Escarpment to Escarpment to Escarpment: Three Vistas Reflecting the Subsurface Structure of Western New York

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INTRODUCTION

This trip, designed for Earth Science teachers, and the general public, presents a non-technical overview of the structural geology of western New York State. It includes stops at each of the three major escarpments, a brief hike, sampling of the escarpment capping lithologies, "snapshots" of geologic features, guided discussions, and includes historical geology interpretations.

Geological Setting

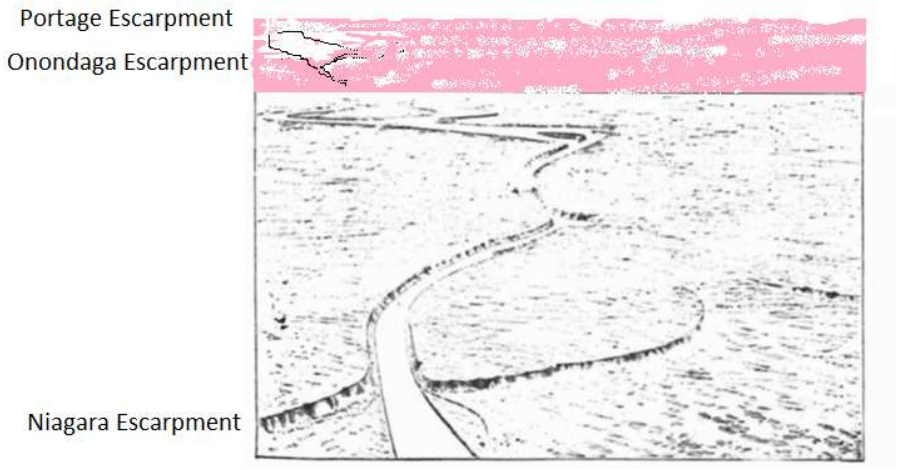
The overall topography in western New York State is cuestaform as a result of Paleozoic sediments dipping about ½ degree to the South and the land surface sloping to the North from 2000 ft above sea level in the Allegheny Plateau to 243 ft above sea level for Lake Ontario. There are three major escarpments: The Portage Escarpment at the edge of the Allegheny Plateau, The Onondaga Escarpment underlain by the Onondaga limestone and the Niagara Escarpment formed by the Lockport Group. As a result of this situation, there about 300 waterfalls within an hour and a half drive from Buffalo (Kershner 1980). Western New York falls range from the stunning Niagara Falls where about 100,000 cubic feet of water per second roar over the lip rock of Lockport dolostone to small intermittent falls of tributaries entering 18 Mile Creek.

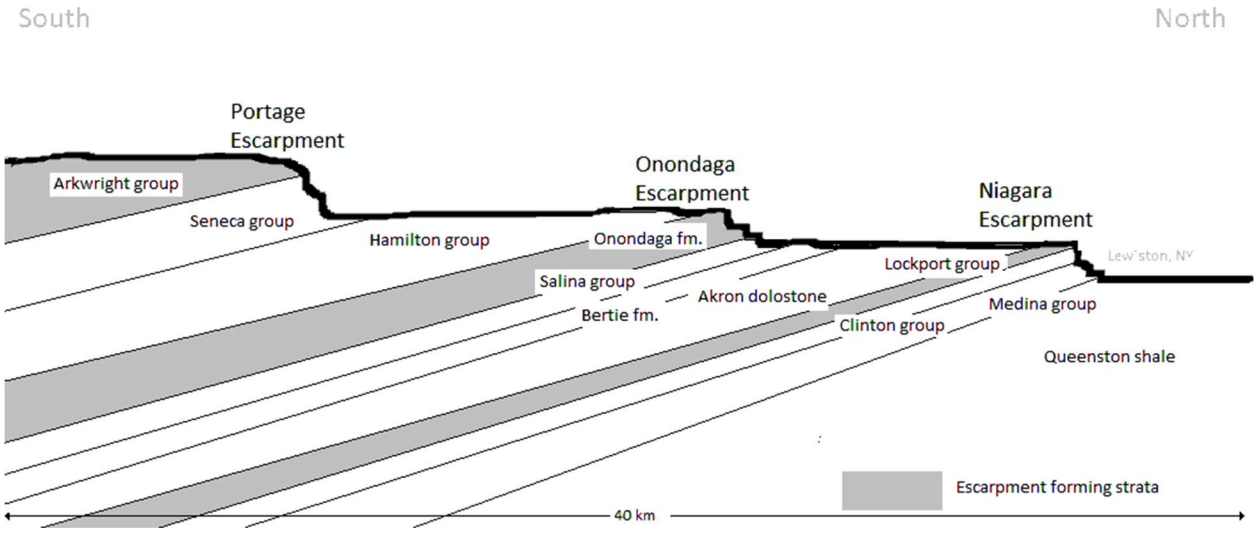
The leaders/authors have scoped out the best points in WNY where you can get a real feel of this cuestaform structure of WNY topography that are readily available to the public. We will also see and collect if you wish, some of the major formations that cap the escarpments.

