AN OVERVIEW OF THE EARLY PALEOZOIC STRATIGRAPHY OF THE CHAMPLAIN VALLEY OF NEW YORK STATE

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TRIP ABSTRACT

This, Sunday only, trip provides participants with an opportunity to visit some of the well-exposed, classic Early/Medial Cambrian to Medial Ordovician clastic and carbonate shelf sequences and the Medial Ordovician foreland basin carbonates and calcareous shales. Stops include the Potsdam Group (Lower/Middle and Upper Cambrian), the Theresa Formation and the Beekmantown Group (Lower Ordovician), the Chazy Group (Middle Ordovician) and the Trenton Group (Middle Ordovician). The trip essentially repeats the author's 2002 Joint New England Intercollegiate Geological Conference/New York Geological Association trip (Dawson, 2002) and is ideal for high school teachers and undergraduates seeking an introduction to these rocks.

INTRODUCTION

The field trip begins at the Comfort Inn, near Exit 37, I-87 'the Northway', Plattsburgh, NY at 8:30 AM and will end about 4:00 PM at the Comfort Inn, Plattsburgh, NY. This trip visits many of the localities that are commonly visited in the undergraduate classes at SUNY Plattsburgh. The field trip description is largely based on the work of Fisher (1968) and Isachsen, et al. (2000) and is not based on any significant research by this author.

TECTONIC SETTING

The Paleozoic rocks of the Lake Champlain Valley of northeastern New York State consist of a sequence that began in the Early/Medial Cambrian (520 Ma) and continued through the Early Ordovician (480 Ma) as a typical quartz sandstone and carbonate, passive shelf margin sequence, that transitions to the initiation of the Taconic foreland basin in Medial Ordovician (460 Ma) time (Isachsen, et al., 2000). The shelf sequence was deposited on the passive margin that formed in the Neoproterozoic (640 Ma) on, what is today, the eastern edge of Proto North America (called Laurentia by Hoffman, 1988 and others), as the continental landmasses, that were later to form Gondwanaland, rifted eastward to form the Iapetus Ocean (Isachsen, 2000).

Isachsen, et. al., (2000) suggest that the Iapetus Ocean began to open approximately 640 Ma; however the earliest of the shelf depositional units are not found in northeastern New York until 120 Ma or so later, when the Lower to Middle Cambrian Potsdam Sandstone, which lies directly on Precambrian meta-anorthosites and metagabbros, is deposited. Overlying, probably unconformably, the Potsdam Sandstone (Figure 1), at approximately the Cambro-Ordovician boundary, is the Theresa Dolostone/Sandstone which is followed unconformably by the dolostones of the Lower Ordovician Beekmantown Group. The shallow shelf carbonates, and the well-known known patch reef bioherms of the Chazy Group unconformably overlie the Beekmantown Group. The Chazy Group is followed by the relatively thin, eastern representation of the Black River Group that is not well exposed in the area (Fisher, 1968).

Toward the end of the Early Ordovician, approximately 480 Ma, an eastward dipping Taconic subduction zone, with an adjacent Taconic Island Arc lying immediately east of the subduction zone, were rafted westward to close a portion of the western Iapetus Ocean. The collision of this Taconic subduction zone and its adjacent Taconic Island Arc with Proto North America created the Taconic Orogeny during medial Ordovician time, approximately 460 Ma (Isachsen, et. al., 2000). The beginnings of this Taconic Orogeny are represented in northeastern New York by the lower portion of the Trenton Group.

As the Taconic Orogeny collision progressed, the eastern edge of Proto North America was uplifted while the region to the west of the uplift, that is now northeastern New York, was down warped into a foreland basin that is associated with steep angle strike slip faulting (Stone, 1957). The beginnings of a part of the northern portion of this downwarp are represented by the Cumberland Head Argillite of the Trenton Group with younger portions of the formation being deposited as flysch in progressively deeper water (Hawley, 1957). As the collision progressed, Lower Cambrian quartz sandstone and carbonate shelf deposits were thrust westward, possibly as gravity driven slides, as thick allochthonous sheets. These thrust faults over-rode the eastern portions of the Cumberland Head Argillite creating significant folding and shearing within the eastern portions of the Cumberland Head Argillite. Portions of the Middle Ordovician Cumberland Head Argillite also form allochthonous strata that appear to have overridden portions of the Lower Ordovician Beekmantown Group. Allochthonous Chazy Group strata are not found in northeastern New York, although they have been described further south near Granville, NY (Selleck and Bosworth, 1985).

The next portion of the tectonic setting is represented by the many mafic dikes (Kemp and Marsters, 1893; Hudson and Cushing, 1931) that cross cut the Paleozoic sequence. These have been interpreted (Fisher, 1968) as being of Late Jurassic/Early Cretaceous age and may be related to the ultrabasic intrusives of the Monteregian Hills of southern Quebec that have been dated at 110 Ma.

