Trip A-2

SOME CLASSIC TEACHING LOCALITIES IN ST. LAWRENCE COUNTY, NEW YORK

John T. Bursnall and Catherine H. Shrady
Department of Geology, St.Lawrence University, Canton, New York 13617

INTRODUCTION

Western St.Lawrence County, within the central section of the St.Lawrence Lowlands in New York, contains a wonderful variety of outcrops that lend themselves to illustrating a wide range of geological processes and principles for all levels. The purpose of this trip is to visit a limited number of these - 'tried and true' localities – those that have proven to be excellent ones for introducing students to a variety of geological problems in addition to the regional geology of the North Country. The stops on this field trip have been chosen for ease of accessibility in addition to their outstanding teaching possibilities. All have been used in introductory to advanced field labs in the Geology Department at St.Lawrence. They are, therefore, suitable for moderately large groups (say, a maximum of 20 or so). Our choice clearly had to be constrained by logistical limitations such as accessibility in the time available, and the number of stops appropriate for a single day field trip, but we may prove to have been over-ambitious (!) and so it should be anticipated that we might not be able to cover all the stops described in this field guide. What we offer here is, by necessity, far from comprehensive (and certainly not complete), but is a subjectively biased attempt to provide an introduction to some of the teaching possibilities in what is a geologically quite complex and varied terrain. Five of the ten stops are featured in Van Diver's (1976) highly recommended Rocks and Routes of the North Country.

A BRIEF BACKGROUND

The St. Lawrence Valley was an important area for mineral exploration in the early nineteenth century and a number of mines were developed in the western part of the region. Lead, zinc, and iron ore were important products. Most are now defunct but a few still remain in operation, notably the zinc and talc mines in Balmat, just south of Gouverneur (Fig. 1).

In part in response to this early exploration and also to subsequent research of the complex geology, the region has become an important collecting and study area for a wide variety of minerals (see MATRIX: a Journal of the History of Minerals, Fall 1998; also, field trips A7 and B4, this volume). The geology of this area is now generally well understood and this, coupled with some magnificent outcrop coverage, has resulted in the area becoming an important one for teaching at all levels, and has been a venue for many traveling field parties.

The geology of the St.Lawrence Valley, including St.Lawrence County, is essentially made up of three major rock groups. A ca.1.35-1.0 Ga Precambrian basement (Stops 2-5) comprised of medium- to high-grade gneisses is overlain by sedimentary cover rocks, which may be divided into three age-defined packages. The oldest of these is somewhat enigmatic since these sediments (quartz-arenites and breccias) likely represent a latest Precambrian to Cambrian phase of deposition, and infill depressions on an undulating (in part karstic) Precambrian erosion surface. There is clear evidence for dissolution of marble and subsequent infill at many localities, as well as some interesting possible cave collapse structures (see Stops 6, 7 and 8). Clearly separating this 'transitional' sequence from the overlying Potsdam Sandstone, sensu stricto, has proven to be very difficult, and is still one of the outstanding problems in the region.

The Potsdam Sandstone represents the base of an east to west Lower Paleozoic marine transgression sequence. Overlying limestones and shaley limestones (Theresa and Ogdensburg formations) indicate a progressive deepening and distance from terrigenous sources. The age of the Potsdam is likely uppermost Cambrian to Ordovician.

Pleistocene glacial and related fluvial and lacustrine deposits (Stop 1) make up the third depositional package and these, together with glacial erosional features, provide the most significant control on the North Country landscape.