Previous Investigations

The major escarpments in the physical geography of western New York State were recognized in this block diagram in 1901 by Amadeus W. Grabau.

Grabau 1901 fig. 16 p. 70 presents a view looking south along the Niagara River. Lewiston, New York is in the lower left-hand corner.
A highly stylized cross section from South to North is presented as follows.





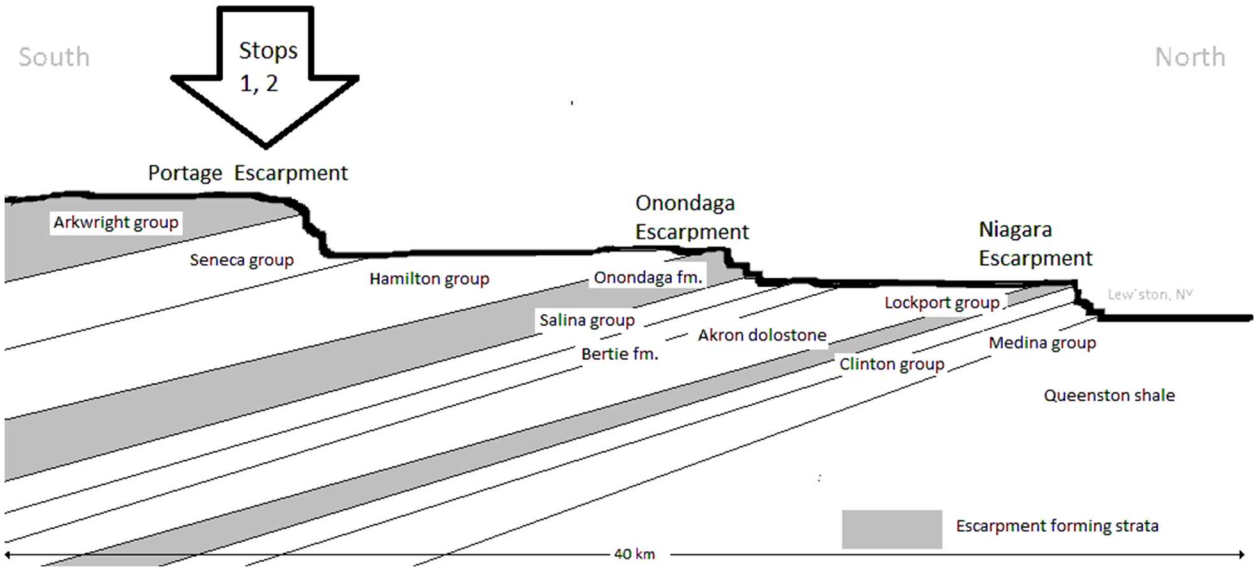
The Niagara Escarpment and the Onondaga Escarpment are underlain by resistant layers. The Portage Escarpment is the remnant of a dissected plateau.