STRATIGRAPHIC SUMMARY

Saratoga Springs Group

The Potsdam Sandstone (Figure 1) was described by Emmons, (1843), and named after Potsdam, NY, as being the base of the 'Transition System' in quarries near Potsdam, NY. Three lithologic facies are generally recognized including an Altona Member, the Ausable Member and the Keeseville Member. Early literature refers to the Altona Member (Landing, 2007) as the ‘basal’ member. The Altona Member consists of a maroon, hematitic, feldspathic, micaceous, quartzose dolostone with many maroon shale interbeds (Stop 15). Portions of this basal unit may be early to medial Cambrian (Landing, 2007; Landing et. al., 2009 and Landing et. al., 2013)) and recently Mehrtens (2015) has proposed a partial age equivalency for the Altona Member with the Monkton Formation of northwestern Vermont on the basis of a shared *Olenellus* age fauna and sequence stratigraphy analysis. The Ausable Arkose is a cross laminated, feldspar rich, dolomitic sandstone that occurs irregularly throughout the main Potsdam section. The Keeseville Member (Stops 11, 13, and 14) is a fine to coarse quartz sandstone. Detailed lithologic descriptions of the three units can be found in Lewis (1971) and Wiesnet (1961). Most

Figure 1. Rock Section (after Fisher, 1968).

Age	Lithology/Formation	Thickness	Field Trip Location
Late Jurassic/ Early Cretaceous	Lamprophyre Dikes		Stops 1 and 16
'uncertain'	LaColle Melange		Stops 8 and 9
Ordovician	Trenton Group		
	Iberville and Stony Point Shales	1000'+	
	Cumberland Head Argillite	200'+	Stops 2 and 4
	Glens Falls Limestone		
	Montreal Member	150-200'	Stop 1
	Larrabee Member	30'	
Ordovician	Black River Group		
	Isle LaMotte Limestone	30'	
	Lowville Limestone	12'	
	Pamelia Dolostone	5-40'	
Ordovician	Chazy Group		
	Valcour Limestone		
	upper argillaceous	80-125'	
	lower reefs/calcarentite	40-55'	Stops 6 and 10
	Crown Point Limestone	50-250'	Stops 7 and 16
Ordovician	Beekmantown Group		
	Providence Island Dolostone	150-200'	Stop 3
	Fort Cassin Limestone/Dolostone	150'+	
	Spellman Limestone	100'+	
	Cutting Dolostone	200'+	
	concealed dolostone	75-275'	
Cambrian	Saratoga Springs Group		
	Theresa Dolostone/Sandstone	50'	Stop 12
	Potsdam Sandstone		
	Keeseville Sandstone	455'+	Stops 11, 13 & 14
	Ausable Arkose	250'+	
	Altona Dolostone/Shale	230'+	Stop 15
Precambrian	Meta-anorthosite and Metagabbro pierced by Diabase Dikes (Grenville).		

authors have interpreted the Potsdam Sandstone as being deposited in a complex arrangement of fluvial and aeolian to intertidal and barrier beach environments (Fisher, 1968). This field trip guide follows Fisher's (1968) stratigraphy and includes the Theresa Dolostone/Sandstone (Stop 12) in the Saratoga Springs Group although some authors have included it in the overlying

Beekmantown Group. Much has written about the Potsdam Group through Beekmantown Group boundary in the Ottawa Embayment of eastern Ontario (Dix et. al., 2004) and the Theresa may be a short-lived transgression bounded unconformably above and below. The Theresa is a thick bedded, quartzose dolostone that occupies the stratigraphic position between the quartz sandstones of the Potsdam below and the dolostones of the Beekmantown above.

Beekmantown Group

The Beekmantown Group (Figure 1) was erected (Clarke and Schuchert, 1899) as a new name for the Calciferous Sandrock (Formation) of Emmons (1843) and others and was named for Beekmantown, NY. Unfortunately, the section at Beekmantown, NY is not well exposed and the two main sections described by Brainerd and Seely (1890) as five units (Divisions A through E), north of Shoreham, VT and at West Cornwall, VT, are generally accepted as the type section. Fisher (1968) made a determined effort to carry the Brainerd and Seely (1890) units to northeastern New York and in ascending order he has mapped the Cutting Dolostone, Spellman Formation, Fort Cassin Formation and Providence Island Dolostone. The prevalent unit is the Providence Island Dolostone (Stop 3), a supratidal dolostone.

Chazy Group

The Chazy Group (Figure 1) comprises what is arguably the best known unit of northeastern New York and adjacent Vermont. The Group was originally defined by Emmons (1843); but, many researchers (Brainerd, 1891; Brainerd and Seely, 1888 and 1896; Oxley and Kay, 1959; Pitcher, 1964a and 1964b) have contributed to our understanding of the Group. The Chazy Group consists of three well defined limestone formations that unconformably (Knox Unconformity) overly the Beekmantown Group. The Day Point Formation (Stop 5) consists of gray, cross bedded, calcarenite in northeastern New York with small bioherms of bryozoans, corals and sponges near the top that we will not see on this trip. Above the Day Point lies the Crown Point Limestone (Stops 7 and 16) an argillaceous, medium textured, calcisiltite, calcilutite to argillicalcilutite (Fisher, 1968). The characteristic, large, planispiral gastropod, *Maclurites magnus* Le Sueur (1818) (Stop 7) is common and small stromatoporoid reefs can be found. The Valcour Limestone is the youngest unit of the Chazy Group. The lower part of the Valcour (Stops 6 and 10) contains extensive bioherms of bryozoans, sponges, algae and stromatoporoids and reef flank calcarenites. The upper portion becomes more argillaceous and grades into the Pamelia Dolostone of the Black River Group.

Black River Group

In northeastern New York the exposures of the Black River Group (Figure 1) are limited. Fisher (1968) has mapped, in ascending order, the Pamelia Dolostone, Lowville Limestone and Isle La Motte Limestone as a single Black River group unit with limited success. The Black River group in northeastern New York is relatively thin and consists of thick bedded dolostone, and some argillacous dolostone, of the Pamelia just above the Valcour Formation, and massive, light gray limestones, that are interbedded as the Lowville and Isle La Motte. The best exposures occur in two quarries, one of which has largely been mined out (International Lime and Stone Quarry southeast of Chazy) and one of which is full of water (a shallow quarry southwest of Rouses Point, NY). We will not attempt to visit the Black River Group on this field trip.

