EARLY PALEOZOIC CONTINENTAL SHELF TO BASIN TRANSITION ROCKS: SELECTED CLASSIC LOCALITIES IN THE LAKE CHAMPLAIN VALLEY OF NEW YORK STATE

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TRIP ABSTRACT

Well-exposed classic localities in the Lake Champlain Valley of New York provide opportunities to examine the transition from Early Cambrian to Early and Medial Ordovician continental clastic and carbonate shelf sequences (e.g. Upper Cambrian Potsdam Group, Lower Ordovician Theresa Formation and Beekmantown Group, and Middle Ordovician Chazy Group) to the Medial Ordovician foreland basin carbonates and calcareous shales (Middle Ordovician Trenton Group).

INTRODUCTION

This field trip is designed to begin at the SUNY Plattsburgh campus at 8:00 a.m., and end near Plattsburgh, NY about 4:00 p.m., in time for participants to drive to Lake George, NY to make their lodging arrangements, have dinner, and attend the conference welcoming party. This trip visits many of the localities that are commonly visited in the introductory geology 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. The trip is included among the package of four trips originating in Plattsburgh, NY, in order to round out the offerings so that they include an opportunity to see a portion of the Lower Paleozoic section. Other faculty at SUNY Plattsburgh are involved in offering opportunities to see Adirondack bedrock geology, glacial geology, and hydrology and geomorphology localities in the area.

TECTONIC SETTING

The Paleozoic rocks of the Lake Champlain Valley of northeastern New York State consist of a sequence that began in the Late Cambrian and continued through the Early Ordovician as a typical, quartz sandstone and carbonate, passive shelf margin sequence, that transitions to the initiation of the Taconic foredeep basin in Medial Ordovician time (Isachsen, et. al, 2000). The shelf sequence was deposited on the passive margin that formed in the Late Proterozoic 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, et. al., 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 million years or so later, when the Upper Cambrian Potsdam Sandstone, which lies directly on Precambrian metanorthosites and metagabbros, is deposited. Overlying the Potsdam Sandstone (Figure 1), at approximately the Cambro-Ordovician boundary, is the Theresa Dolostone/Sandstone which is followed by the dolostones of the Lower Ordovician Beekmantown Group. The shallow shelf carbonates, and the well known patch reef bioherms, of the Chazy Group overly 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.

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

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'	
	Black River Group	Isle LaMotte Limestone	30'	
		Lowville Limestone	12'	
		Pamelia Dolostone	5-40'	
	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
		Day Point Limestone	80-300'	STOP 5
	Beekmantown Group	Providence Island Dolostone	150-200'	STOP 3
		Fort Cassin Limestone/Dolostone	150'+	
		Spellman Limestone	100'+	
		Cutting Dolostone	200'+	
		concealed dolostone 75-275'		
	Saratoga Springs Group	Theresa Dolostone/Sandstone	50'	STOP 12
Cambrian		Potsdam Sandstone		
		Keeseville Sandstone	455'+	STOPS 11, 13 and 14
		Ausable Arkose	250'+	
		'Basal Member'	unknown	STOP 15
Precambrian	Metanorthosite penetrated by Metagabbro both pierced by Diabase Dikes.			

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 foredeep 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, probably 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) as being the base of the 'Transition System' in quarries near Potsdam, NY. Three lithologic facies are generally recognized including a 'Basal' Member, the Ausable Member and the Keeseville Member. The 'Basal' Member consists of a maroon hematitic, feldspathic micaceous quartzose sandstone with some maroon shale interbeds (STOP 15). Portions of this basal unit may be older than Late Cambrian. The Ausable Arkose is a cross laminated, feldspar rich 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 authors have interpreted the Potsdam Sandstone as being deposited in a complex arrangement of fluvial to intertidal and barrier beach environments (Fisher, 1968).

