by Muskatt (1969, 1972) and Zenger (1966, 1971).

Gillette (1947) recognized five ostracode zones in the Clinton Group and related them to Ulrich and Bassler's (1923). This is shown in Table 3. A facies diagram of the Clinton Group and lower Lockport Group is shown in Figure 1.

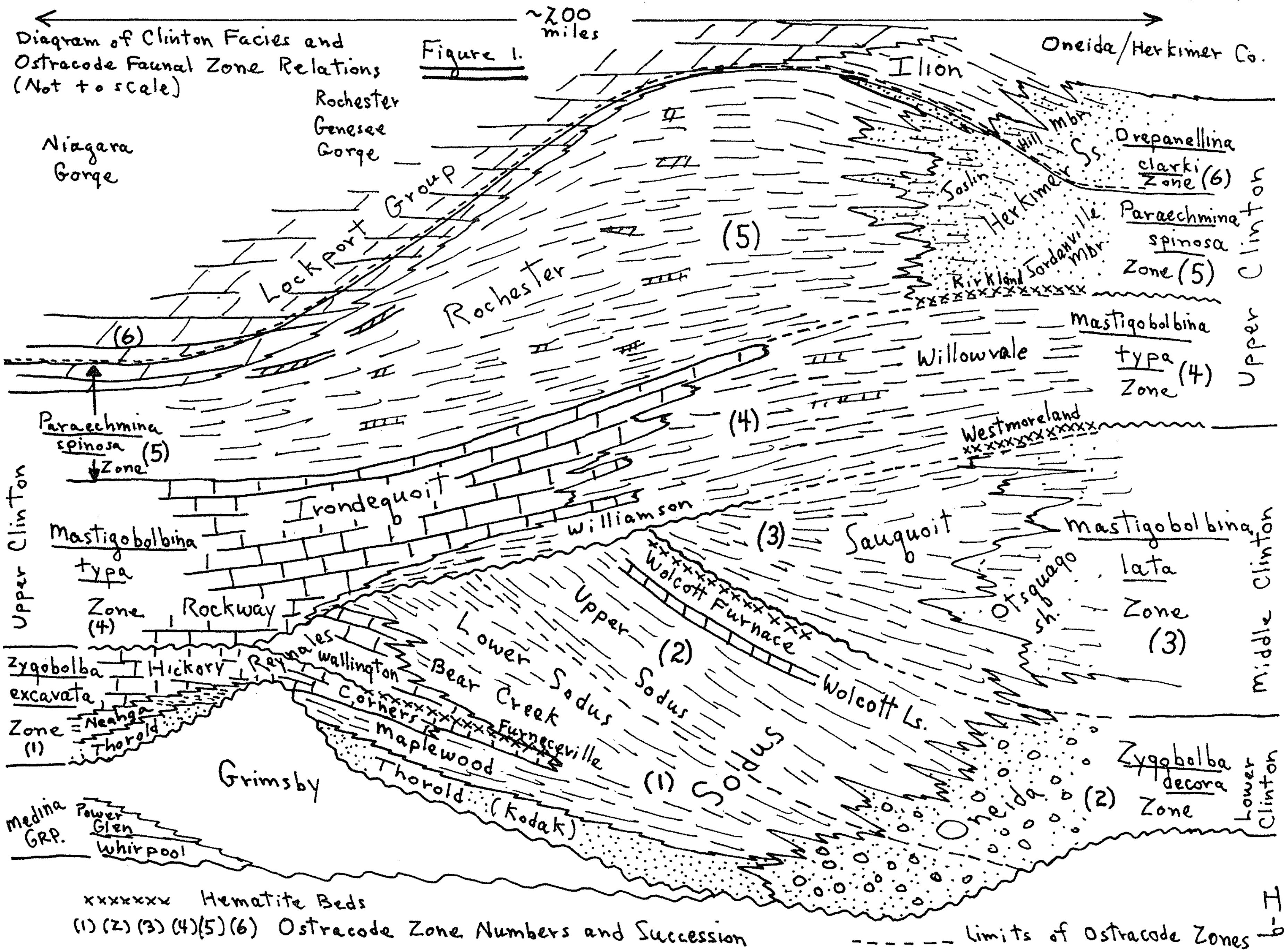
TABLE III

CLINTON GROUP OSTRACODE ZONES

(GILLETTE, 1947)