ROADLOG AND STOP DESCRIPTIONS

Meeting Point: Buffalo State College in parking lot I-37 on the East side of the Science Bldg.
Meeting Point Coordinates: 46.56N 78.52W
Meeting Time: 8:00 AM

Distance in miles (km) Cumulative	Point to Point	Route Description
0 (0)	0 (0)	Exit Parking Lot, Left on Iroquois Drive to Grant Street Exit right on Grant Street Right on entrance to rt 198 West
1.3(2.1)	0.7(0.9)	Take the Scajaquada Pky. West to I 190 South.
12 (19.3)	10.7(17.2)	left on I 190 South to I 90 West to 219 South
17(27.4)	5.1(8.1)	Take the 219 South to Armor Dulles Road
17.6(28.4)	0.6(0.9)	Take Armor Dulles Road East to Rt 277 South - Chestnut Ridge Rd.
20.6(33.2)	3(4.0)	Take Chestnut Ridge Rd. South to Eternal flame parking lot. 1 mile plus a little past the park entrance.

STOP 1: Chestnut Ridge Park parking lot for the trail to the Falls of the Eternal Flame
Location Coordinates: (42.43N 78.44W)
Meeting Time: 8:40 AM



Field trip location description

Hike to Falls of the Eternal Flame (If, perchance, the eternal flame is out, we will light it and not tell anyone.) You will lose and then gain about 80 feet of altitude on the hike. The trail is rugged and should not be taken unless you are sure you can get back up. Hiking boots best, sturdy sneakers second, sandals or flip-flops forbidden. You will be following a stream bed and may get your feet wet. You should have extra socks. It will take 25 minutes down, and 30 minutes back.

Interesting sedimentary features for photos and samples can be taken. We will be hiking through outcrops of the Upper Devonian Arkwright group's Canadaway formation. The rock formation making up the sides of the small canyon we will be hiking up is the Canadaway formation, the Gawanda member to be specific. The lithology is described as gray and black shale, thin and thick bedded siltstone and occasional limestone concretions and layers. The black shale is highly petroliferous, the likely source of the gas for the "eternal flame" and on calm days can be smelled near the falls. We will point out and discuss sedimentary, topographic, and structural features along the hike.

Distance in miles (km)		Route Description
Cumulative	Point to Point	
21.6(34.8)	1(1.6)	Take Chestnut Ridge Road north to Main Park Entrance Turn right and park close to the toboggan slides
22.2(35.8)	0.6(1)	You are now at the edge of the Allegheny Plateau

Meeting Point: STOP 2: Chestnut Ridge Park view from the edge of the Portage Escarpment

Location Coordinates: (42.42N 78.45W)