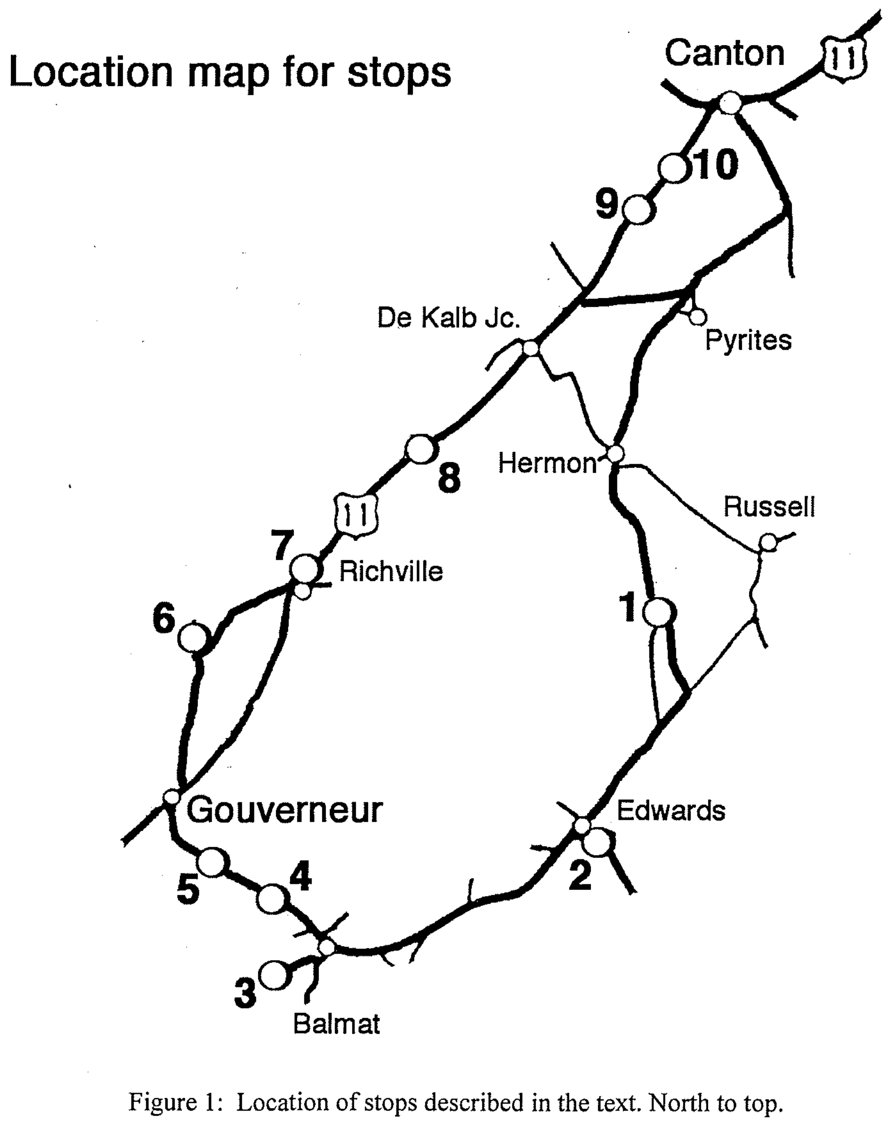

Figure 1: Location of stops described in the text. North to top.

ROAD LOG

Cumulative Mileage	Miles from last point	Route description
Start	0.0	Canton village park, in the center of Canton, junction of Rte 11 and Park Street. Follow Park St. southwards through St.Lawrence University.
2.3	2.3	Turn right at traffic lights onto County Route 25 (CR 25)
3.3	1.0	Turn right onto CR 21 and follow signs for Hermon. Notice small marble outcrop on right at 4.5 total miles and amphibolite at 5.2.
6.7	3.4	Sharp bend to left then turn right, continuing on CR 21.
7.0	0.3	Remains of pyrite mine on left just before bridge over the Grasse River, then large outcrop of marble on left. Continue straight ahead for Hermon. Notice outcrops of sand/gravel and horizontal surfaces indicating glacial meltwater deposits (delta top?). Adjacent outcrops of gneiss indicate significant relief on the post-glacial surface.
11.3	4.3	Enter Hermon.
11.6	0.3	Traffic lights, continue straight ahead and leave Hermon on CR 21 towards Edwards. Drive through a broad valley in Marshville and follow CR 21 noticing numerous roadcuts of basement gneiss. The valley is rejoined in a few miles.
16.5	4.9	Notice the small knolls in the center of the valley which is underlain by 300-900ft of till.
17.0	0.5	At a sharp right hand bend turn left.
17.1	0.1	**STOP 1**, opposite one of these knolls

Figure 2: 'Moulin kame'(?) viewed from CR 21 (in front of smaller pylon).