	Ulrich and Bassler - 1923	Gillette - 1947
UPPER CLINTON	*Drepanellina clarki* Not Recognized *Mastigobolbina typus* *Bonnemaia rudis*	Not Recognized * *Paraechmina spinosa* *Mastogobolbina typus* Not Recognized
MIDDLE CLINTON	*Zygosella postica* *Mastigobolbina lata* *Zygobolbina emaciata*	Not Recognized *Mastigobolbina lata* Not Recognized
LOWER CLINTON	*Zygobolba decora* *Zygobolba anticostiensis* *Aygobolba erecta*	*Zygobolba decora* *Zygobolba excavata* Not Recognized

*Not recognized by Gillete; found by Zenger 1971. In the west this zone occurs in the lower Lockport.


~200 miles
Diagram of Clinton Facies and Ostracode Faunal Zone Relations (Not to scale)
Figure 1.
Niagara Gorge
Rochester Genesee Gorge
Oneida/Herkimer Co.
Lockport Group
Rochester
Ilion
Herkimer Ss.
Joslin Hill Mbr.
Sordanville Mbr.
Kirkland
Willowvale
Westmoreland
Irondequoit
Williamson
Sauquoit
Otsquago sh.
Rockway
Hickory
Reynales
Wallington
Bear Creek
Lower Sodus
Upper Sodus
Wolcott Furnace
Wolcott Ls.
Sodus
Oneida
Corners
Furnaceville
Maplewood
Thorold (Kodak)
Neahga
Thorold
Grimsby
Medina GRP.
Power Glen
Whirpool
Drepanellina clarki Zone (6)
Paraechmina spinosa Zone (5)
Mastigobolbina typa Zone (4)
Mastigobolbina lata Zone (3)
Zygobolba decora Zone (2)
Zygobolba excavata Zone (1)
Upper Clinton
Middle Clinton
Lower Clinton
(1) (2) (3) (4) (5) (6)
xxxxxxx Hematite Beds
(1) (2) (3) (4) (5) (6) Ostracode Zone Numbers and Succession
------ Limits of Ostracode Zones

<u>Thorold Sandstone</u> - Named by Grabau (1913), the Thorold Sandstone is a light gray, to green, fine grained sandstone with a maximum thickness of 5 feet. Once known as the "grey band of Eaton" it is an easily identifiable unit lying above the Grimsby and forming the caprock of the Lower Falls of the Genesee at Rochester.

Although the Thorold is present at Niagara, it is missing for a distance of about 15 miles in the vicinity of Lockport, probably as a result of the Grimsby being an island or peninsula when the Thorold sea was sweeping around two or more sides. This would explain the Thorold pinching out from the east and west.

Chadwick (1935) erected the name Kodak Sandstone for the Thorold at Rochester believing it to be an entirely different physical stratigraphic unit. Gillette (1947) regarded the Thorold as continuous across Western New York State and therefore disregarded the term Kodak. Fisher (1959, 1966) proved that the Kodak was not continuous with the Thorold at Niagara. Furthermore, the absence of any transition upward into the definitely lower Clinton unit (Neahga Shale) led him to place the Thorold in the Medina Group as a facies of the Grimsby. The author thinks that the light sandstone above the Grimsby at Rochester and the light sandstone above the Grimsby at Niagara represent the initial depsit of the same transgressing sea over the Grimsby Sandstone. Although the name Kodak is not necessary, it could be used locally to designate the Thorold at Rochester.

Maplewood Shale - The Maplewood Shale was named by Chadwick (1918) for the 21 feet of smooth, slightly calcareous, green, platy shale overlying the Thorold in the Genesee Gorge. The lower 3 feet is more sandy and calcareous, while several thin stringers of limestones (less than 1 inch) occur in the remaining portion. It is the correlative of the Neahga Shale in the Niagara region. Macrofossils are rare, however, Fisher (1953) reports that it has yielded microfossils.

The Maplewood represents a quiet water deposit in slightly deeper more offshore water.