Meeting Time: 9:50am

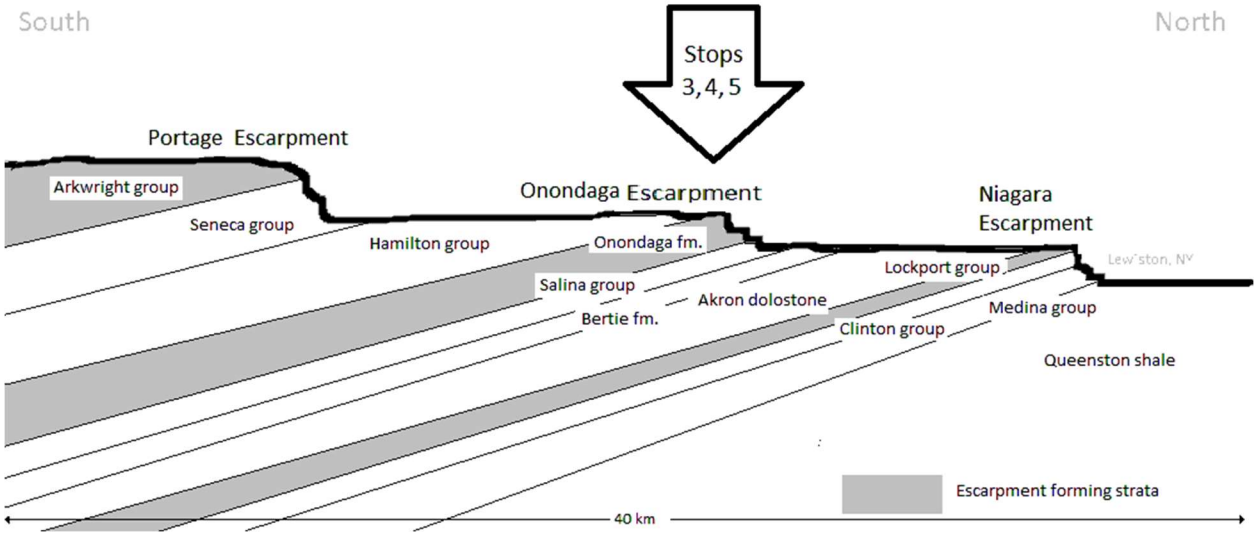
Field trip location description

The view from the edge of the Portage Escarpment will open our discussion on the three topographic vistas of western New York. Looking north you can see UB (South Campus) and the Vet's Hospital on the horizon which is located on the Onondaga Escarpment. If you look a little west (left) of Buffalo, you can see Niagara Falls on a clear day about 30 miles.

Distance in miles (km)		Route Description
Cumulative	Point to Point	
24.2(39.0)	2(3.2)	Take Chestnut Ridge Rd. North and turn left on Amor Dulles Rd.
24.8(39.9)	0.6(1)	Take Armor Dulles Rd. West to Rt 219 North
34.0(54.7)	9.2(14.8)	Take Rt 219 North to I 90 East

44.6(71.7)	10.6(17.0)	Take I 90 East past toll booths to Exit 48 Transit Rd. North
45.2(72.7)	0.6(1)	Take Transit Rd. north to Wehrle Dr. Turn East (right) on Wehrle Dr.
47.5(76.4)	2.3(3.7)	Take Wehrle Dr. East to Barton Rd.
47.9(77.0)	0.4(0.6)	Turn South (right) on Barton Rd and go to gate of quarry.

STOP 3: New Enterprise Stone and Lime Company
Location Coordinates: (42.57N 78.39W)
Meeting time: 11:00 AM



Field trip location description
New Enterprise Stone and Lime Co.
We will meet at 11:am at the quarry gates. All visitors will be required to sign a permission slip before entering the quarry. During the tour, we will stay together as a group and follow all quarry rules.
The quarried area is about one square mile. The rock layer quarried is the Nedrow member of the Onondaga Limestone which is middle Devonian in age. Quarried Onondaga was used as "dimensional stone in most of the bridge abutments of the old railroad bridges in WNY. It was considered strong and resistant enough to be used in the abutments of the Brooklyn Bridge. It outcrops from Lake Huron and the NW shore of Lake Eri to The Hudson valley. The Nedrow member contains a lot of flint that was used by indigenous peoples for weapons and tools. In Erie County, there are three active quarries on the Onondaga and quite a few abandoned quarries.