Trenton Group

In northeastern New York the Trenton Group (Figure 1) consists of the lower Glens Falls Limestone and the upper Cumberland Head Argillite (Stops 2 and 4). The Glens Falls Limestone in turn is subdivided into a lower Larrabee Member (Kay, 1937), a thick bedded medium gray limestone that we will not see on this field trip and an upper Montreal Limestone, the Shoreham Limestone of Kay (1937) (Stop 1). The transition from the continental shelf deposits of the main portion of the Chazy Group to the more argillaceous grayish black limestone of the Montreal represents a transition from pre-Taconic shelf deposits to the incipient formation of the Taconic Orogeny foreland basin. The Cumberland Head Argillite is a regionally restricted unit that formed as a flysch, turbidity current deposit in a portion of the early foreland basin of the Taconic Orogeny. Above the Cumberland Head Argillite very limited exposures of the Stony Point Shale, can be found in northeastern New York. The non-calcareous Iberville Shale is only found in Vermont and Quebec (Hawley, 1957).

LaColle Melange

Initially the La Colle (Conglomerate) Melange (Figure1) was described as a sedimentary formation (Clark and McGerrigle, 1936; Kay, 1937); but, Stone (1957) and Fisher (1968) have interpreted the unit as a Taconic Orogeny tectonic rock formed by the Tracy Brook (normal) Fault (Stops 8 and 9) and by thrust faults where it is found in Vermont.

ROAD LOG AND STOP DESCRIPTIONS

Meeting Point: The trip begins in the parking lot of the Comfort Inn and Suites/Perkins Restaurant, 411 Route 3, Plattsburgh, NY.

To reach the Comfort Inn, leave I-87 'the Northway' at Exit 37, which is the main Plattsburgh, NY exit. This is a trumpet exit that brings one to Route 3. Turn right (0 miles/0 km) on to Route 3 heading east. Continue through the traffic lights at LaBarre Street (0.1 miles/0.2 km) and Smithfield Boulevard (0.2 miles/0.3 km). Cross under the I-87 bridge and turn right at the traffic light for Consumer Square (0.4 miles/0.6 km). The Comfort Inn will be on your right.

Meeting Point Coordinates: 44.696^{o} N, 73.4881^{o} W

Meeting Time: 8:30 AM, Sunday, September 13th, 2015.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
0.0 (0.0)		Assemble in the parking lot of the Comfort Inn. Exit the parking lot and drive to the Consumer Square/ Route 3 traffic light. Turn right/east on Route 3.
0.1 (0.2)	0.1 (0.2)	Continue through a traffic light at Healy Avenue.
0.3 (0.5)	0.2 (0.3)	Continue through a traffic light at Cogan Avenue.
0.6 (1.0)	0.3 (0.5)	Bear right at the Y-intersection. There will be a Walgreens Pharmacy set back on the right and a Liberty Tax service in the crotch of the Y.
0.7 (1.2)	0.1 (0.2)	Continue through a traffic light a Prospect Avenue.

0.9 (1.4)	0.2 (0.3)	Continue through a traffic light at Draper Avenue. There is a large stone SUNY Plattsburgh sign on the left. You will see a concrete pedestrian overpass ahead. The overpass connects to the Hudson Hall and Hudson Hall Annex on your left. The Hudson buildings are named after Professor George H. Hudson (Hudson, 1905; Hudson, 1907; Hudson and Cushing, 1931) who taught science and music at SUNY Plattsburgh for many years. His portrait hangs in the foyer of Hudson Hall.
1.0 (1.6)	0.1 (0.2)	Continue through a traffic light at Beekman Street.
1.1 (1.8)	0.1 (0.2)	At a traffic light, at a Y-intersection, Rugar Street enters on the right.
1.4 (2.3)	0.3 (0.5)	Turn right/south at the traffic light at South Catherine Street.
1.8 (2.9)	0.4 (0.6)	Continue through a traffic light at River Street.
1.9 (3.1)	0.1 (0.2)	Cross the Saranac River and immediately turn left/east on South Platt Street.
2.3 (3.7)	0.4 (0.6)	At a traffic light at Route 9 make a slow right/south on to U. S. Avenue. Do not make the hard right on to Peru Street.
2.7 (4.3)	0.4 (0.6)	Enter the rotary and take the third exit on to New York Road heading east. Do not take the first New York Road exit out of the rotary.
2.9 (4.6)	0.2 (0.3)	At the stop sign turn right/south on to Ohio Avenue. On your right you will note three stone buildings constructed by the U. S. Army before the area became Plattsburgh Air Force Base (PAFB). The oldest building, the Old Stone Barracks, is the one furthest from the road. Construction on this started in 1839, but due to construction and funding issues, the building was not occupied until 1843. The two younger replica barracks date from the 1930s. All three buildings are constructed of local Keeseville Sandstone.
3.1 (4.9)	0.2 (0.3)	Turn left on Marina Drive toward Lake Champlain. You will cross the Canadian Pacific mainline railroad tracks on a very narrow bridge (sound your horn). Wind your way down to a small parking area (Stop 1).