Reynales Limestone - Initially referred to by Hall (1843) as the "Pentamerous limestone of the Clinton Group", the name Reynales was proposed by Chadwick (1918). It is 17 feet thick and consists of three members, from oldest to youngest as follows: Hickory Corners Limestone (3 feet); Furnaceville Hematite (8 inches - 2 feet); Wallington Limestone (13 feet). The present dam in the river north of the Bausch Bridge covers the Reynales-capped Middle Falls.

The Hickory Corners Limestone is a light gray crystalline limestone with shaley partings, named by Kilgour (1963). It replaces the name Brewer Dock Member of Sanford (1935).

The minute gastrapod Cyclora; the brachipods Hyattidina congesta and Stropheodonta corrugata can be found in this unit. Walliser's (1964) conodont zone of Neospathognathiodes celloni has been found in the Hickory Corners Limestone of the Niagara Gorge by Rexroad and Rickard (1965).

All of the Reynales (4-5 feet) in the Niagara Gorge is referred to as the Hickory Corners Limestone.

The Furnaceville Hematite (Hartnagel 1907) is a thin, lightly variable hematitic limestone. It is a fossiliferous ore, the hematite having replaced the fossil fragments. Round oolites are mingled with fossil fragments, but are more pronounced at some localities than at others. In the Genesee Gorge the oolites are comparatively rare. According to Alling (1947) the oolites contain nuclei of fossil fragments in the west and nuclei of quartz grains in the east.

The origin of the Clinton iron ore beds has been the subject of much controversy. Since the turn of the century, most investigators favor a primary origin for the hematite, wherein, the iron is precipitated on rolling grains of fossil fragments or quartz particles.

The debate seems to be centered around the mineralogical composition of the original iron and the chemistry of the water during precipitation. Hunter (1970) and Sheldon (1970) suggest that the iron was deposited originally as chamosite that subsequently became oxidized, whereas Schoen (1965), believes that hematite was precipitated directly from sea water.

The iron was probably derived from the deep weathering of plutonic igneous rocks in the Taconic landmass to the east. James (1966) believes that warm and humid conditions prevailed at this time. As relief in the source area would decrease, after the Taconic orogenic climax, the intensity and depth of weathering would increase due to decreased mass wasting and stream competency. Hunter (1970) concluded that this is the most important reason for iron rich rocks being deposited in the Clinton Group. During intense tectonic activity, rapid erosion prevents thorough weathering of source rocks and coupled with rapid sedimentation any iron deposition that would occur would be masked. At the opposite extreme, during maximum inundations of transgressing seas, source areas are flooded or nearly so, and therefore not contributing large amounts of iron rich water. Therefore iron concentrated rocks seem to form most readily between times of intense tectonic activity and stability.

Ferrous iron was probably transported to the sea by streams of low Eh and pH although groundwater of similar chemistry may have been partly responsible.

Rapid precipitation of iron resulted when the stream waters entered the somewhat higher Eh and pH waters of the marine basin.

Above the Furnaceville in the Genesee Gorge are about 13 feet of crystalline dolomitic limestone interbedded with layers containing enormous numbers of the brachiopod Pentamerous laevis. Fisher (1959) named these limestones the Wallington. Some of the limestones yield the brachiopods Coelospira hemispherica, Stropheodonta corrugata and Rhynchotreta robusta. Thin shale partings are found throughout the unit as well as cherty beds. Ostracodes of the Zygobolba excavata zone have been recovered from the Wallington and other members of the Reynales. Gartland (1973) also reports conodonts of the Neospathognathoides celloni zone from this unit.

Eastward the Wallington Limestone passes into the Bear Creek Shale (Chadwick, 1918) and eventually into the Oneida Conglomerate (Vanuxem, 1942).

Westward the Wallington corresponds to Kilgours (1963) Merrintton Limestone of the Ontario Penninsula. Neither are present in the Niagara Gorge their position being marked by a major disconformity.

Lower Sodus Shale - The Lower Sodus Shale was named by Gillette (1940) for those Sodus shales carrying the ostracod zone of Zygobolba excavata. The Upper Sodus Shale occurs in the overlaying Zygobolba decora zone. In the Genesee Gorge this unit is marked by a disconformity.