This field trip guide follows Fisher (1968) and includes the Theresa Dolostone/Sandstone (STOP 12) in the Saratoga Springs Group although some authors have included it in the overlying Beekmantown Group. The Theresa is a thick bedded, quartz rich 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. 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, calciciltite 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 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 foredeep basin. The Cumberland Head Argillite is a regionally restricted unit that formed as a flysch, turbidity current deposit in a portion of the early foredeep 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

The trip begins in the parking lot at the west end of Hudson Hall on the SUNY Plattsburgh campus. To reach the Hudson Hall parking lot from the Exit 37 (the Plattsburgh-Cornelia Street/Route 3 Exit) of I-87, 'the Adirondack Northway', head east from Exit 37 on Cornelia Street/Route 3. Continue east past a congested series of traffic lights and pass under the Northway bridge. Approximately 0.5 miles east of the bridge under the Northway , at a traffic light, make a slow right on to Broad Street (Plattsburgh Plaza is to your left/north and the WIRY radio station is set back to your right/south at this intersection). Continue east on Broad Street for another 0.3 miles past the traffic light at Prospect Avenue and past the traffic light at Draper Avenue. Turn left/north into the parking lot on the north side of Broad Street, just east of Draper Avenue, and west of Hudson Hall. If you miss the parking lot you will go under a concrete pedestrian bridge over Broad Street.

Hudson Hall is named after Professor George H. Hudson (Hudson, 1905; Hudson, 1907; Hudson, 1931; Hudson and Cushing, 1931) who taught science and music for many years at SUNY Plattsburgh. His portrait hangs in the foyer of the building.

Mileage

0 Leave the parking lot at the west end of Hudson Hall on the SUNY Plattsburgh campus and turn left/east on to Broad Street.

0.5 Continue east on Broad Street under the pedestrian bridge, pass through the traffic lights at Beekman Street and Rugar Street, and turn right/south on to South Catherine Street at the traffic light.

1.0 Continue south on South Catherine Street, pass through the Pine/Steltzer Street traffic light, and cross the Saranac River bridge.

1.1 Immediately after crossing the river turn left/east on to South Platt Street.

1.5 Continue east on South Platt Street to the traffic light at Route 9/United States Avenue and turn right/south. This is a slow right and you should avoid the hard right on to Peru Street, i.e. follow the sign for Clinton Community College.

1.8 Continue south on Route 9 to the traffic light at New York Road and turn left/east.

1.9 Continue east on New York Road and pass through the gate to the 'old base' side of the former Plattsburgh Air Force Base that is now being operated under the auspices of the Plattsburgh Area Redevelopment Corporation (PARC).
Turn right/south on to Ohio Avenue East.

2.2 Note the 'old base' stone buildings constructed in the 19^{th} century of Potsdam Sandstone. Turn left/east, at the bike route sign, on to a narrow access road.

2.3 Continue on the access road and immediately cross a steep bridge (sound your horn). Continue through the sharp U-turn to the left and continue to the end of the road and park on the apron area near a small boat launch to Lake Champlain (STOP 1).

STOP 1. Montreal Member of the Glens Falls Limestone of the Trenton Group and Lamprophyre (Monchiquite Dike).

You are parked on the apron of the former Plattsburgh Air Force Base marina and boat launch. To reach the outcrop hike, approximately 2000' 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 weathers to medium dark gray. Crab Island (the smaller island that can be seen in Lake Champlain two miles southeast of this stop) takes its name from the trilobite, *Isotelus*, that is commonly found in exposures of the the Montreal Member on the island. Fisher (1968) maps 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.

2.9 After returning to the vehicles, retrace your route back across the narrow railroad bridge (sound your horn again) and through the former Plattsburgh Air Force Base to the 'old base' gate and Route 9. Turn right/north on Route 9.

3.2 Continue north on Route 9/United States Avenue with the 'old base' buildings to your right/east. At the traffic light with South Platt Street bear right and continue north on Route 9.