STOP 1: Montreal Member of the Glens Falls Limestone of the Trenton Group and Lamprophyre (Monchiquite) Dike at the former PAFB Marina.

From the parking area walk down the obvious roadway to the lake shore where the former PAFB marina and warf can be seen on Marina Point. To reach the outcrop, hike, approximately 700 or so paces north along the cobble beach shore of Lake Champlain. The Pleistocene sediments forming the bluff between the railroad track and Lake Champlain along the way include a contact between earlier Lake Vermont varved and later Champlain Sea sediments. The Montreal Member and a cross cutting Lampophyre Dike are exposed to varying degrees depending on the water level of Lake Champlain. The Montreal Member is a medium-bedded limestone with some shale partings that weather to medium dark gray. Thin laminations within the medium-thickness beds have been interpreted as turbidity current deposits. Crab Island (the smaller island that can be seen in Lake Champlain two miles/3.2 km southeast of this stop) takes its name from the trilobite, *Isotelus*, that is commonly found in exposures of the Montreal

Member on the island. Fisher (1968) mapped the Lamprophyre Dike as a monchiquite dike, containing phenocrysts of titanaugite with some biotite and barkevikite (a monoclinic amphibole), phenocrysts of olivine and titanomagnetite. After visiting the outcrop return to the vehicles.

ALTERNATIVE STOP 1.

If the Lake Champlain water levels are much over 95 feet above sea level most of the Stop 1 outcrops will be under water. There is an Alternative Stop 1 where the Montreal Limestone (but not the Lamprophyre Dike) can be seen.

To reach the Alternative Stop 1 return to Ohio Avenue and turn right/north (0 miles/0 km). Continue north to the New York Road stop sign (0.2 miles/0.3 km) and go straight ahead. Turn right on to U. S. Oval (0.3 miles/0.48 km). Continue north on the east side of the oval. The former U. S. Army and PAFB parade ground, constructed in 1893, is on your left. On your right you will pass four large, red brick former military buildings including the 22 U. S. Oval agency building, the 34 U. S. Oval apartments, the 52 U.S. Oval Plattsburgh City Recreation Center and the 64-70 apartments. Turn right, just past the last apartment building (0.6 miles/0.96) and continue to the parking area behind the apartment building and park.

After parking, walk north along the paved pedestrian walkway for 0.3 miles/0.5 km to a pedestrian bridge on your right/east. Cross over the Canadian Pacific mainline railroad tracks on the pedestrian bridge and follow the path down to the lake shore. This will bring you to Sailor's Point, the former PAFB beach and picnic area. The Montreal Limestone is exposed at the south end of the cobble beach. From the outcrop you can see Crab Island to the southeast and Marina Point to the south.

Distance in miles (km) Cumu-lative	Point to Point	Route Description
3.1 (5.0)		From Stop 1 follow Marina Drive back across the Canadian Pacific mainline railroad track to Ohio Avenue and turn right/north.
3.3 (5.3)	0.2 (0.3)	At the New York Road stop sign turn left/west.
3.5 (5.6)	0.2 (0.3)	Enter the rotary and take the first exit on to Route 9/United States Avenue heading north.
3.7 (5.9)	0.2 (0.3)	At the South Platt Street traffic light bear right and continue north on Route 9.
3.9 (6.2)	0.2 (0.3)	You will pass the Fort Brown historic markers and the remains of the defenses on your left/west. Fort Brown was the left/west flank of the American defense during the land portion of the Battle of Plattsburgh on September 6 – 11, 1814.
		Continue north on Route 9 past the traffic light at the Pike Street intersection.
4.4 (7.0)	0.5 (0.8)	Turn left/west at the T-intersection traffic light on to Bridge Street. Route 9 continues on Bridge Street.
4.6 (7.4)	0.2 (0.3)	At the four-way stop turn right/north on to City Hall Place. Route 9 continues as City Hall Place. Continue north on City Hall Place past the

		Plattsburgh City Hall on your left and the Macdonough (American naval commander during the Battle of Plattsburgh) Monument on your right.
4.8 (7.7)	0.2 (0.3)	Just past the City Hall turn left/west and immediately turn right/north on to Miller Street. Route 9 continues on Miller Street.
5.1 (8.2)	0.3 (0.5)	On Miller Street you will pass the Plattsburgh Post Office on your right and cross the Canadian Pacific mainline railroad tracks on a level crossing.
5.4 (8.6)	0.3 (0.5)	At a traffic light make a slow right turn/north on to Margaret Street. Route 9 continues on Margaret Street.
5.5 (8.8)	0.1 (0.2)	At a traffic light you will cross the Cumberland Head Avenue/Boynton Avenue intersection where the Georgia-Pacific paper mill is located.
6.3 (10.1)	0.8 (1.3)	Cross Scomotion Creek.
6.8 (10.9)	0.5 (0.8)	Continue north on Route 9 past the traffic light for Route 314 (Exit 39, I-87 ‘the Northway’) intersection.
7.5 (12.0)	0.7 (1.1)	Pass Cumberland 12 theatres on your left and cross under the transmission lines that carry St. Lawrence Seaway energy across Woodruff Pond and Lake Champlain on your right to Vermont.
8.4 (13.4)	1.4 (2.2)	Pass the Plattsburgh Rod and Gun Club on your right.
9.8 (15.7)	1.4 (2.2)	Pull over to the right/east side of Route 9 and park near a low road cut, Stop 2.

STOP 2: Cumberland Head Argillite of the Trenton Group on Route 9.