Distance in miles (km) Cumulative	Point to Point	Route Description
48.2(77.6)	0.4(0.6)	Take Barton Rd. North to Wehrle Dr turn East (right)
50.7(81.5)	2.4(3.9)	Take Wehrle Dr. East to Shisler Rd (Note outwash deposits)
51.3(82.5)	0.6(1)	Take Shisler Rd. North to first right (Rear entrance to Clarence Town Park)

STOP 4: outcrop south of Clarence Town Park
Location Coordinates: (42.57N 78.36W)
Meeting Time: 11:50 AM to 12:30 PM

Field trip location description
We will take a close look at an outcrop south of Clarence Town Park. We will discuss the nature of the outcrop, collect flint, discuss the weathering process, and interpret how the features observed could have been formed.
Discussion questions:
How does the bedrock outcropping at this stop differ in appearance from the bedrock visible at the New Enterprise Stone and Lime Co. quarry? How would you explain this?
The calcium carbonate in the limestone is stable in an alkaline environment and rapidly decomposes in an acidic environment. The silica in the chert nodules contained in the limestone is stable in an acidic environment. How might a cherty limestone have been formed?

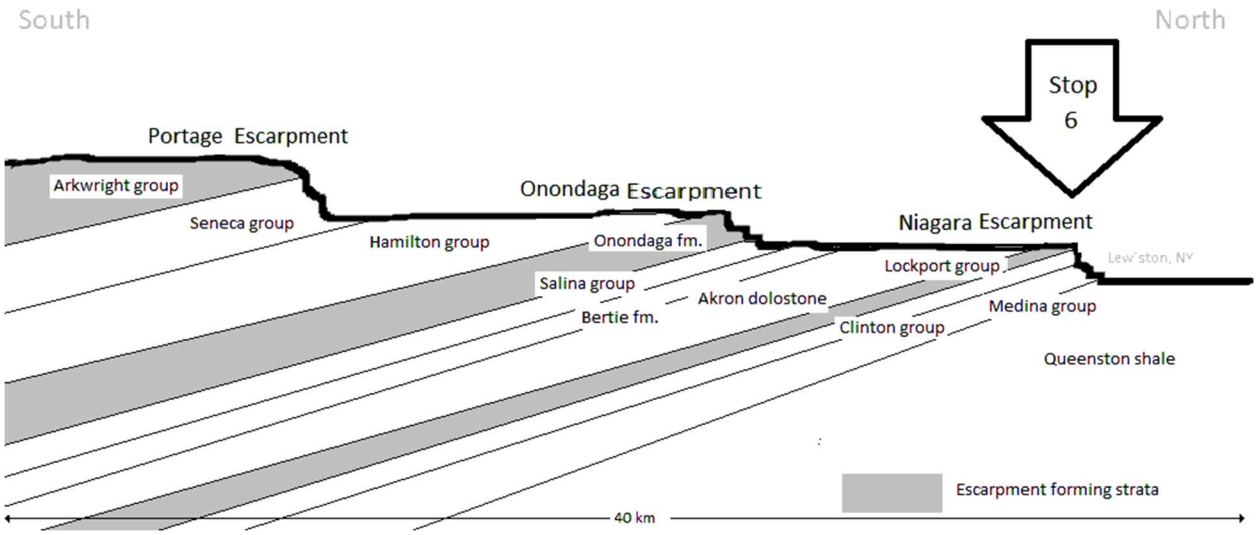
Distance in miles (km) Cumulative	Point to Point	Route Description
51.5(82.9)	0.2(0.4)	Go back to Shisler Rd. and go North (right) to Main St.
57.1(91.9)	5.6(9.0)	Take Main St East (right) to Buell St. – Rt 93 N Turn Left (North) on Buell St.
58.7(94.5)	1.6(2.6)	Take Buell St. North to Mechanic St. North to John St.
59.6(95.9)	0.9(1.4)	Turn East (right) on John St to Airport Rd.

STOP 5: Airport Road in Akron, NY
Location Coordinates: (43.01N 78.29W)
Meeting Time 1:00 PM to 1:10 PM
Field trip location description

A stop along Airport Road in Akron NY affords a view from the Onondaga escarpment and an opportunity to discuss physical geogrphy. The first draft of this field guide instructs us to "take pictures, sing & dance." The geologic processes forming this escarpment have produced an east-west string of waterfalls across New York State including Williamsville Falls, Akron Falls, Indian Falls, Buttermilk Falls and others.