3.3 Pass the Fort Brown historic site markers 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^{th}, 1814.

4.0 Continue north on Route 9, through the traffic light at the Hamilton Street/Pike Street intersection, to the T-intersection with Bridge Street. Turn left/west on Bridge Street which becomes Route 9.

4.1 Turn right/north on to City Hall Place which becomes Route 9.

4.3 Continue north past the Plattsburgh City Hall on your left and Macdonough (American naval commander during the battle of Plattsburgh) Monument on your right.
Just past the City Hall, turn left/west and then immediately turn right/north again on to

Miller Street which becomes Route 9.

4.8 Continue north on Miller Street, cross the railroad tracks at the Delord Street level crossing. Make a slow right, at the traffic light, on to Margaret Street, which becomes Route 9.

6.3 Continue north on Margaret Street/Route 9 past the Georgia-Pacific paper mill at the Cumberland Head Avenue/Boynton Avenue intersection. Cross the small Scomotion Creek bridge. Continue north on Route 9 through the traffic light at the Route 314 (Exit 39 entrance to the Northway) intersection.

8.8 Continue north on Route 9 past the North Country Shopping Center on your left/west. Cross under the transmission lines that carry St. Lawrence Seaway energy across Woodruff Pond and Lake Champlain on your right/east to Vermont and pass the Pioneer Motel on your left/west.

9.3 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.

The Cumberland Head Argillite is exposed in this road cut on both sides of Route 9, although the exposures are better on the left/west side. The roadcut (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.

9.7 Return to the vehicles and continue north on Route 9, cross the slight topographic dip, and pull over to the right/east side at the next low road cut and park (**STOP 3**).

STOP 3. Providence Island Dolostone of the Beekmantown Group.

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 enviornments. The dolostone is sometime vuggy and fracture zones that have been filled with secondary crystalline calcite are common.

10.1 Return to the vehicles and continue north on Route 9 and turn right/east on to the Point au Roche Road.

11.7 Continue east on the Point au Roche Road to the entrance to Point au Roche State Park and turn right/south to enter the Park. You will be entering the western entrance to the Park that leads to the beach.

12.3 Follow the Park road south past the entrance gate to the beach parking lot and head to the far right/southwest corner of the parking lot and park (**STOP 4**).

STOP 4. Cumberland Head Argillite 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.

12.9 Return to the vehicles and retrace your route back to the Point au Rocke State Park entrance.
14.5 Turn left/west on the Point au Roche Road and retrace your route back to Route 9 and turn right/north on to Route 9.
15.8 Continue north on Route 9 past the intersection with Route 456 on the left/west. A hump in the road will indicate that you are crossing the Ingraham Esker (Denny, 1972).

16.6 A series of sand pits can be seen to the right/east after you first cross the Esker. Route 9 crosses the Ingraham Esker again, just before the hamlet of Ingraham on the left/west.
19.2 Continue north on Route 9 past the Giroux Poultry Farm.
19.6 Continue north on Route 9 past Trombley Lane (formerly Slosson Road).

19.7 At a low road cut on the left/west that is located in front of a robin's egg blue home pull over and park **(STOP 5)**.

STOP 5. Day Point Limestone of the Chazy Group. (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.

20.7 Return to the vehicles and continue north on Route 9 and at a point where Route 9 makes a bend to the left/west turn right/east on to Sheldon Lane.
21.2 Continue east on Sheldon Lane and you will see a quarry on the left/north. There is a large new white home at the east end of the quarry. Park on Sheldon Lane opposite the west end of the quarry **(STOP 6)**.

STOP 6. Valcour Limestone of the Chazy Group at Sheldon Lane. (THIS IS NOT A HAMMER STOP.)

This is the first of two opportunities that we will have (see also STOP 10) to see the bioherms in the Valcour Limestone.