This stop is a 'puzzler,' and may be only appropriate for those students who have taken an advanced glacial geomorphology class – although it was regularly, and quite successfully, used in a summer session introductory course for many years. Notice that the four hillocks visible from this vantage point are comprised of poorly sorted boulder-rich sandy till (i.e., they do not have the characteristics of the agricultural boulder piles common elsewhere in the North Country). Jim Street (long time geomorphologist at St. Lawrence University until his untimely death in 1993) persuaded us that these are the remains of subglacial or englacial debris piles that collected at the base of glacial 'sinkholes'. [The term 'moulin' (mill) refers to the noise of moving pebbles and boulders at the base of the waterfalls producing these deposits, which is reminiscent of the noise of a mill.] What do you think of Jim's hypothesis?

Return to vehicles and continue along this minor road, noting the severely 'underfit' stream to the other side of the valley.

17.7	0.6	Turn right onto Belleville Road and continue southwards to the junction with CR 24.
20.1	2.4	Turn right onto CR 24, past Edwards Knox School and drive obliquely across the termination of the valley of Stop 1. Notice the hummocky terrain to the right (moraine?) and the large gravel pit to the left at 22.6 miles.
24.1	3.0	Enter Edwards and turn left opposite the town hall onto Maple Avenue
25.0	1.9	Turn right at T-junction with Route 58 and park on verge beyond barrier. STOP 2 is a short walk behind on Route 58.

STOP 2. MINERAL IDENTIFICATION AND METAMORPHIC REACTIONS

A classic collecting site, now suffering from 'field party erosion'! **(PLEASE DO NOT SAMPLE FROM THE OUTCROP).** Superb samples of diopside occur in the contact zone between pink calcite veins and the granular textured diopside-rich gneiss.

In our experience, a relatively large number of students will misidentify the salmon pink calcite as K-feldspar (providing an almost guaranteed teachable moment!) Other minerals present are actinolitic amphibole, phlogopite (a mica), pyrite, and rare molybdenite and blue apatite. Some genuine potassium feldspar has been collected from a pit just to the north. It is likely that the protolith for this rock was a siliceous dolomitic limestone with the abundant diopside in the outcrop being produced in part by the simple reaction:

$$2(Ca,Mg)CO_3 + SiO_2 > 2(CaMg)SiO_3 + CO_2$$
$$\text{dolomite} \; + \; \text{quartz} > \; \text{diopside}$$

Return to vehicles and continue northwestwards on Route 58.

29.0	4.0	Talcville road on right
33.2	4.2	Crossroads. Turn left onto Route 812 South towards Balmat. Notice tailings and stockpiles from Gouverneur Talc mine on left.
33.4	0.2	Turn right onto Sylvia Lake Road.
34.5	1.1	At right-hand bend pull over onto left-hand verge and park. near the gates to Ontario Zinc Co. (formerly Zinc Corporation of America, or ZCA).

STOP 3. STROMATOLITIC FORMS IN MARBLE.