At Rochester, the Lower Sodus Shale is 18 feet thick and consists of green to greenish gray, calcareous, slightly fossiliferous, silty shale with thin (1-3 inches) limestone layers. The basal four or five feet are dominated by less calcareous dark gray or purple shales. In the upper 3 feet there are three prominent layers containing nearly 95 per cent calcareous material. The high calcareous content is due to the layers being composed almost entirely of the brachiopod Coelospira hemisphaerica, thereby resulting in the term "pearly layers" used to describe them. A shell rubble up to 3 inches thick marks the top of the formation in the Genesee Gorge.

The Lower Sodus is a fossiliferous unit of mostly brachiopods (Coelospira hemisphaerica, Stropheodonta corrugata), bryozoans (Phaenopora ensiformis) and bivalves (Ctenodonta machaeriformis, Cyrtodonta alata). Gartland (1973) discovered conodonts of the celloni zone to the top of the Lower Sodus. The true top of the celloni zone is in the Middle Clinton Sauquoit Shale.

Williamson Shale - Hartnagel (1907) proposed the name Williamson Shale for the shales encompassed between the Reynales and Irondequoit Limestones. Chadwick (1918) limited the Williamson to the graptolite bearing shale above the Upper Sodus.

In the gorge the Williamson is about 6 feet of dark green to black, calcareous to slightly calcareous fissile, graptolite-bearing shale, disconformably overlying the Lower Sodus. A few thin limestone beds occur toward the top.

Eastward the Williamson passes into the Willowvale Shale (Gillette, 1947) as does the overlying Irondequoit Limestone. Westward the Williamson grades into the Irondequoit Limestone; therefore its absence at Niagara is due to a facies change.

Monograptus clintonensis is the dominant graptolite; less abundant is the brachiopod _Sowerbyella transversalis_. Upper Clinton ostracodes of the _Mastigobolbina typa_ zone are present in the Williamson.

Irondequoit Limestone - Hartnagel (1907) named the Irondequoit for the 18 feet of variable limestone, dolomite, and thin dark gray calcareous shales, overlying the Williamson, in the Rochester area. The lower part is more dolomitic and corresponds to Kilgour's (1963) Rockway Dolomite Member in the Niagara Gorge. The Rockway was previously included in the upper part of the Reynales (_Zygobolba excavata_ zone) by Gillette (1947), thereby placing it in the Lower Clinton. However, he specifically never reported any ostracodes from the top of "his Reynales" in the Niagara Gorge; preferring to state (pg. 50) ---"ostracodes are much more abundant (at Rochester) than in the ourcrops to the west" (parenthesis mine).

Rexroad and Rickard (1965) have found abundant specimens of the conodonts _Pterospathodus amorphognathoides_ and _Ozarkodina gaertneri_ thereby confirming Walliser's (1964) _amorphognathoides_

Zone in the Rockway Member. This zone is known to overlie the celloni Zone, and since the top of the celloni zone is at the top of the Middle Clinton Sauquoit Shale the Rockway must be Upper Clinton and not part of the Lower Clinton Reynales Limestone.

The upper part of the Irondequoit Limestone is a light gray, coarsely crystalline, crinoidal, limestone with thin calcareous shale bands. Crinoid stems, bryozoans, brachiopods, and rugose corals characterize the upper Irondequoit. Mastigobolbina typa and associated ostracodes can also be found. Small biohermal masses characterize the upper most portion and arch the topmost beds of the Irondequoit and basal Rochester Shale. This can best be seen on Densmore Creek up from Norton Street.

Rochester Shale - James Hall (1839) named the Rochester Shale for the typical exposures in the Genesee Gorge at Rochester, where it makes up most of the Upper Falls. Here it is 85 feet thick and in western New York is the uppermost unit of the Clinton Group. Except for the lower 10 feet of brownish gray shale, the Rochester is a dark, bluish gray, calcareous, shale with numerous limestone and dolomite layers. Dolomite is more pronounced in the upper 20-25 feet forming the caprock of the upper falls and grading upward into the Lockport Formation. Chadwick (1918) called this upper unit the Gates Limestone. Fossels are most abundant beginning a few feet from the base and extending upward to 15 feet from the top.