The Cumberland Head Argillite is exposed in this road cut on east of Route 9. At one time the exposures were better on the left/west side. The road cut (Fisher, 1968 - Figure 27) is typical of the Cumberland Head Argillite. The thin bedding (it looks like varves) of fairly distal turbidite deposition can clearly be seen as more calcarous layers alternate with the thinner, pale buff-colored quartz-silt bearing layers being slightly more resistant to erosion. Fresh surfaces of the rock are uniformly black; however, the thin layers can still be distinguished. The rocks in the vicinity are folded; but, the strike is generally N35E with a dip of 23 degrees N. Be sure to look north along Route 9 and see the slight dip that the highway makes north of the road cut. Stop 3 is just beyond the dip.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
9.8 (15.7)		Return to the vehicles and continue north on Route 9.
10.3 (17.0)	0.5 (0.8)	Pull over to the right/east side of Route 9 at the next low road cut, Stop 3.

STOP 3: Providence Island Dolostone of the Beekmantown Group on Route 9.

The Providence Island Dolostone is exposed in this road cut on both sides of Route 9, although the exposures are better on the right/east side (Fisher, 1968 - Figure 17). Before examining the outcrop, be sure to look south along Route 9 and recognize that you can see Stop 2. The Rocks at Stop 3 are nearly horizontal, compared to the steeper dips at Stop 2 and the entire Chazy Group and lower portion of the Trenton Group (some 400' or more of rock section) are missing. Fisher (1968) has mapped the edge of the Cumberland Head Allochthon, a Taconic thrust fault, as passing between these two trip stops on the basis of missing section at both the surface and in a 200' deep water well on Cumberland Head.

The Providence Island Dolostone is a thick bedded, massive unit that weathers to the buff color characteristic of dolostones. With careful examination, horizons that display significant soft sediment rip ups and other features characteristic of supratidal environments can be observed. The dolostone is sometimes vuggy and fracture zones that have been filled with secondary crystalline calcite are common.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
10.3 (17.0)		Return to the vehicles and continue north on Route 9.
10.6 (17.0)	0.3 (0.5)	Turn right/east on to the Point au Roche Road.
12.2 (19.5)	1.6 (2.6)	At the entrance to Point au Roche State Park turn right/south and enter the park. You are entering the western park entrance that leads to the beach. Follow the park road south past the entrance gate to the beach parking lot.
12.7 (20.3)	0.5 (0.8)	At the beach parking lot head to the far right/southwest corner of the parking lot and park, Stop 4.

STOP 4: Cumberland Head Argillite of the Trenton Group at Point au Roche State Park.

Walk the short distance from the parking lot to Lake Champlain and examine the large outcrop of Cumberland Head Argillite along the shore. The folding and jointing associated with the Taconic thrusting is very obvious. The rock is essentially the same as that seen at Stop 2 and again the thinning bedding of the fairly distal turbidite deposition can be seen as the more calcareous layers alternate with the thinner, pale buff-colored, quartz silt bearing layers being more resistant to erosion.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
12.7 (20.3)		Return to the vehicles and retrace your route back to the park entrance.
13.2 (21.1)	0.5 (0.8)	Turn left/west on to Point au Roche Road.
14.8 (23.7)	1.6 (2.6)	Turn right/north on Route 9.

15.8 (25.3)	1.0 (1.6)	A hump in the road will indicate that you are crossing the Ingraham Esker (Denny, 1972).
16.2 (25.9)	0.4 (0.6)	A series of sand pits can be seen to the right/east after you first cross the esker.
16.6 (26.6)	0.4 (0.6)	Route 9 crosses the Ingraham Esker again, just before the hamlet of Ingraham on the left/west.
19.2 (30.7)	2.6 (4.2)	Pass the Giroux Poultry farm on the left/west.
19.5 (31.2)	0.3 (0.5)	Pass Trombley Lane (formerly Slosson Road).
19.6 (31.4)	0.1 (0.2)	Pull over and park on the right/east side of Route 9 in front of a low Road cut that is located on the left/west side of Route 9 in front of a blue house, Stop 5.

STOP 5: Day Point Limestone of the Chazy Group on Route 9.

THIS IS NOT A HAMMER STOP

This road cut is part of the upper part of The Day Point Limestone, probably the Fleury Member of Oxley and Kay (1959). It is a medium gray calcarenite that is both cross bedded and regular bedded in this small exposure. Fisher (1968) mentions this outcrop as containing pelmatozoan debris. Note the nicely developed stylolites.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
19.6 (31.4)		Return to the vehicles and continue north on Route 9.
20.7 (33.1)	1.1 (1.8)	As Route 9 makes a bend to the left turn right/east on to Sheldon Lane.
21.1 (33.8)	0.4 (0.64)	On the left/north you will see a quarry with a large white house at its eastern end. Pull over and park at the western end of the quarry, Stop 6.

STOP 6: Valcour Limestone of the Chazy Group at the Sheldon Lane Quarry.