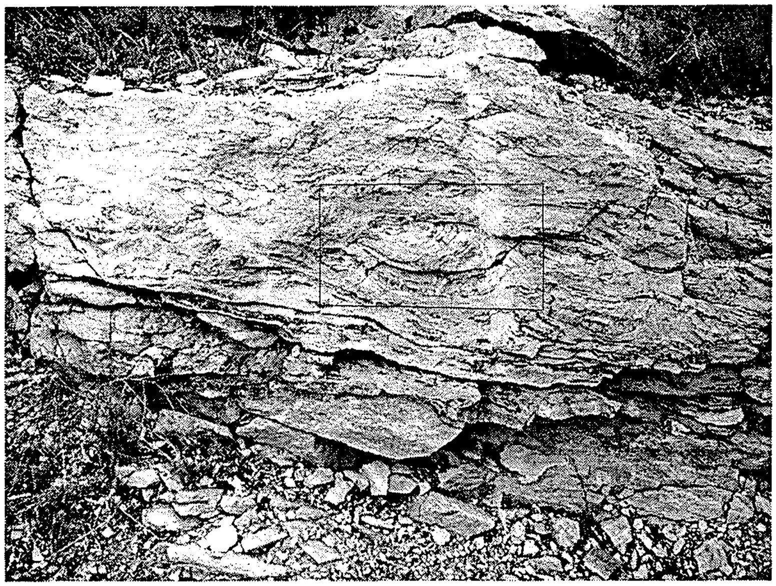

Figure 3: An overturned 'cauliflower' stromatolite occurs mid-photo (rectangle approx 20" wide).

One of the most significant outcrops in the Grenville geology of New York. The stromatolites are not only important as vestiges of past life (as old as 1.3Ga) but, since they are upside down, gives credence to the existence of postulated large-scale folds (nappes) in the St.Lawrence Valley. **AGAIN, PLEASE, NO HAMMERS.**

Return to the junction of Route 58 and 812

35.9	1.4	Turn left onto Route 58 and continue northwards.
36.9	1.0	Pull over and park just beyond the entry to a road on the right. These large roadcuts comprise STOP 4

STOP 4. MIGMATITIC GNEISS COMPLEX (POPLAR HILL GNEISS)

Gray paragneiss invaded by a variety of moderate to steeply dipping granitic veins and dikes, most of which have suffered (or enjoyed) significant extension (stretching). Rare veins that have low dip may be quite strongly folded. A very fine example of this occurs on a grass ledge at the top of the southern end of the western outcrop, and at least one structural geology text has featured these as 'ptygmatic' folds (see Fig. 4). The varied response of the veins to the deformation is systematic within small areas of these outcrops and can give a fairly crude assessment of the principal axes of finite strain – moderately steep extension and shallow shortening. Return to vehicles and continue northwards.

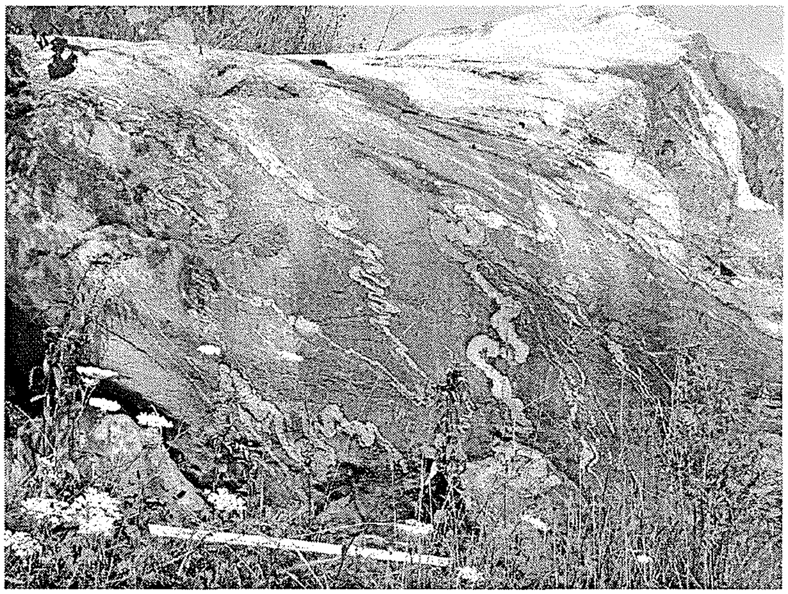

Figure 4: 'Ptygmatic' folds from the west side of Route 56. (3ft measure for scale)