21.7 Return to the vehicles and turn around. There is a place to do a Y-turn on the left/north side of Sheldon Lane just ahead. Retrace your route back to Route 9. Turn right/north on Route.
22.4 Just past a red barn on your right/east there is an amateurish 'stone henge' and an old road. The road leads to the abandoned International Lime and Stone quarry where the Pamelia Dolostone, the Lowville Limestone and the Isle LaMotte Limestone formations of the Black River Group (Fisher, 1968 - Figure 25) were once exposed. A few years ago the remainder of this outcrop was mined and the quarry floor today consists of Valcour Limestone. None of the Black River Group remains.
23.2 At the Fiske Road (formerly Old Route 348) turn left/southwest.
24.6 Continue southwest on the Fiske Road and follow the road as it bends left/west. As the Fiske Road approaches the bridge over I-87, the Adirondack Northway, pull over on the right/north and park **(STOP 7)**.

STOP 7. Crown Point Limestone of the Chazy Group at the Northway in Chazy:
***Maclurites magnus* Le Sueur, Death Assemblage** (THIS IS NOT A HAMMER STOP.)

To reach the outcrop cross the open area 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).

26.0 Return to the vehicles and turn around. Retrace your route back /northeast along the Fiske Road to route 9. Turn left/north on Route 9.
26.1 Continue north on Route 9 and cross the Little Chazy River.
26.4 Continue north and pass under the railroad bridge.
26.5 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 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 angular clasts are composed of angular sandstone fragments in a sandstone matrix, presumably a tectonically crushed portion of the Keeseville Sandstone.

27.7 Return to the vehicles and carefully return to Route 9 heading north. Continue north on Route 9 and cross Corbeau Creek. Corbeau Creek was studied, as a monitored watershed, by a succession of students at SUNY Plattsburgh in the 1970s and early 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 Institute and some of this work is described in Field Trip A. 6 of this field conference.
29.1 Turn right/east on Route 9B.
30.8 Cross the Great Chazy River in Coopersville.
31.1 Cross the bridge over the railroad.
31.4 Just past the Hayford Road pull over in front of a small outcrop and park **(STOP 9).**

STOP 9. Lacolle Melange at Coopersville.

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 made of carbonate fragments that appear to of Black River group and Trenton Group origin.

31.9 Return to the vehicles and continue east on Route 9B. Cross the Dumont Road.
32.2 Continue east on Route 9B as it bends left/north and after passing a brown log cottage (#862) on your left/west turn left into a driveway that leads to an agricultural field and park **(STOP 10).**

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

To reach the quarry walk across the agricultural field to the higher vegetated are 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 intertidal stromatolites (algae), stromatoporoids, and bryozoans with the various colonies being completely compatible (Pitcher, 1964b) and building their colonies on top of one another.

33.6 Return to the vehicles and turn around. Follow Route 9B back south and then east and re-cross the Great Chazy River in Coopersville.
35.3 Turn right/north on to Route 9.
37.2 At the Clinton Farm Supply enterprise on the left/west turn left into the northern most drive way and park **(STOP 11).**

STOP 11. Keeseville Sandstone of the Potsdam Sandstone at the Clinton Farm Supply, Champlain.

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.

38.5 Return to the vehicles and continue north on Route 9. Cross Route 11 at a traffic light.
39.1 Continue north as Route 9 enters Champlain as Main Street. Follow Main Street north as it descends and begins to bend to the left/west. Turn right on Elm Street and immediately cross the Great Chazy River.
39.2 After crossing the Great Chazy River follow Elm Street to the right/east. Do not make the sharp right turn on to River Street and do not make the left turn on to Oak Street which is marked as a dead end. After a short distance on Elm Street turn left at an antique shop on to Prospect Street (formerly the Bostock Hill Road).
40.9 Follow Prospect Street north and east past the Village of Champlain water supply to a stop sign at Route 276. Turn left/north on to Route 276.
41.2 Follow Route 276 north to a driveway on the left that is paved with thick cement and turn left/west into the driveway. Park on the left when you see the quarry ahead and to your left after a short distance **(STOP 12)**.