THIS IS NOT A HAMMER STOP

This is the first of two opportunities that we will have to see the bioherms in the Valcour Limestone.
See the Stop 10 description for the details of what to see at this stop.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
21.1 (33.8)		Return to the vehicles and turn around. There is a place to do a Y-turn on the left/north side of Sheldon Lane at an orchard access just east of the stop. Return to the intersection with Route 9.
21.5 (34.4)	1.2 (1.9)	Turn right/north on Route 9.
22.2 (35.5)	0.7 (1.1)	Just past a faded red barn on the right/east there is an amateurish 'stonehenge' and an unpaved road. The road leads to the abandoned International Lime and Stone quarry where the Pamelia Dolostone, the Lowville Limestone and the Isle La Motte Limestone formations of the Black River Group (Fisher, 1968 – Figure 25) were once exposed. A few years ago much of the remainder of this outcrop and the quarry floor today consists of Valcour Limestone. Some of the Black River Group remains on the north side of the quarry on private property; but, this exposure is only accessible when the water in the quarry is frozen.
23.1 (37.0)	0.9 (1.4)	At the Fiske Road in Chazy, NY turn hard left/southwest toward West Chazy. Continue southwest on the Fiske Road as it bends to the right/west.
24.3 (38.9)	1.2 (1.9)	Pull over to the right and park as the Fiske Road approaches the bridge over I-87, the Northway, Stop 7.

STOP 7: Crown Point Limestone of the Chazy Group at the Northway in Chazy, NY: *Maclurites magnus* Le Sueur, Death Assemblage.

THIS IS NOT A HAMMER STOP

To reach the outcrop cross the open area to the north and enter the woods on a vague trail behind and to the right of the obvious transmission pole. The vague trail heads north a few yards in a white cedar forest and then bends left/west toward the Northway. The outcrop is close to the Northway, a short distance north of the Fiske Road Bridge and is illustrated in Fisher, 1968 (Figure 20). The Crown Point Limestone is mainly a medium to dark gray calcilutite. This locality exhibits an unusually large assemblage of the planispiral gastropod *Maclurites magnus* along with trilobite and brachiopod fragments. Be sure to note the insipient karst development.

Distance in miles (km) Cumu-lative	Point to Point	Route Description
24.3 (38.9)		Return to the vehicles and turn around. Head back east and northeast on the Fiske Road.
24.6 (39.4)	0.3 (0.5)	Turn left/north on Route 9.
24.9 (39.9)	0.3 (0.5)	Cross the Little Chazy River.
25.1 (40.2)	0.2 (0.3)	Pass under the Canadian Pacific mainline railroad bridge.
25.2 (40.3)	0.1 (0.2)	Immediately after passing under the railroad bridge turn left on to the Miner Farm Road. As you turn left watch for an opportunity to continue with your left turn on to a short dead end street that enters the intersection and park on the apron, Stop 8.

Stop 8: Lacolle Melange at the Chazy Railroad Bridge.

The road cut is located along the west side of Route 9 as you walk south along Route 9 toward the railroad bridge and is figured in Fisher, 1968 (Figure 30). Fisher, 1968 maps this locality and the Stop 9 locality as part of the Tracy Brook (normal) Fault. The wide range of clasts are composed of mostly angular sandstone fragments in a sandstone matrix, presumably a tectonically crushed portion of the Keeseville Sandstone.

Distance in miles (km) Cumu-lative	Point to Point	Route Description
25.2 (40.3)		Return to the vehicles and carefully return to Route 9 heading north.
26.4 (42.2)	1.2 (1.9)	Cross Corbeau Creek. Corbeau Creek was studied, as a monitored watershed by Professor John Malanchuck and a succession of SUNY Plattsburgh students in the 1970s and 1980s. In recent years SUNY Plattsburgh students have been engaged in watershed studies on the Altona Flat Rock lands owned by the William H. Miner Agricultural Institute.
27.9 (44.6)	1.5 (2.4)	Turn right on Route 9B.
29.5 (47.2)	1.6 (2.6)	Cross the Great Chazy River in Cooperstown, NY.
29.9 (47.8)	0.4 (0.6)	Cross the bridge over the Canadian Pacific mainline railroad tracks.
30.1 (48.2)	0.2 (0.3)	Just past the Hayford Road pull over to the right and park in front of very small outcrop, Stop 9.

STOP 9: Lacolle Melange at Coopersville, NY.

The small outcrop is located adjacent to the south side of Route 9B and is figured in Fisher, 1968 (Figure 29). The breccia clasts include a wide range of sizes and the lithology of the clasts is predominately carbonate fragments, likely of Black River Group and Trenton Group origin. Also refer to the Stop 8 description.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
30.1 (48.2)		Return to the vehicles and continue east on Route 9B.
30.4 (48.7)	0.3 (0.5)	Pass the Dumont Road on the right and follow Route 9B around a big bend to the left. Lake Champlain will appear on the right/east.
30.7 (49.2)	0.3 (0.5)	After passing a brown log cottage, # 862, on the left/west turn into a driveway that leads to an open pasture, Stop 10.

STOP 10: Valcour Limestone of the Chazy Group at the Bechard Quarry, near Kings Bay.

To reach the quarry walk across the open pasture to the higher vegetated area that is visible to the west. Once you reach the top of the vegetated mound the quarry can be seen as illustrated in Fisher, 1968 (Figure 22). The bioherms consist of intertidal stromatolites (algae), stromatoporoids, and bryozoans with the various colonies being completely compatible (Pitcher, 1964b) and building their colonies on top of one another. Nautiloid cephalopods have been found.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
30.7 (49.2)		Return to the vehicles and turn around. Head south and west on Route 9B.
34.0 (54.5)	3.3 (5.3)	Turn right/north on Route 9.
37.9 (60.7)	3.9 (6.2)	Turn left into the northernmost of the two entrances to the (former) Clinton Farm Supply property (no sign), Stop 11.

STOP 11: Keeseville Sandstone Member of the Potsdam Sandstone Group at the Clinton Farm Supply, Champlain, NY.