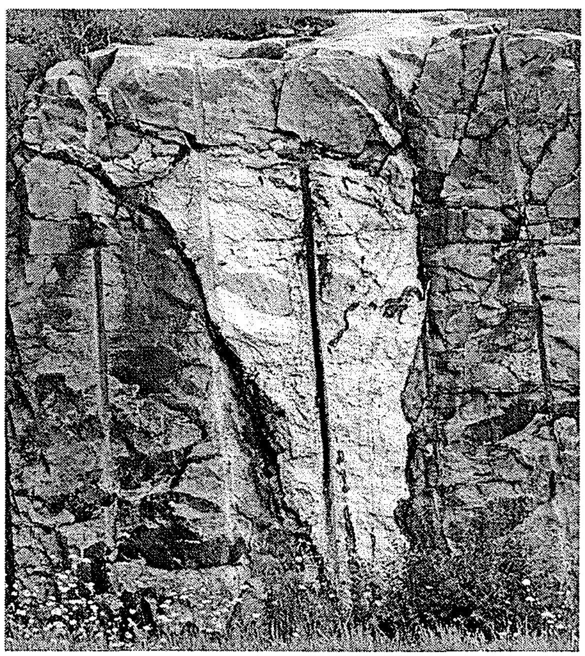

Figure 5: The 'steers head'. Intrusive marble into gray gneiss.
(Outcrop approximately 15 feet high)

39.9	3.0	Pass the turn-off for Hailsboro and the 'steers head' on the right (marble injection into in gray gneiss, Figure 5).
40.5	3.4	STOP 5. Very large roadcut of marble. Park on the right.

PLEASE WATCH FOR SPEEDING TRAFFIC!

STOP 5. DISRUPTED AND METAMORPHOSED MAFIC DIKE IN GNEISSIC MARBLE

The marble in this magnificent roadcut is a compositionally layered variety with alternating graphite-rich and graphite-poor layers. It is uncertain if the layers are original layering or are deformational in origin. Careful observation of the train of boudinaged dike fragments will indicate a complex relationship to the layers. Note also that the attitude of the layering along the outcrop suggests the existence of a large recumbent fold with the lower limb below road level in the southern part of the cut. More than one phase of folding is necessary to accommodate the complex geometry, even if the 'dike' was originally non-planar. Our introductory geology field lab exercise for this outcrop require students to make a sketch of the whole section on the east side of the road as well as to identify the principal minerals present in both the marble and the mafic dike remnants. Return to vehicles and continue north on Route 58.

41.2	0.7	Small low outcrops of marble on both sides of the road with a basaltic dike (short stop, if time permits).
42.1	0.9	Past large cemetery on right, down a short hill, under a railroad bridge and over the Oswegatchie and turn right at traffic lights.
42.25	0.15	Onto Route 11 at the traffic lights.

LUNCH PICK-UP: Pick-up at un-named fast food sources, Gouverneur

42.4	0.3	Second traffic lights on Route 11. turn left.
42.6	0.2	Turn right at T-junction, (fair ground straight ahead).
42.7	0.1	Turn left at T-junction onto Rock Island Road.
46.5	3.8	Turn right at top of hill onto Welsh Road and park on right,

LUNCH STOP

STOP 6: ROCK ISLAND ROAD CUT.

This outcrop is perhaps one of the most intriguing road sections in the North Country and is a common stopping point for field parties visiting the region. It is appropriate for all levels - introductory physical geology to advanced courses (senior level structural geology, for example). Our main interest here is to characterize the relationship of the presumed Potsdam Sandstone to Grenville gneisses, which at the upper part of the roadcut are calcitic marbles. This deep roadcut provides magnificent exposure and is one of the better outcrops in illustrating the variety of marble–sandstone relationships present in the region. Evidence for significant post-arenite deposition deformation is present at many localities.

At the southeast end of the cut, a well-bedded quartz-arenite illustrates the attractiveness of an interpretation that these represent the lowermost Potsdam Sandstone. However, the very complex relationships of these sandstones with the "underlying" marbles invite alternative explanations to a simple erosional unconformity. Moderate dips (~30°), angular marble clasts in quartzarenite, thin sandstone dikes extending outwards and upwards from contacts, and changes in composition of the sandstones close to the marble have all contributed to a karst surface depression infill (see Van Diver, 1976). Some of the contact relationships in this section have been used as evidence for structural control of deposition and basement remobilization (Bannerman *in* Carl and Van Diver, 1971) - similar to that of Barber and Bursnall (1978) for outcrops in the area around Theresa, some twelve miles to the west.