STOP 12. Theresa Dolostone/Sandstone at Champlain.

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

43.3 Return to the vehicles and retrace your route south on Route 276, turn right/west on Prospect Street. Follow Prospect Street west and south to Elm Street and follow Elm Street the short distance across the Great Chazy River to Route 9. Turn left/south on Route 9.
43.9 Turn right/west at the traffic light on to Route 11.
44.5 Follow Route 11 across I-87, the Northway at Exit 41. Anyone needing to leave the trip early can conveniently do so at this point.
47.7 Continue west on Route 11 and cross the Great Chazy River.
51.1 Continue west on Route 11 and enter Mooers. Route 22 enters from the south on the left.
53.8 Continue west and then southwest on Route 11 and turn right/west on to the Davison Road.
59.2 Continue west on the Davison Road to the stop sign in Cannon Corners.
Turn left/south on to the Cannon Corners Road and immediately cross the English River.
59.7 Turn right/west at the Adirondack Nature Conservancy 'Gadway Sandstone Pavement Barrens' sign on to the unpaved Gadway Road. The road enters **STOP 13** and the road log continues with two **STOPS** on the way in and a final third **STOP** at a turn around.

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

This stop requires driving in to the Gadstone Preserve of the Adirondack Nature Conservancy and consists of three short STOPS within the STOP. Vehicles with low clearance should not attempt this and we will consolidate riders at the entrance.

60.0 Continue west on the Gadway Road and **STOP** and park at a bare rock rock wash. Carefully cross over a barbed wire fence to examine a pavement of large scale ripples in the Keeseville Sandstone.
60.1 Continue west on the Gadway Road and **STOP** and park at the next significant open area on the right/north and stop and park. At the north end of the open area near a red posted sign there is a 4 meter long (10 cm wide) *Climachtichnites* 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.
60.8 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 and park **(STOP)**.

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 *Climachtichnites* tracks. One track is 1.4 meters long (11 cm wide) and some partial tracks appear cross over one another. Additional trace fossils may be *Protichnites*, and northern New York examples of these in the Keeseville Sandstone are also illustrated in Yochelson and Fedonkin (1993)

61.9 Return to the vehicles that are parked at the turn around and carefully drive back to the Cannon Corners Road. Turn right/south on the Cannon Corners Road.
63.4 Turn left/east on to Route 11.
65.1 Turn right/south on to the Alder Bend Road (labeled Irona Road).
66.4 At the stop sign turn left/east on to the Irona Road.
69.0 At the stop sign turn right/south on to the Devils Den Road.
69.4 Continue south past the Miner Farm Road on the left/east.
70.2 Continue south on the Devil Den Road as it crosses the Great Chazy River. As the Devils Den road bends to the right/southwest turn left on to the unpaved Rock Road.
70.9 Follow the Rock Road generally south to an obvious outcrop in the road on the left side and park **(STOP 14)**.

STOP 14. Trough Cross Stratification in the Keeseville Sandstone of the Potsdam Sandstone on the Rock Road.

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

72.9 Follow the rock Road south to the intersection with Route 190, the Military Turnpike. Turn left/south.
74.6 Pass the historic Robinson Tavern on the left/east.
76.5 Pass the Blue Chip Farm on the right/west.
76.9 Carefully turn left on to a grassy area by a private driveway and park **(STOP 15)**.

STOP 15. Ausable Arkose of the Potsdam Sandstone on the Military Turnpike.

Cross to the ditch on the west side of Route 190.Military Turnpike and walk north. Excellent examples of the 'Basal' Member of the Potsdam Sandstone, a hematitic, feldspathic and micaceous sandstone can be found over much of the distance to the Blue Chip Farm driveway.