The outcrop is exposed along the north side of the northernmost of the two driveways and in the flat area behind the Farm Supply building. In a series of articles (Erickson, 1993a. Erickson, 1993b. Erickson and Bjerstdt, 1993. Erickson, Connett and Fetterman, 1993) the stratigraphy and trace fossils of the Keeseville Sandstone and Theresa Dolostone/Sandstone have been described. Stop 11 (Erickson, 1993a, and Erickson, Connett and Fetterman, 1993) consists of medium bedded, cream colored Keeseville Sandstone. At this locality large scale ripple marks, and an unusual abundance of trace fossils can be seen.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
37.9 (60.7)		Return to the vehicles and continue north/left on Route 9.
39.2 (62.7)	1.3 (2.0)	Turn right at the traffic light at Route 11.
39.8 (63.7)	0.6 (1.0)	Cross the Great Chazy River.
40.8 (65.3)	1.0 (1.6)	Turn left at the traffic light on to Route 276.
41.4 (66.3)	0.6 (1.0)	Pass the Northeastern Central School on the left/west.
41.6 (66.6)	0.2 (0.3)	Turn left into the Prospect Hill Quarry, Stop 12.

STOP 12: Theresa Dolostone/Sandstone at Champlain, NY.

The Theresa Dolostone/Sandstone consists of an interlayed, medium and thick bedded, quartzose dolostone. Bjerstedt and Erickson (1989) and Erickson and Bjerstedt (1993) have described the trace fossils of the Theresa in detail and *Skolithos* has been found on the south wall of this quarry.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
41.6 (66.6)		Return to the vehicles and retrace your route south on Route 276.
42.4 (67.9)	0.8 (1.3)	Turn right at the traffic light on to Route 11.
44.5 (71.3)	2.1 (3.4)	Follow Route 11 to I-87 the Northway at Exit 41. Anyone needing to leave the trip early can conveniently do this here. Continue west on Route 11 across I-87.
47.5 (76.1)	3.0 (4.8)	Cross the Great Chazy River.
50.2 (80.4)	2.7 (4.3)	Enter Mooers, NY. Route 11 turns right and Route 22 enters on the left. Stay on Route 11 heading west.
52.7 (84.7)	2.7 (4.3)	Make a slow right turn/west off Route 11 on to the Davison Road.

57.9 (93.0)	5.2 (8.3)	The Davison Road comes to a stop sign at a T-intersection with the Cannon Corners Road in Cannon Corners, NY. Turn left/south on the Cannon Corners Road and immediately cross the English River.
58.5 (94.0)	0.6 (1.0)	Turn right/west on to the unpaved Gadway Road at the Adirondack Nature Conservancy 'Gadway Sandstone Pavement Barrens' sign, Stop 13. The 2.2 mile/3.5 km round trip on the Gadway Road is not suitable for vehicles with low clearance and drivers should consolidate riders into high clearance vehicles.

STOP 13: Keeseville Sandstone of Potsdam Sandstone Group at the Gadway Preserve.

Stop 13 consists of three short stops (13a, 13b and 13c) within the stop.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
58.5 (94.0)		Stop on the Gadway Road and park (**Stop 13a**) at a bare rock wash. Carefully cross over a barbed wire fence to examine a pavement of large scale ripples in the Keeseville Sandstone.
58.6 (94.2)	0.1 (0.2)	Continue west on the Gadway Road and park (**Stop 13b**) at the next significant open area on the right/north. At the north end of the open area near a red posted sign there is a 4 meter long (10 cm wide) *Protichnites* track. Yochelson and Fedonkin (1993) illustrate several similar examples of this trace fossil in the Keeseville Sandstone of northern New York. Additional trace fossils can be seen near the Adirondack Nature Conservancy sign. Recent literature suggests that the trace fossil *Protichnites* may be the track of a eurypterid-like stem arthropod (Seilacher, 2007; Hagadorn and Seilacher, 2009) or by euthycarcinoid arthropods travelling in pairs (Collette and Hagadorn, 2010; Collette, et. al, 2012).
		Continue west on the Gadway Road. Follow the arrow to the left track at the Y-intersection. At this point the road becomes solid rock. Continue to the marked turn-around loop.
59.3 (95.3)	0.7 (1.1)	Park (**Stop 13c**) at the turn around loop. Walk about 100 paces beyond the turn-around loop and pass an arrow sign. On the left/south side of the road you can locate additional *Protichnites* tracks. One track is 1.4 meters long (11 cm wide) and some partial tracks cross over one another.
		Return to the vehicles and return to the intersection of the Gadway Road.
60.4 (97.1)	1.1 (1.8)	Turn right/south on the Cannon Corners Road.
62.9 (101.1)	2.5 (4.0)	Turn left/east on to Route 11.
64.6 (103.8)	1.7 (2.7)	Turn right/south on to the Alder Bend Road toward Irona.
65.8 (105.7)	1.2 (1.9)	At the four-way stop sign turn left/east on to the Irona Road.
68.4 (109.9)	2.6 (4.2)	At the T-intersection stop sign turn right/south on to the Devils Den Road.