For introductory students, clear evidence of faulting and a basaltic dike at approximately half-distance down the outcrop are additional important features.

Contact zones need to be carefully examined and advanced students should be directed to iron oxide and iron pyrite that armor many of the surfaces, and the potential significance of angular marble fragments. Subtle brecciation features particularly in the northern sections (perhaps, autobrecciation), matrix supported conglomerates (upper west side of northern section), etc., may be easily overlooked, and a spectacular tourmaline-rich breccia in the latter area further suggest a protracted and complex history for the section.

Return to vehicles and continue east along Welsh Road towards Richville.

49.7 3.3 Junction with Route 11. Turn left and immediately park on the right.

STOP 7. SANDSTONE WITHIN MARBLE AND THE RICHVILLE BRECCIA

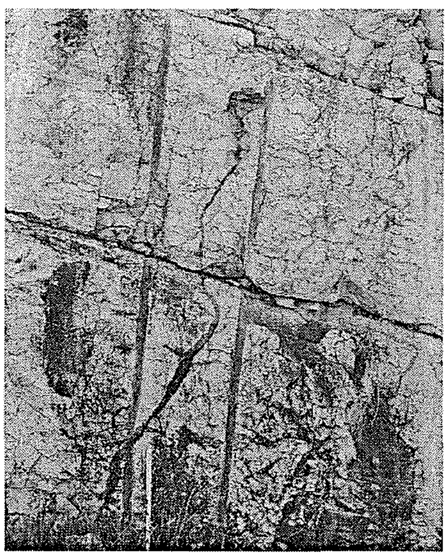

Figure 6: Narrow seam of quartzarenite in marble. Drill-hole spacing for scale.

(a) If time permits, an outcrop of marble on the northwest side of Route 11, a few hundred yards to the south should be visited (see Fig. 6, above). It contains narrow subvertical veinlets of arenite at the northeast end, which provide good evidence for solution cavity infill (Bursnall and Elberty, 1993).

PLEASE CROSS WITH CARE (DUAL LANES IN THE UPHILL DIRECTION).

(b) Return to Welch Road and continue along a large outcrop on the north side of Route 11. Karboski et al. (1983) describe this outcrop as containing a "flow breccia" at its base. This is overlain by a densely consolidated breccia with an overlying highly deformed metaquartzite, overlain by an "orthoquartzite," which contains pebble-sized quartz clasts – possibly derived from the underlying metaquarzite. The breccias contain quartz clasts set in a hematite stained, medium-grained arenite.

Large (0.5m) phacoidal blocks of the breccia are enveloped by thin shaley borders, the whole giving the impression of a shear zone.

This outcrop certainly inhibits any notion that the unconformity between Precambrian basement and overlying arenaceous cover rocks is a simple one!

Points of interest are:

i) possible shear fabrics in the lower part of the outcrop, in part defining the borders of coherent blocks of breccia;
ii) compositional variation of clasts in the breccias; and,
iii) the relationship between and the textural character of each of these identified rock types.

If the upper part of this outcrop is indeed comprised of rocks which are parts of the Grenville basement, as supposed by Karboski (1976) and Karboski et al. (1983), then the current disposition of lithologies seems not to be satisfied by a model that involves karst infill alone. It is possible, however, that the wall collapse of a large solution depression may have allowed a slab of basement to slide into a sediment filled basin. The presence of shear fabrics within the breccia may be accommodated by this model, provided that these rocks were only partially lithified at the time. Another possibility, since there is evidence of folding and brittle faults in Lower Paleozoic rocks elsewhere in the St.Lawrence Valley (Barber and Bursnall, 1978), is that these shear fabrics are a remote product of Alleghenian deformation.

