TRIP #9

LOWER ORDOVICIAN STRATIGRAPHY AND SEDIMENTOLOGY, SOUTHWESTERN ST. LAWRENCE LOWLANDS

by

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Introduction

The Potsdam Sandstone and overlying Theresa Formation of the southwestern St. Lawrence Lowlands record the initial transgression of marine waters into the region during latest Cambrian to early Ordovician time (Fisher, 1977). The Potsdam Sandstone is widespread throughout the peripheral Adirondack region of northern and eastern New York, but is highly variable in thickness, composition and environments of deposition. In the area of this field trip (Figure 1), the Potsdam Sandstone (In this region, all of the Potsdam is referable to the Keeseville Member of the Potsdam Sandstone, Fisher, 1968, 1977.) can be subdivided into a lower and upper facies. The lower Potsdam consists dominately of flat-bedded medium- to fine-grained quartz arenites with occasional cross-stratified units of varying scales. The lower facies lacks both body and trace fossils. A variety of red-pink coloration patterns are common in the lower Potsdam, making it a desirable building stone in northern New York. The lower Potsdam in this region is dominately shallow marine in origin, but locally aeolian dune, beach and braided fluvial facies are present.

The upper portion of the Potsdam Sandstone consists of alternating burrowed and flat-bedded slightly calcareous sandstones deposited in a shallow subtidal to low tidal flat setting.

The overlying Theresa Formation consists of three informal subdivisions: lower Theresa thin-bedded calcareous siltstones of intrashelf lagoon origin; middle Theresa interbedded bioturbated dolomitic sandstones and cross-laminated quartz sandstones deposited in a shallow subtidal to low tidal flat environment; and upper Theresa sandy dolostones, dolomitic sandstones and calcareous siltstones of high tidal flat origin.

Biostratigraphically diagnostic macrofossils are absent throughout both formations in this area, although late Tremadocian conodonts have been reported from the Theresa-correlative March Formation in Ontario (Greggs and Bond, 1971). The extremely low faunal abundance and diversity may indicate that high and/or fluctuating salinities were prevalent in these shallow marine peritidal environments.

In the course of the trip, we will cross the so-called "Frontenac Axis", a region where Proterozoic rocks outcrop in a northwest-southeast trending belt, providing a connection in surface exposure between the Adirondack Lowlands and the Grenvillian Canadian Shield to the northwest. We will view the stratigraphic section in descending order as we drive southwest from Morristown to Alexandria Bay, New York, paralleling the St. Lawrence River. The Thousand Islands of this section of the St. Lawrence River are largely held up by Proterozoic gneisses and quartzites, although the larger islands (Wellsley, Grindstone) expose the mantling Potsdam Sandstone.