68.9 (110.7)	0.5 (0.8)	Continue south past the Miner Farm Road on the left/east.
69.5 (111.7)	0.6 (1.0)	Continue south on the Devil Den Road as it crosses the Great Chazy River. Just upstream from the bridge to the right/west is the McGregor Powerhouse, in Spanish architectural style, and the LaSalle Dam that were constructed by William H. Miner in 1923. Excellent exposures of the Keeseville Sandstone can be found on both sides of the river between the road bridge and the powerhouse.
69.7 (112.0)	0.2 (0.3)	As the Devils Den road bends to the right/southwest turn left and continue going south on the unpaved Rock Road.
70.7 (115.2)	0.6 (1.0)	There is a wide flat rock area of Keeseville Sandstone.
71.5 (115.5)	0.2 (0.3)	There is a second wide flat rock area of Keeseville Sandstone, Stop 14.

STOP 14: Trough Cross Stratification in the Keeseville Sandstone of the Potsdam Sandstone Group on the Rock Road, Altona, NY.

The trough cross stratification is located on the east side of the road, within what goes for a right of way. It is an outcrop of well exposed cross stratification in the Keeseville Sandstone.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
71.5 (115.5)		Return to the vehicles and continue south on the Rock Road.
72.3 (116.8)	0.8 (1.3)	Turn left/south at the stop sign intersection with Route 190, 'the Military Turnpike'. You will soon see one of the local wind farms set back on both sides of the road. These units feed their power to the nearby Power Authority of New York's Duley, Altona, NY, substation.
73.9 (119.4)	1.6 (2.6)	On the left/east side of the road you pass the overgrown ruins of Lewis Sage Robinson's Tavern, erected in 1837. The opposite/west side of the road is the site of the Original Log Tavern erected in 1810. This 1810 tavern was visited by President James Madison in 1817.
75.8 (122.4)	1.9 (3.0)	Pass the Blue Chip Way on the right/west.
75.9 (122.6)	0.1 (0.2)	'Truck ½ Mile' sign, warning trucks about the hill ahead. There is no shoulder on the right/west side of Route 190; but, it is possible to park on the left/east side of Route 190, Stop 15.

STOP 15: Altona Dolostone/Shale of the Potsdam Sandstone Group on the Military Turnpike.

Cross to the ditch on the west side of Route 190.Military Turnpike. Examples of the Altona Member of the Potsdam Sandstone can be found in and along the ditch from near the 'Truck ½ Mile' sign south to the near the bottom of the hill. The best exposures are toward the top of the hill. Grenville meta-anorthosite can be found just across the small drainage at the bottom of the hill.

The prominent hard reddish rock is a hematitic, micaceous quartzose dolostone. When highway crews clear the ditch it is also possible to see interbedded red shales; but, these tend to get grassed over in between ditch clearings.

About 2 miles/3.2 km east of here, SUNY Plattsburgh has a series of research hydrology wells on the William H. Miner Agricultural Research Institute's Altona Flat Rock. One of these wells penetrated 235 feet of Altona Dolostone/Shale before entering the underlying Grenville meta-anorthosites and basalt dikes.

Distance in miles (km)		
Cumu-lative	Point to Point	Route Description
75.9 (122.6)		Return to the vehicles and carefully return to Route 190 and continue south.
76.7 (123.9)	0.8 (1.3)	Pass the Murtagh Hill Road on the right/west. Just south of the Murtagh Hill Road on both sides of Route 190 there are good exposures of Grenville meta-anorthosites that have been intruded by a series of diabase dikes, also of Grenville age, and locally known as the Rand Hill Dikes.
77.3 (124.9)	0.6 (1.0)	Pass the Recore Road on the left/east.
83.0 (134.0)	5.7 (9.1)	Turn left/east at the traffic light intersection with Route 374, 'the Cadyville Expressway'.
86.1 (139.0)	3.1 (5.0)	Pass the Wallace Hill Road on the left/north. Route 374 is broadened to four lanes in this vicinity.
86.2 (139.2)	0.1 (0.2)	Pull over to the right and park, Stop 16.

STOP 16: Crown Point Limestone of the Chazy Group with Lamprophyre Dikes on Route 374.

This extensive road cut along both sides of Route 374/Cadyville expressway contains two Late Jurassic/Early Cretaceous lamprophyre dikes on the south side of the road that intrude the Crown point Limestone with a strike of N70W and a dip 85 degrees N. Only the easternmost of the two dikes appears on the north side of the road. Interesting features, including baked zones, zenoliths and partial zenoliths, can be seen associated with the intrusions. The Crown Point Limestone is mainly a medium to dark gray calcilutite. Some of the large planispiral gastropod, *Maculurites magnus* Le Sueur are present along with trilobite and brachiopod fragments.

Distance in miles (km) Cumu-lative	Point to Point	Route Description
86.2 (139.2)		Return to the vehicles. Stop 16 is the last stop and from here we will return to the Comfort Inn and Suites. Continue straight ahead.
86.3 (139.4)	0.1 (0.2)	Traffic light intersection with Quarry Road on the right/south and Route 22 on the left/north. Continue straight ahead and immediately access I-87 southbound, 'the Northway', using the Exit 38 entrance ramp on the right. Exit 38, I-87 is a convenient place for those who do not need to return to the Comfort Inn to leave the trip.
88.4 (142.8)	2.1 (3.4)	Leave I-87, the Northway, at Exit 37.
89.0 (143.8)	0.6 (1.0)	Turn right/east on Route 3. Continue east through two sets of traffic lights at LaBarre Street and Smithfield Boulevard.
89.3 (144.3)	0.3 (0.5)	Cross under the I-87 Northway bridge.
89.4 (144.5)	0.1 (0.2)	Turn right into Consumer Square. The Comfort Inn and Suites/Perkins Restaurant will on your right/west.

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