Cross over Route 11 to return the vehicles and investigate the southern end of the outcrop on the southeast side of the road. Here, a narrow zone of sandstone breccia dips steeply through marble. One of the contacts is sheared indicating high angle faulting. Is there evidence for displacement sense? Continue northeast on Route 11.

54.8	4.1	Junction with Route 812 from Ogdensburg. Continue on Route 11.
55.4	0.6	Pull over on right beside large outcrop, STOP 8.

STOP 8. SANDSTONE/MARBLE CONTACT, EAST DEKALB.

This series of outcrops (Figure 7), known as the 'Red and White' by St.Lawrence introductory geology students illustrates some of the complexities of the unconformity between the Grenville meatamorphic rocks and overlying quartzarenite sediments, which may, or may not, be Potsdam Sandstone. The stop has a number of interesting features that will test students' abilities in assessing field relationships and has similarities to the Rock Island Road outcrops (solution pockets, sulfide mineralization close to gneiss-sediment contact, etc.). A number of small sandstone breccia wedges (see below) penetrate downwards into the underlying marble close to its steep contact with a rusty sulfidic quartzarenite in the central section of outcrops on the northwestern side of the road.

A poorly defined cylindrical structure (supposed solution pocket collapse structure, Bursnall and Elberty, 1993; see Figure 8, below) may be seen on the top of a low outcrop of compact, rusty weathered, quartzarenite in the southernmost outcrop on the northwest side of Route 11. Bedding in the sandstone is irregular and breccia/conglomerates are present low in this section and in the outcrop on the southeast side of the road a short distance to the south.

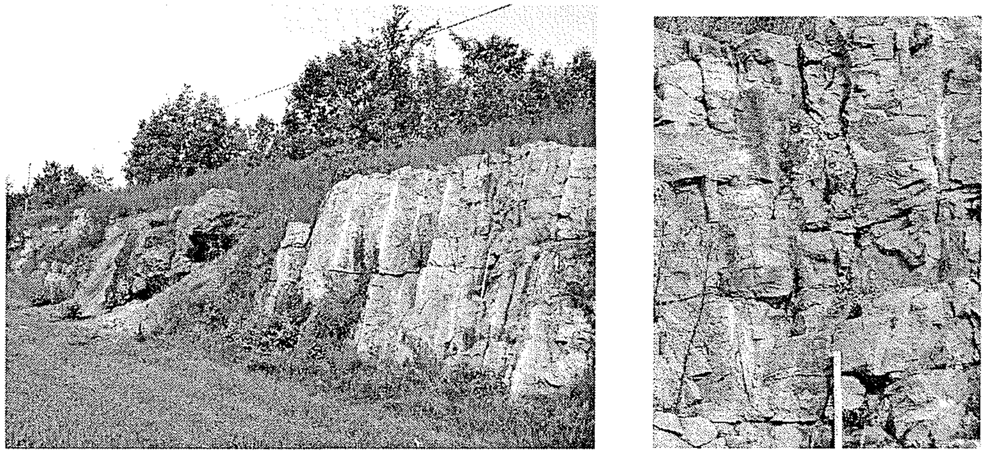

Figure 7: Left. General view of the contact between Grenville marble on the right and rusty weathered sandstones to the left. Notice position of meter rule and breccia solution pocket infill above it – right-hand photograph.

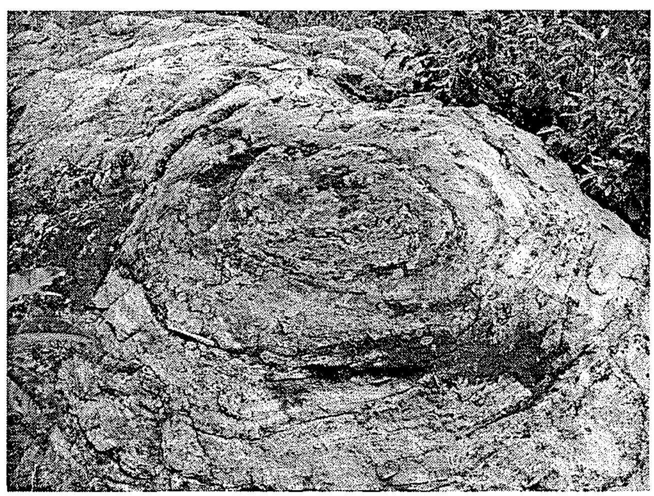

Figure 8: Cylindrical structure in well-bedded sandstone. (Lowermost Potsdam?)