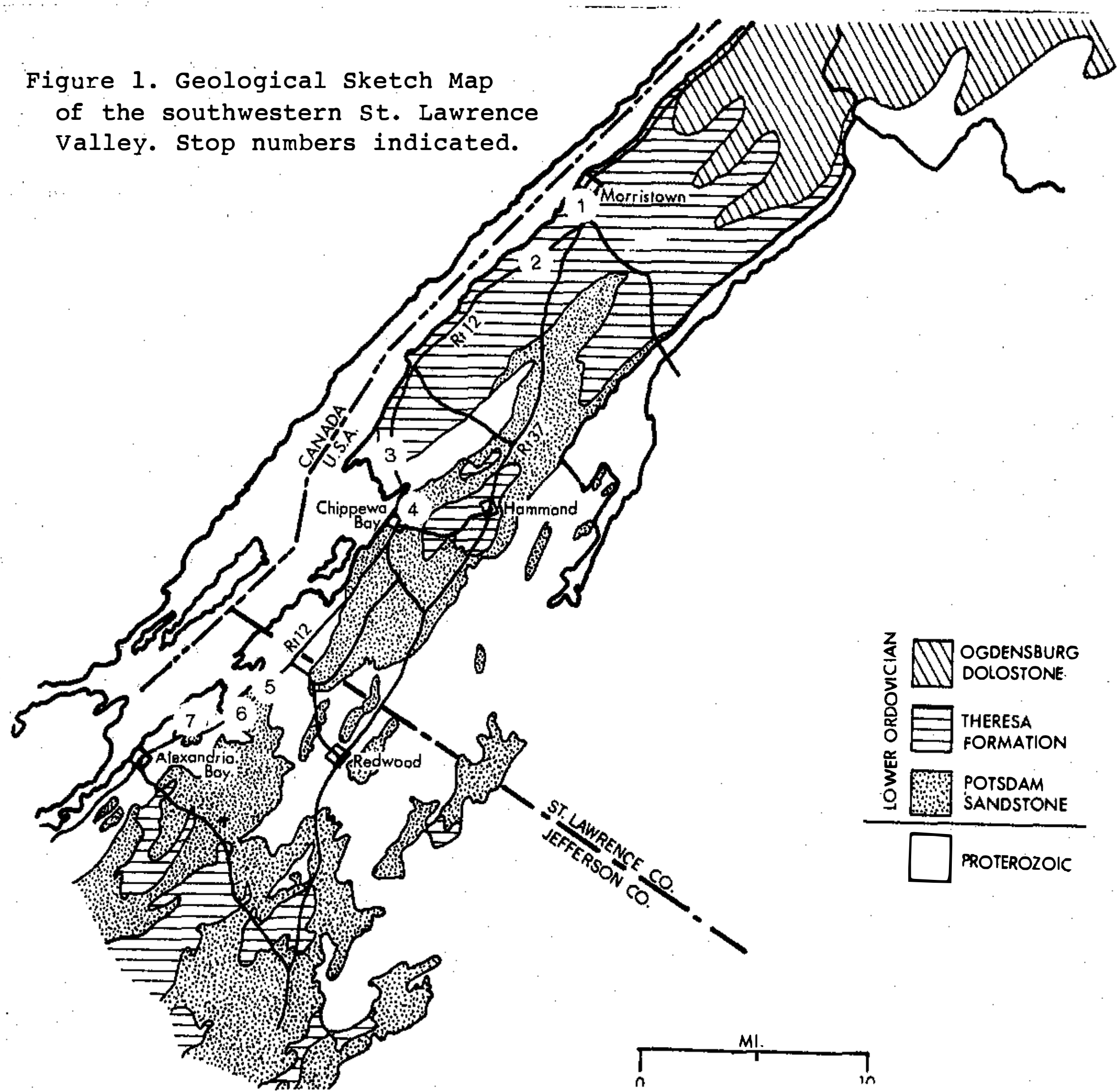
References

1) Fisher, D.W. (1968) Geology of the Plattsburg and Rouses Point, New York-Vermont, Quadrangles; N.Y.S. Mus. and Sci. Serv., Map and Chart Series #10, 51 pp.

2) ____ (1977) Correlation of the Hadrynian, Cambrian and Ordovician Rocks in New York State; N.Y.S. Mus. and Sci. Serv., Map and Chart Series #25, 75 pp.

3) Greggs, R.G. and Bond, I.S. (1971) Conodonts from the March and Oxford Formations in the Brockville Area, Ontario; Can. Jour. Earth Sciences, v. 8, #11, p. 1455-1471.

Figure 1. Geological Sketch Map of the southwestern St. Lawrence Valley. Stop numbers indicated.