77.4 Return to the vehicles and carefully return to Route 190 continuing south. Pass the Murtagh Hill Road on the right/west.
77.5 Pass the Rand Hill dikes on both sides of the road with the best exposure on the left/east side of Route 190. (add more description and reference)
83.8 Turn left/east at the traffic light on to Route 374, the Cadyville Expressway.
86.8 As Route 374 broadens to four lanes pull over on the right/south, 100 yards beyond the 'Lion International' sign, and park **(STOP 16)**.

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

This extensive road cut along both sides of Route 374/Cadyville expressway contains two 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.

87.1 Return to the vehicles and continue east on Route 374, cross the Route 22 intersection and immediately bear right on to Exit 38 to I-87, the Adirondack Northway, southbound.

Those interested in returning to SUNY Plattsburgh may exit I-87 at the next exit, Exit 37, and continue east (it is a right turn at the traffic light off the 'trumpet' exit) on Cornelia Street/Route 3, as described in the first paragraph of this road log, to the Hudson Hall parking lot.

Those wishing to continue to Lake George, NY for the remainder of the field conference should continue south on I-87 to Exit 21. This is the second and more southern exit to Lake George, NY. This trip will take approximately 90 minutes from Exit 38. After leaving I-87 at Exit 21 in Lake George, turn left/east on to Route 9N. Cross under I-87 and turn left/north on to Route 9. As you travel north on Route 9 into Lake George, the Fort William Henry Resort Hotel will be one mile north of the Route 9N intersection on the right/east side of Route 9.

REFERENCES CITED

Bjerstedt, T. W. and J. M. Erickson. Trace Fossils and Bioturbation in Peritdal Facies of the Potsdam-Theresa Formations (Cambrian-Ordovician), Northwest Adirondacks. Palaios, 4: 203-224. 1989.

Brainerd, E. The Chazy Formation in the Champlain Valley. Geological Society of America Bulletin, 2: (3): 293 - 300. 1891.

Brainerd, E. and H.M. Seely. The Original Chazy Rocks. American Geologist, 2: 323 - 330. 1888.

Brainerd, E. and H.M. Seely. The Calciferous Formation in the Champlain Valley. American Museum of Natural History Bulletin 3: 1-23. 1890.

Brainerd, E. and H.M. Seely. The Chazy of Lake Champlain. American Museum of Natural History Bulletin, 8: 305 - 315. 1896.

Clark, T. H. and H. W. McGerrigle. LaColle Conglomerate: A New Ordovician Formation in Southern Quebec. Geological Society of America Bulletin, 47: (5): 665 - 674. 1936.

Clarke, J.M. and C. Schuchert. The Nomenclature of the New York Series of Geological Formations. Science, New Series 10: 874-878. 1899.

Denny, C.S. The Ingraham Esker, Chazy, New York. Pages B35 - B41 *in* Geological Survey Research 1972. United States Geological Survey Professional Paper 800-B. 1972.

Emmons, E. Geology of New-York. Part II. Comprising the Survey of the Second District. Natural History Survey of New York. 437 pages. 1843.

Erickson, J.M. Cambro-Ordovician Stratigraphy, Sedimentation, and Ichnobiology of the St. Lawrence Lowlands-Frontenac Arch to the Champlain Valley of New York. Trip A-3(1). New York Geological Association Field Trip Guidebook, pages 68 - 95. 1993a.

Erickson, J. M. A Preliminary Evaluation of Dubiofossils from the Potsdam Sandstone. New York State Geological Association Field Trip Guidebook. Trip A-3(3), pages 121 - 130. 1993b.

Erickson, J. M. and T. W. Bjerstedt. Traces Fossils and Stratigraphy in the Potsdam and Theresa Formations of the St. Lawrence Lowland, New York. Trip A-3(2). New York State Geological Association Field Trip Guidebook, pages 97 - 119. 1993.