It is by far the most fossiliferous unit of the Clinton Group. Some of the more common forms are:

brachiopods
- Parmorthis elegantula
- Sowerbyella transversalis
- Leptaena "rhomboidalis"
- Rhipidomella hybrida

bryozoans
Mesotrypa nummiformsis
Chasmatopora asperatostriata

cephalopod
Dawsonoceras annulatum

trilobites
Dalmanites limulurus
Trimerus delphinocephalus
Arctinurus nereus

cystoid
Caryocrinites ornatus

ostrocods
Paraechmina spinosa
P. postica
Dizygopleura proutyi
Beyrichia veronica

The Rochester Shale of Western New York properly belings to the *Paraechmina spinoza* Zone, the uppermost Clinton ostracod zone of Gillette (1947).

Eastward in Oneida and Herkimer Counties, the Rochester Shale passes into the Herkimer Sandstone. Zenger (1971) refined the uppermost Clinton in this area subdividing the Herkimer Sandstone into a western shaly unit, the Joslin Hill Member and an eastern sandstone unit the Jordanville Member. In addition he found the base of the ostracode zone of *Drepanellina clarki* at the top of the Herkimer which is younger than Gillette's *Paraechmina spinoza* Zone. This makes the upper part of the Herkimer in the east equal in age to the lower part of the Lockport Formation in the west. The top of the *spinosa* zone occurs at the top of the Eramosa Dolomite Member of the Lockport. The upper Clinton Group and the base of the Lockport Formation are facies of one another becoming progressively younger eastward.

The Rochester Shale represents a more offshore environment than the Joslin Hill Member, deposited in well oxygenated relatively quiet waters as indicated by the diverse fauna contained therein.

Lockport Group - Hall (1839) designated the section south of Lockport, along the old Erie Canal (present Barge Canal) as the type Lockport. At Rochester the Lockport is a sugary, gray massive dolomite, in places quite sandy. The formation commonly contains vugs of dolomite, gypsum, pyrite, fluorite , sphalerite, and galena. It is approximately 180 feet thick in the Rochester area and being a very resistant unit forms the crest of Niagara Falls, the uppermost part of the Upper Falls at Rochester and the Niagara Escarpment.

Zenger (1962, 1965, 1966) has revised most of the Lockport stratigraphic subdivisions and correlations. Crowley (1971) has worked extensively on the reefs in the Lockport of Western New York.

In the Rochester vicinity the Lockport can be divided into three formations from oldest to youngest as follows: Decew Formation (or Gates Dolomite)20 feet (silty and sandy dolomite); Penfield Dolomite-20 feet (dolomitic sandstone), and the Oak Orchard Dolomite - 140 feet (vugy, massive, stylolitic, dolomite).

Eastward, between Rochester and Syracuse, the Lockport Group is a limestone-dolomite complex separated as the Sconondoa Formation. In the Oneida region the Sconondoa passes eastward into the Illion Shale. The upper part of the Illion interfingers with the lower part of the overlying Salina Group, the contact becoming progressively older eastward.

Fossils are not abundant in the Lockport Formation at Rochester.

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FIELD TRIP I

Stop 1 Lower Falls and Gorge

Down from Seth Green Drive at St. Paul and Norton Streets, on east side of gorge below Driving Park bridge.

Units Exposed

Group	Formation	Member
Lower Clinton	Reynales	Wallington Ls. Furnaceville Hematite Hickey Corners Ls
	Maplewood Shale Thorold Ss.	
Medina	Grimsby Fm.	
	Queenston Fm.	

Stop 2 Middle Falls and Gorge

At the bottom of Brewer St. down from St. Paul Street on east side of river, south of Driving Park Bridge and North of the Bausch Bridge (Smith St. Bridge)

Units Exposed

Group	Formation	Member
Upper Clinton	Rochester Shale Irondequoit Ls. Williamson Shale	
Lower Clinton	Lower Sodus Shale	
	Reynales Ls.	Wallington Ls. Furnaceville Hematite Hickory Corners Ls.
	Maplewood Shale	

Stop 3 Upper Falls and Gorge

Down from Mill St. and Falls St., on access road to Rochester Gas and Electric Power Stations # 2 & 3, on west of gorge below Platt Street bridge

Units Exposed

Group	Formation	Member
Lockport	Decew Dolomite	
Clinton	Rochester Shale	