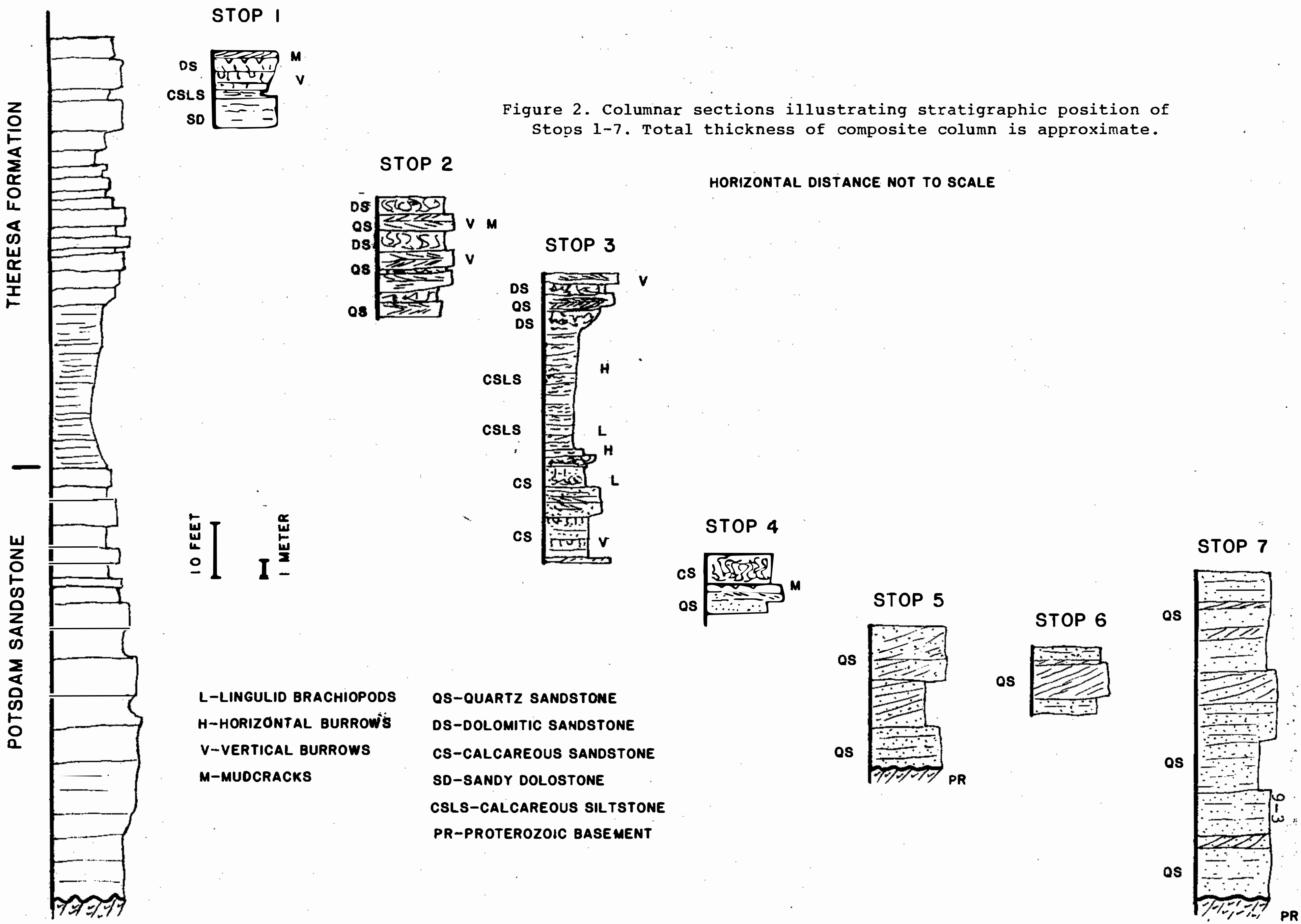


Figure 2. Columnar sections illustrating stratigraphic position of Stops 1-7. Total thickness of composite column is approximate.

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Road Log

Note: The detailed road log begins at Stop #1. To reach Stop #1 from Potsdam, N.Y., drive southwest on Rt. 11 to Canton, N.Y., (approx. 11 miles), turn northwest on Rt. 68 to Ogdensburg, N.Y. (approx. 19 miles). In Ogdensburg, turn southwest on Rt. 37 to Morristown, N.Y. (approx. 12 miles). Stop #1 is located on Rt. 37, immediately southwest of the village of Morristown.

Cumulative Miles	Miles from last Stop	
0.0	0.0	**Stop #1.** Roadcuts on both sides of Rt. 37 expose the high tidal flat facies of the upper Theresa Formation. The basal beds at this exposure consist of vuggy, sandy dolostones deposited as upper intertidal mudflats. A thin unit of laminated calcareous siltstone of tidal pond origin overlies the vuggy dolostone. The remainder of the section consists of dolomitic sandstones with abundant vertical and U-shaped burrows alternating with less bioturbated cross-laminated sandstones. These facies represent middle to high tidal flat sands. Quartz- and calcite-infilled voids in the sandy dolostone unit may document the former presence of evaporite (gypsum/anhydrite) nodules. Continue southwest on Rt. 37
0.8	0.8	Intersection of Rts. 12 and 37. Bear right and continue southwest on Rt. 12.
2.65	2.65	Entrance to Jacques Cartier State Park on right.
4.05	4.05	**Stop #2.** Middle portion of Theresa Formation. The rhythmic interbedding of yellow-white cross-laminated quartz sandstones and darker, bioturbated dolomitic sandstones is typical of this portion of the Theresa Formation. Rare mudcracks are present within the yellow-white sandstones. The dolomitic sandstones represent shallow subtidal to lower inter-tidal muddy sand flats that supported an abundant infauna. The yellow-white cross-laminated sandstones were deposited as slightly topographically higher mid-tidal flat sand bodies, upon which benthic fauna could not persist due to active current reworking and/or subaerial exposure to the substrate.

