TRIP A2

THE POTSDAM-GRENVILLE CONTACT REVISITED (I)

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INTRODUCTION

The purpose of this field trip is to examine the relationships at the boundary between Proterozoic Grenville gneiesses within the Adirondack Lowlands and overlying arenaceous rocks, presumed to belong to the Potsdam Sandstone of Upper Cambrian (?) age. It is the first of two that will explore the diverse mineralogy, lithology and structure of a number of arenaceous outcrops in the Canton-DeKalb-Gouverneur area and will provide an overview of the compositional and structural characteristics of some of these problematic rocks.

(Please note that trips A2 and B2 can be taken together, as a single long day sequence, or independently. This fieldguide includes a repeat in Trip B2 of Trip A2 stops 7 and 8 to conveniently provide a shorter day's review.)

The Potsdam-Grenville contact in the St. Lawrence valley represents a hiatus of some 500 Ma. Mineral assemblages within the Grenville gneisses indicate that perhaps 25 km of material was eroded prior to the deposition of the transgressive Cambro-Ordovician sequence, over an undulating Precambrian erosion surface. Many of the isolated, predominantly sandstone, bodies within the Grenville gneiss terrane of the Adirondack Lowlands can be confidently interpreted as outliers of Potsdam Sandstone. The focus of this field trip, however, is to question the affinity of those whose relationship to the Cambro-Ordovician sequence is equivocal. Such enclaves vary in composition from matrix supported breccias to equigranular orthoquartzites and their depositional environment has been variously interpreted as: pre-Potsdam solution pocket infills (related to a karst topography on a Grenville marble surface); fault related debris slides; fault breccias; and fault scarp talus accumulations. Some are seemingly crudely interlayered with the gneisses and are locally foliated. Rare sandstone/breccia dykes within the gneisses may be of significance in understanding the origin of these enigmatic, apparently sedimentary, clastic rocks.

This fieldtrip commences at exposures close to the St. Lawrence Seaway between Ogdensburg and Alexandria Bay - including the text book exposures of the Potsdam - Grenville unconformity east of Alexandria Bay (Fig. 1). This will take from 25 to 40 mins., depending on traffic conditions. We then head south towards the village of Theresa and staert our investigation of the arenaceous enclaves within the gneiss terrane. In the process we will visit some of the classic outcrops of the St. Lawrence Valley and Adirondack Lowlands where arenaceous rocks in contact with demonstrable Precambrian are of uncertain age and origin. Some of these rocks are seemingly deformed along with late Grenville deformation (that is, exhibiting a qualitative strain level not seen in the Potsdam Sandstone; Trip B2) whereas others exhibit intrusive relationships to the gneisses (Trips A2 and B2), or lie structurally beneath them (Trips A2 and B2). The origin of these enigmatic relationships have variously been proposed as:

1) outliers of Potsdam Sandstone;

2) pre-Potsdam, post-Grenville in age;

3) Grenville in age, in that they have enjoyed at least the later stages of Grenvillian deformation.

It is likely that all of these relationships are represented on this fieldtrip - but the question we ask, since most relationships are at least superficially ambiguous, is - "how can we discriminate between them". We hope for fruitful discussion on outcrop that will lead towards a better understanding of the status of these "enclaves". Some of these outcrops have long been recognized as contentious and constitute a longstanding problem. It would be nice to move closer to solving it!

ROAD LOG

Cumulative mileage	Miles from last point	Route description
Start		Junction of Route 11 and Park Street in the center of Canton. Head southwest, cross the Grasse River, and continue straight (onto Route 68 towards Ogdensburg)
16.9	16.9	Junction of Route 68 and Route 37. Turn left (southwest) onto Route 37 and proceed towards Morristown, passing St.
23.6	6.7	Lawrence State Park on the right.