Distance in miles (km)		Route Description
Cumulative	Point to Point	
60.5(97.3)	0.9(1.4)	Take John St to Rt 93 North (right). Follow Rt 93 to Transit Rd Rt. 78 North (right). As we travel north on Transit Road, we will cross low-lying east-west trending
61.5(99.0)	1.1(1.7)	ridges. These are terminal moraines.
78.9(127.0)	17.4(28.0)	Take Transit Rd. North to Outwater Dr. Turn South (right) on Outwater Dr. to
79.4(127.8)	0.5(0.8)	Outwater Park.

STOP 6: Outwater Park, 125 Outwater Drive, Lockport, NY
Location Coordinates: (43.01N 78.42W)
Meeting Time: 2:00 PM to 2:20 PM
Field trip location description

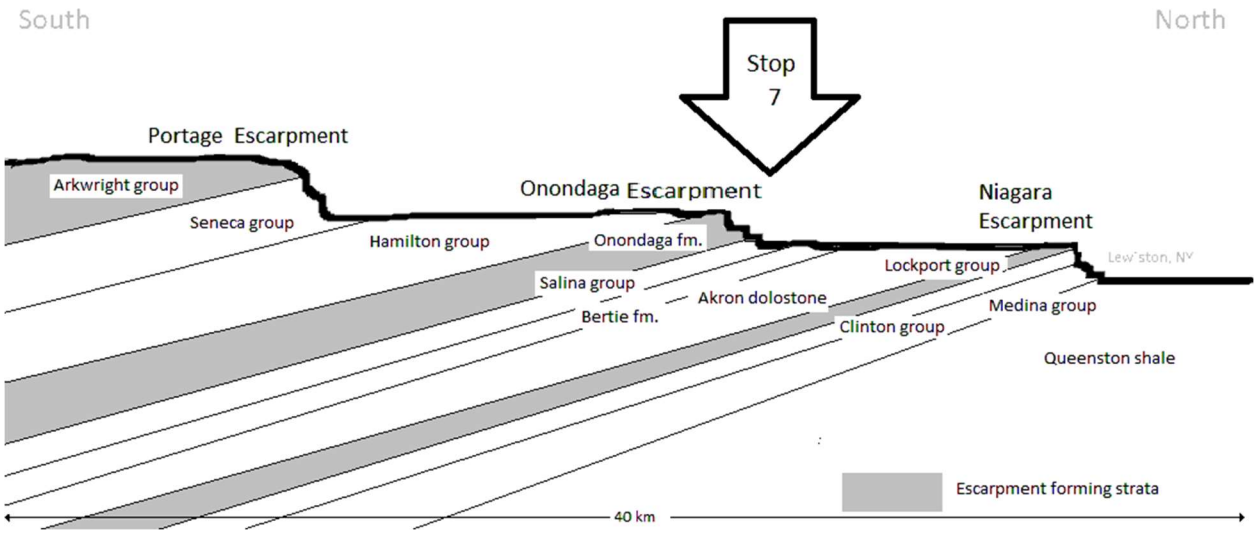


Outwater Park in Lockport New York provides an excellent safe view of Lake Ontario Lowlands. Discuss glacial Lake Iroquois and the carving of the Lake Ontario basin. On a clear day you can see Toronto about 50 miles away.
Since we will be not able to park and walk around at Stop 7, we can take time to discuss this outcrop while we are assembled here.