Cumulative Miles	Miles from last Stop	
		The sharp basal contacts of the bioturbated facies with underlying cross-laminated sandstones may indicate that the rhythmic alternation is due to a series of successive slight relative sea level rises of 2-3 meters. Thus, each bioturbated dolomitic sandstone-cross-laminated sandstone pair can be interpreted as a single shallowing upward sequence. A peculiar "wavy-bedded" unit near the northeast end of the outcrops appears to have resulted from intraformational soft-sediment deformation. Note the general low-amplitude folding and small high-angle fault in the exposure.
		Continue southwest on Rt. 12.
7.55	3.50	Long roadcut exposing lower Theresa Formation and upper Potsdam Sandstone near Oak Point, New York.
11.00	6.95	**Stop #3.** Basal Theresa Formation and Uppermost Potsdam Sandstone. The contact between the Potsdam Sandstone and lower Theresa Formation is prominently displayed at this stop and is marked by a color change (Potsdam= grey-white-yellow; Theresa=grey-brown), an abrupt increase in carbonate content in the basal Theresa, and changes in bedding style. The lower Theresa in this area consists of 2-10 cm beds of plane-laminated or low angle cross-laminated calcareous fine sandstones/ siltstones regularly interbedded with bioturbated calcareous fine sandstones/siltstones. Subvertical escape(?) burrows commonly traverse the plane-laminated beds and record attempts by deposit-feeding fauna to return to the sediment surface following a sudden influx of sediment. The environment of deposition of this basal Theresa facies is interpreted as a subtidal protected intrashelf lagoon characterized by sporadic periods of sediment influx (plane-laminated beds) followed by periods of quiescence of the substrate, allowing colonization by deposit feeders (bioturbated beds). This facies is limited in extent in the region, apparently because of the distribution of basement ridges of Proterozoic quartzite which acted as wave and current barriers. To the south and west of this area, coarser, bioturbated sandstones

Cumulative Miles	Miles from last Stop	
		resembling those seen at Stop #2 occupy the basal Theresa Formation. The upper Potsdam Sandstone at this top consists of a series of units of bioturbated calcareous medium-grained sandstones and plane-laminated to small-scale cross-laminated calcareous medium sandstones interbedded on a scale and style resembling the middle portion of the Theresa Formation seen at Stop #2. Alternating shallow subtidal (bioturbated sandstones) and low intertidal (plane-laminated to small-scale cross-laminated sandstones) environments are similarly inferred. The interesting trace fossil Diplocraterion yoyo is ubiquitous in the Potsdam Sandstone here. The forms are generally indicative of a response to growth and/or erosion of the sediment surface. The generally vertical orientation of these and other burrows is typical of burrows found in modern settings where organisms live within the sediment for purposes of protection from wave and current violence or dessication. This burrow style contrasts strongly with the generally horizontal traces seen in the basal Theresa Formation. Fragments of the inarticulate brachiopod Lingulepis accuminata are common in both the upper Potsdam Sandstone and lower Theresa Formation at this stop. Continue southwest on Rt. 12.
12.65	1.65	**Stop #4.** The contact between the lower Potsdam and upper Potsdam lithofacies is exposed at this roadcut on the southwest side of Rt. 12. The lower portion of the outcrop consists of pink-yellow plane-bedded and cross-bedded medium-fine sandstones typical of the lower Potsdam. The upper, massive calcareous sandstone bed is riddled with burrows, including Diplocraterion yoyo, and resembles some beds of the uppermost Potsdam seen at Stop #3. The bioturbated upper Potsdam is again interpreted as a shallow subtidal to low intertidal sand flat environment. The lower Potsdam here is likely a subtidal shelf sand, but the lack of burrows and other diagnostic primary structures preclude a definitive paleoenvironmental reconstruction.