Also of interest is well-layered marble at the north end of this long outcrop showing excellent recumbent folds and calcite fiber slickenlines.

Continue northeast on Route 11, driving through Dekalb Junction at approximately 59 miles.

62.5	7.1	Small outcrop on left.

STOP 9. THE DEKALB ANTIFORM (if time and interest permits)

The Dekalb antiform occurs in garnetiferous gneiss. Layering changes from a relatively shallow dip at the northern section of the outcrop to steep to vertical at the southern end. The change in dip and "S" and "Z" parasitic folds suggest an antiformal structure with a few complications including a fault near the large granitic vein toward the northern end of the outcrop and a change of parasitic fold plunge direction. A lab exercise for structural geology students includes sketching the change in orientation of layering, measuring strike and dip of layering across the outcrop, measuring the trend and plunge of the parasitic fold axes and then interpreting the structure taking into account the afore-mentioned "complications". Return to vehicles and continue northeast on Route 11.

63.3	0.8	Large roadcut in marble on both sides of road.

STOP 10. THE 'SNAKE' (if time and interest permits)

This classic outcrop is well described by Van Diver in *Rocks and Routes of the North Country*. It is appropriate for introductory and advanced students. A thin band of feldspar-rich rock, thought to be a metamorphosed volcanic ash layer, snakes across the outcrop displaying at least two phases of folding on the outcrop face on the east side of the road. Interference patterns on the top of the east side outcrop and at the far northern edge of the west side outcrop show two and possibly three phases of folding.
Continue on Route 11 towards Canton.

67.8	4.5	Junction with Route 68. Turn right.
67.4	0.3	Canton Village Park.

END OF TRIP

REFERENCES CITED

Bursnall, J. and Elberty, W., 1993, The Potsdam-Grenville contact revisited (I). *In* New York State Geological Association 65th Annual Meeting Guidebook (John Bursnall, *Ed.*), pp. 53-65.

Barber, B.G., and Bursnall, J.T., 1978, Deformation structures in Lower Paleozoic rocks, Northwestern New York. *In* New York State Geological Association 50th Annual Meeting Guidebook (Daniel Merriam, *Ed*), pp. 48-57.

Carl, J.D., and Van Diver, B.B., 1971, Some aspects of Grenville geology and the Precambrian/Paleozoic unconformity, Northwest Adirondacks, New York. *In* Geologic Studies of the Adirondack Region, New York, Field Trip Guidebook (Bradford B. Van Diver, *Ed.*), New York Geological Association, 43rd. Annual Meeting, p.A-0 – A-39.

Elberty, W.T. and Romey, W.D., 1990, Enigmatic Pre-Potsdam Enclaves in the Adirondack Lowlands. Northeastern Geology, **12** (1/2). Pp 1-6.

Karboski, F.A., 1977, The geology of the Dekalb area, St.Lawrence County, New York, with special emphasis on the tectonic aspects of some enigmatic quartzarenite masses. Unpublished B.S. thesis, St.Lawrence University, 132p.

Karboski, F.A., Elberty, W.T., Romey, W.D., and Doyle, J.A., 1983, Sandstone and conglomerate enclaves in Grenville rocks, St. Lawrence County, N.Y; Evidence for basement remobilization. Geological Society of America Annual Meeting, Abstracts with Program, **15**, p.607.

Van Diver, B.B., 1976, *Rocks and Routes of the North Country, New York.* Humphrey Press, Geneva, New York, 204p.