Erickson, J. M., P. Connett, and A. R. Fetterman. Distribution of Trace Fossils Preserved in High Energy Deposits of the Potsdam Sandstone, Champlain, New York. Trip A-3(4). New York State Geological Association Field Trip Guidebook, pages 131 - 143. 1993.

Fisher, D. W. Geology of the Plattsburgh and Rouses Point, New York-Vermont, Quadrangles. New York State Museum and Chart Series Number 10 51 pages. 1968.

Hawley, D. Ordovician Shales and Submarine Slide Breccias of Northern Champlain Valley in Vermont. Geological Society of America Bulletin 68: 55-94. 1957.

Hoffman, P. F. United Plates of America, the birth of a Craton: Early proteroxoic Assembly and Growth of Laurentia. Annual Review of Earth and Planetary Sciences 16: 543-603. 1988.

Hudson, G.H. Contributions to the Fauna of the Chazy Limestone on Valcour Island, Lake Champlain. New York State Museum Bulletin 80: 270-295. 1905.

Hudson, G.H. On Some Pelmatozoa from the Chazy Limestones of New York. New York State Museum Bulletin 107: 97-152. 1907.

Hudson, G. H. The Fault Systems of the Northern Champlain Valley, New York. New York State Museum Bulletin 286: 5 - 80. 1931.

Hudson, G. H. and H. P. Cushing. The Dike Invasions of the Champlain Valley, New York. New York State Museum Bulletin 286: 81 - 112. 1931.

Isachsen, Y. W., E. Landing, J. M. Lauber, L. V. Rickard and W. B. Rogers, Editors. Geology of New York: A Simplified Account. New York State Museum Educational Leaflet Number 28. 294 pages. 2000.

Kay, M. Stratigraphy of the Trenton Group. Geological Society of America Bulletin, 48: 233 - 302. 1937.

Kemp, J.F. and V.F. Marsters. The Trap Dikes of the Lake Champlain Region. United States Geological Survey Bulletin 107. Pages 11-62. 1893.

Le Sueur, C.A. Observations on a New Genus of Fossil Shells. Journal of the Academy of Natural Science, Philadelphia 1: 310-313. 1818.

Lewis, D. W. Qualitative Petrographic Interpretation of Potsdam Sandstone (Cambrian), Southwestern Quebec. Canadian Journal of Earth Sciences, 8: (8): 853 - 882. 1971.

Oxley, P. and M. Kay. Ordovician Chazyan Series of Champlain Valley, New York and Vermont, and Its Reefs. American Association of Petroleum Geologists Bulletin, 43: (4): 817 - 853. 1959.

Pitcher, M. G. Evolution of Chazyan (Ordovician) Reefs of Eastern United States and Canada. Ph.D. Dissertation. Columbia University, New York, NY. University Microfilms, Inc. Ann Arbor, MI. #68-8612. 105 pages. 1964a.

Pitcher, M. G. Evolution of Chazyan (Ordovician) Reefs of Eastern United nStates and Canada. Canadian Petroleum Geology Bulletin, 12: (3): 632 - 691. 1964b.

Selleck, B. and W. Bosworth. Allochthonous Chazy (Early Medial Ordovician) Limestones in Eastern New York: Tectonic and Paleoenvironmental Interpretation. American Journal of Science, 285: (1): 1 - 15. 1985.

Stone, D.S. Origin and Significance of Breccias Along Northwestern Side of Lake Champlain. Journal of Geology 65: 85-96. 1957.

Wieset, D.R. Composition, Grain Size, Roundness, and Sphericity of the Potsdam Sandstone (Cambrian) in Northeastern New York. Journal of Sedimentary Petrology 31: 5-14. 1961.

Yochelson, E. L. and M. A. Fedonkin. Paleobiology of *Climactichnites*, and Enimatic Late Cambrian Fossil. Smithsonian Contributions to Paleobiology Number 74. Smithsonian Institution Press. Washington, D.C. 74 pages. 1993.