Cumulative Miles	Miles from last Stop	
		Interestingly, the contact between these two lithofacies at this stop (and throughout this area) appears to represent a period of widespread emergence as documented by shrinkage cracks in the sandstones immediately below the contact and lenses of brecciated sandstones that are interpreted to result from breakup of a silcrete-like cemented soil horizon. Glacially striated and chattermarked surfaces are observable on the northwest side of the road.
		Continue southwest on Rt. 12.
15.65	3.00	Beginning of series of excellent exposures of Proterozoic gneisses.
19.95	7.30	**Stop #5.** The unconformity between the basal Potsdam Sandstone and underlying Proterozoic basement gneisses is exposed in this roadcut on the southeast side of Route 12. This contact represents a time interval of some 600 million years. The basal sandstones here exhibit large-scale low angle planar-tabular cross bedding, and are devoid of trace and body fossils. The depositional setting for this facies is problematic, although shallow marine tidal inlet, beach or aeolian dune environments are potentially workable facies models. Considerable variation in color pattern is evident in the Potsdam Sandstone, with the basal 0.5-1.0 meters white to light grey in color, whereas the upper portion of the outcrop exhibits the pink, red, orange and salmon colors often seen in the Potsdam Sandstone used as a building stone. In this section, the deeply colored beds contain abundant tiny (2-50 micron) disseminated hematite and leucoxene crystals with these pigments both surrounding detrital quartz grains and imbedded in later authigenic silica cement. Highly corroded grains of detrital magnetite and ilmenite in the colored sandstones appear to have been the source of iron and titanium which subsequently precipitated as hematite (probably with a goethite precursor) and leucoxene under oxidizing diagenetic conditions. The white sandstones immediately

Cumulative Miles	Miles from last Stop	
		above the unconformity contain no hematite or leucoxene, although limonite-goethite halos of relatively recent origin are locally developed around magnetite grains. The pristine condition of the majority of magnetite and ilmenite grains indicates that these basal sands never suffered a persistent oxidizing diagenetic history. The proximity of these unoxidized grains to the underlying pyritic gneisses suggests that the pore waters near the contact were "Eh-buffered" by the alteration of pyrite and Fe-silicates in the gneisses, thus preventing breakdown of the magnetite and ilmenite, and the subsequent precipitation of pigmenting agents. Note that the sole surface of the lowermost sandstone bed mimics the shape of the underlying (now weathered) basement erosional surface.
		Continue southwest on Rt. 12.
21.15	1.20	**Stop #6.** The roadcut on the southwest side of Route 12 exposes typical lower Potsdam Sandstone. Flat-bedded medium- to fine-grained sandstones underlie and overlie a 1 meter thick bed of tangentially cross-stratified medium sandstones. The dominant cross-bed dip direction is nearly due south. Immediately above the thick cross-stratified unit smaller-scale cross-beds dip to the north. As with many exposures of the lower Potsdam Sandstone, assignment of an environment of deposition is difficult here. Although the flat-bedded sandstones lack trace or body fossils, a shallow marine subtidal environment is suggested by the continuity of individual beds, the lack of upward fining or coarsening trends and the lack of obvious channel form geometry. However, definitive diagnostic primary structures are absent. The large cross-stratified unit, produced by a bed form of at least 2-3 meters in amplitude (stoss-side erosion beveled the upper portion of the structure as it migrated, leaving behind a scoured lag deposit of granules at the updip termination of the cross-strata), could have been deposited by a large subtidal sand wave, or an aeolian dune during a period of emergence.

Cumulative Miles	Miles from last Stop	
		Continue southwest on Rt. 12.
22.45	1.30	**Stop #7.** The angular unconformity between the basal Potsdam Sandstone and Proterozoic gneisses is again exposed in these large roadcuts on both sides of N.Y.S. Route 12. The dominant facies present here is typical of the lower portion of the Potsdam throughout the southwestern St. Lawrence Lowlands. Flat-bedded medium- to fine-grained quartz arenites are occasionally interrupted by 0.2 to 1.0 meter sets of cross-strata. The lack of diagnostic trace and body fossils is a nettling problem if we assign a shallow marine environment of deposition to this facies. Note the "weathered zone" at the unconformity. Does this represent a "regolith" or buried soil horizon; or is another explanation more viable? Note also the general absence of clasts of the underlying gneiss in the basal Potsdam Sandstone.

End of Trip

Note: Continue southwest on Rt. 12, passing Alexandria Bay village to access Interstate Rt. 81.