Distance in miles (km)	Route Description

Cumulative	Point to Point	
80.2(129.0)	0.7(1.2)	backtrack to rt 78 south, Transit Road
86.0(138.4)	5.8(9.4)	South on Transit Rd.
89.1(143.3)	3.0(4.9)	left on Millersport Highway
95.1(153.0)	6.0(9.7)	right onto I 990 south
99.0(159.4)	4.0(6.4)	290 East
102.3(164.6)	3.2(5.2)	90 west

STOP 7: "Folds" in the bedrock exposed along the Kensington Expressway, Buffalo NY.
Location Coordinates: (43.01N 78.29W)
Meeting Time 3:20 PM to 3:30 PM



Field trip location description
This is a "drive by" field trip stop. Do not stop or leave your vehicle. Through the windows of the vehicle, we will observe what appears to be folds. We will point out characteristic features of folds and look for any field expressions of these features. We will also discuss the surface expressions of buried reefs. Note the upper surface of the outcrops. How would you explain why there is bedrock in some places, and soils in others? Note, the places where bedrock is missing are often U shaped, filled in with gravely soil, and always at the ground surface. These features are remnants of pre-glacial stream erosion that are now exposed by the Route 33 roadcut.
William Oliver provides a detailed report of the Onondaga formation (Oliver 1954) and notes the location of bioherms (Oliver 1956). Bioherms in layers just beneath those exposed in the Route 33 roadcut have been reported across New York State. Upon closer inspection of what at first appears to be anticlines, no consistent trends in the symmetries of dips from the "axial centers" can be noted. Additionally, none of the characteristic features of folded terrain are observed in any of the nearby outcrops. With the absence of certain tectonic features, and considering widespread reported subsurface reefs, we can conclude that these "folds" are the

surface expression of differential compaction over buried reefs rather than the result of tectonic activity.

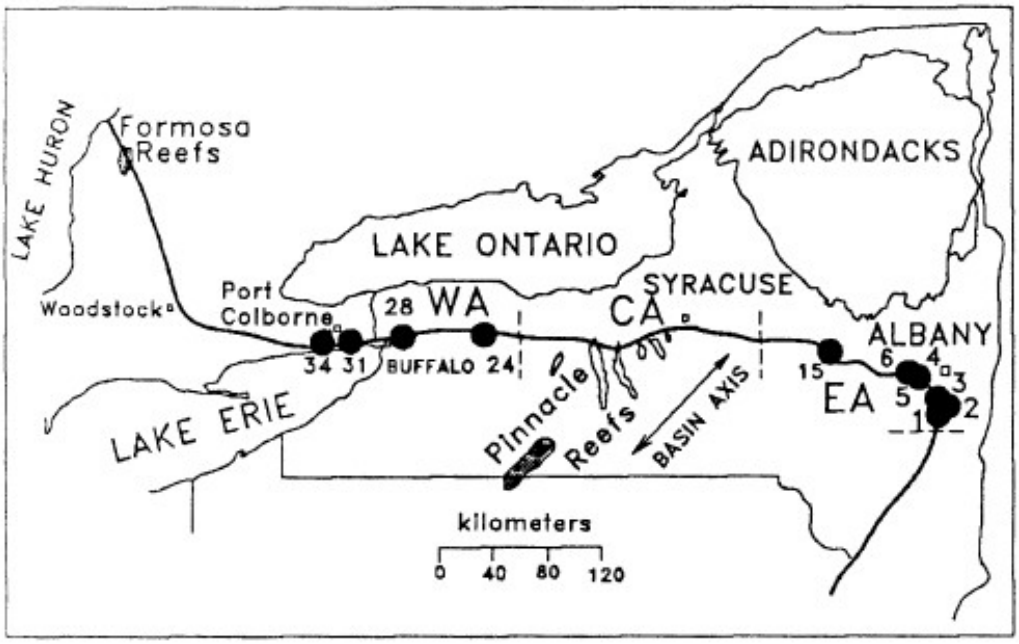


FIGURE *1*—Location of reefs along Onondaga strike belt (numbered) in New York and Canada. Reef numbering follows Oliver (1976), but map includes only those reefs referred to in text: 1, Roberts Hill; 2, Albrights; 3, North Coxsackie; 4, New Salem; 5, no longer accessible exposure at south end of Thompson's Lake; 6, Thompson's Lake bioherm; 15, Mt. Tom; 24, LeRoy bioherm; 28, Buffalo Country Club reef; 31, Ridgemount bioherm; 34, reef #34. Pinnacle reefs are subsurface. Formosa reefs are believed to be Edgecliff equivalents. WA = western facies area; CA = central facies area; EA = eastern facies area. Redrawn with modification from Oliver (1976).

Woloz (1992) describes patterns of reef growth in the Edgecliff member as occurring in a variety of structures; mound/bank, thicket/bank, and ridge/bank based on the degree of paleocommunity development.

Distance in miles (km)		
Cumulative	Point to Point	Route Description
106.4(171.2)	1.0(1.6)	Continue on rt 33 west
108.4(174.4)	2.0(3.2)	198 west To Elmwood Avenue Exit
128.9(207.4)	3.2(5.2)	Return to Buffalo State
		Meeting Point: return to Buffalo State
		Meeting Point Coordinates: 46.56N 78.52W
		Meeting Time: 3:30pm

GLOSSARY OF TERMS

Bioherm … a mound like, domelike, lens like, or reeflike mass of rock built up by sedimentary organisms…

Cuesta … a hill or ridge with a gentile slope on one side and steep slope on the other…

Cuestaform … shaped like a cuesta …

Escarpment … a long, more or less continuous cliff or steep slope facing in one general direction…

Peneplain … a region with an almost flat surface …

GENERAL STRATIGRAPHIC COLUMN OF WESTERN NEW YORK

Bedrock geology from the youngest to the oldest units is as follows:

Pleistocene glacial moraine and till
Upper Devonian Arkwright group
Upper Devonian Seneca group
Middle Devonian Hamilton group
Middle Devonian Onondaga formation
Upper Silurian Salina Group, Bertie Formation, Akron Dolostone
Silurian Clinton group
Upper Ordovician – Lower Silurian Medina group
Ordovician Queenston Shale

DETAILED STRATIGRAPHIC COLUMN OF THE ONONDAGA FM IN NEW YORK STATE

Bedrock geology from the youngest to the oldest units of the escarpment forming Onondaga formation is as follows.

Edgecliff member
Moorehouse member
Nedrow member
Seneca member

DETAILED STRATIGRAPHIC COLUMN OF THE LOCKPORT GROUP IN NYS

Bedrock geology from the youngest to the oldest units of the escarpment forming Lockport Group is as follows.

Gasport Dolomite formation
Goat Island Dolomite formation
Eramosa Dolomite formation
Guelph Dolomite formation

RECONSTRUCTED CHRONOLOGY OF EVENTS

All observable geologic features are a direct consequence of the cumulative effects of every past event. In western New York the major events from oldest to youngest, are reconstructed as follows.

Condensation of rocky material and cooling of the protoplanet Earth
Rising of lighter material and sinking of heavier material
Formation of granitic rock crust into shields
Weathering, erosion and transportation of sediments
Formation of rings of sedimentary rocks around shields
Uplift of shields following loss of mass forming concentric rings of progressively younger sediments dipping at low angles away from the shields
Changes in depositional environments resulting in various kinds and amounts of sediments.
Lithification of sediments producing the present stratigraphic column of sandstones, limestones, and shales
Erosion to form a peneplain
Uplift of peneplain
Further erosion and dissection of the peneplain
Continued uplift of shield and tilting of surrounding sedimentary rock formations
Continued erosion with the more resistant layers forming escarpments
Drainage blocked by ice sheets.
Shoreline erosion of resultant glacial lakes defining sharpness of the Onondaga and Niagara escarpments
Advances and pauses in the retreats of Pleistocene ice sheets producing east-west trending moraines.
Deposition of till filling in preserves pattern of pre-glacial drainage.

Collectively, the stops on this trip provide evidence for the events outlined in the chronology above. During the discussions at each stop, we will point out the evidence in the rock, soils, and surface features for each event.

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