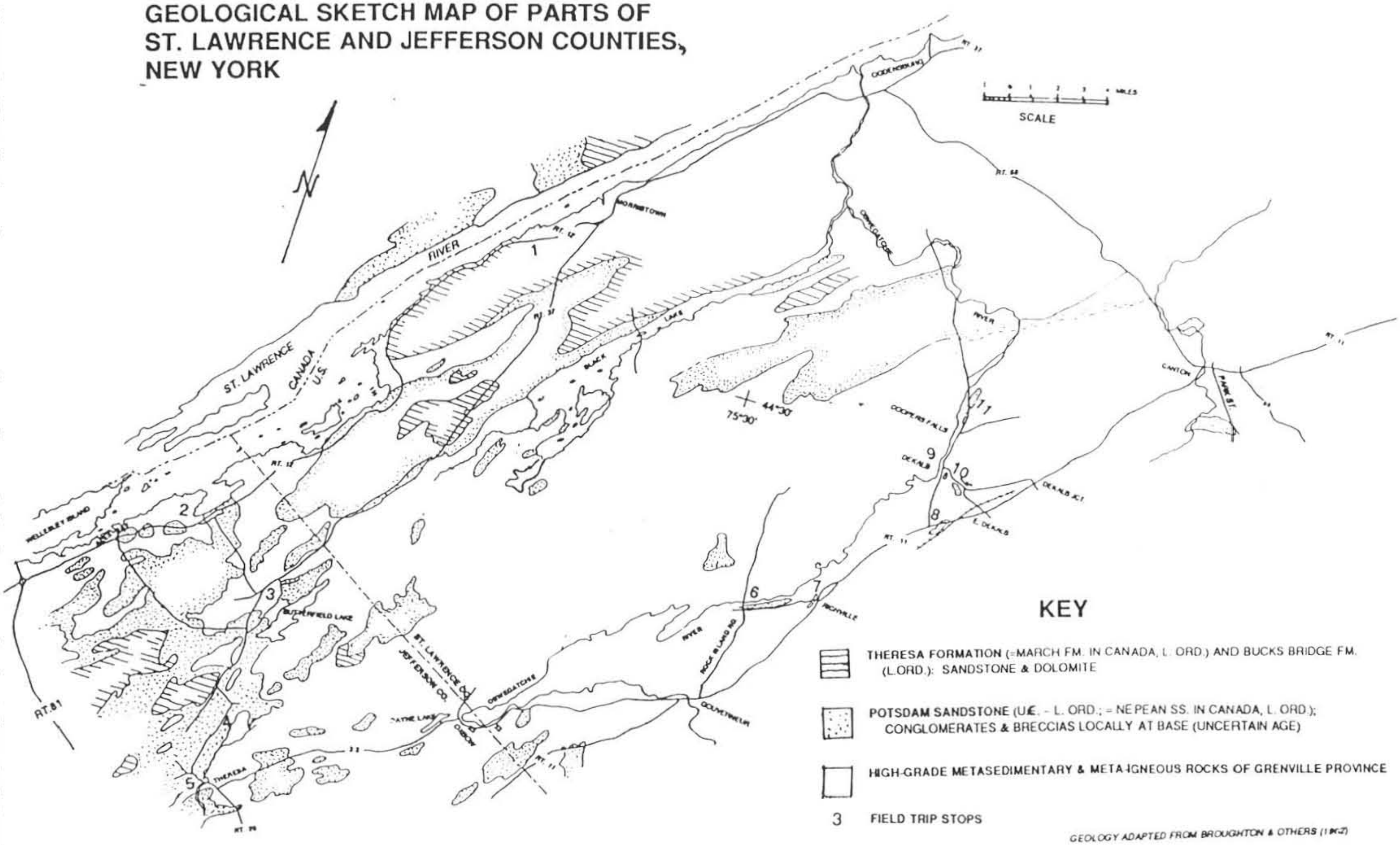

Figure 1: Distribution of arenaceous rocks on Precambrian basement in the Adirondack Lowlands. Location map for stops mentioned in the text.

28.8	5.2	Proceed westwards, bearing right onto Route 12
30.6	1.8	Pass entrance road to Jacques Cartier State Park on right
31.9	1.3	Stop 1. Outcrops of Theresa Formation (see Trip B2, Stop 2, this volume)

STOP 1: Deformation in middle Theresa Formation

Gentle northeasterly-trending folds of Potsdam Sandstone and Theresa Formation are relatively common to the south and west of Theresa (Barber 1977). The examples in this road section are similar in geometry to those observed in that area. They are significant to this field trip in that they clearly demonstrate significant post Potsdam regional deformation. Folds in the Potsdam Sandstone north of Theresa will be seen (Stop 4, Figure 2, this trip) are considered likely to be the same age. A minor fault will be seen in the central part of this section.

Continue on Route 12 passing through some magnificent roadcuts of Theresa Formation and Potsdam sandstone that are featured in Trips A3 (Erickson) and B2 (Selleck). Continue past the village of Chippewa Bay, across marshy ground on the southern shore of the St. Lawrence.

50.2	18.3	Very large outcrops on both sides of road with an obvious contact at their eastern end.
50.4	0.2	Continue to a turnaround (side road on right) and proceed eastwards back to through the roadcut to its eastern end and
50.7	0.3	park. This is Stop 2.

PLEASE WATCH FOR FAST MOVING TRAFFIC

STOP 2: The Postdam Grenville unconformity at Alexandria Bay.

This classic example of an unconformity shows typical, regularly layered, lowermost Potsdam Sandstone lying on deformed Grenville gneisses. Some slip has occurred along the contact resulting in small-scale buckling of a subvertical foliation within the gneisses on the north side of the road.

The nature of the unconformable relationship and the character of the Potsdam Sandstone immediately above the contact at this stop will provide a basis for discussion at subsequent outcrops and is typical of the basal Potsdam in this area, although no trace fossils have been observed (Selleck, this volume). Note the rare conglomeratic horizons and the well-defined bedding.

Continue northwest on Route 12:

51.4	0.7	Pass Log Hill Road on the right.
51.7	0.3	Turn right onto Jefferson County Route 1, up a sharp rise onto the plateau underlain by the flat-lying Paleozoic sequence which is characteristic of this section of the St. Lawrence Valley.
52.3	0.6	Turn right (southeast) onto Limestone Road and continue through the junction at Skinners Corners
55.65	3.35	Turn left at T-junction
55.85	0.2	Junction with State Route 37. Turn left (northeast) and proceed towards Hammond. Note exposures of gneisses in fields to the right. The wooded higher ground ahead on both sides of Route 37 are underlain by sandstones. An excellent example of the unconformity at their base occurs in a roadside outcrop approximately two miles further north.
56.9	1.05	Turn right onto Stein Road. Drive across a bridge, noting gneisses to the north, and head up the escarpment ahead to the junction with Spies Road on the left. Park, and walk back down the hill for approximately 50 yards.
57.2	0.3	Stop 3. Cylindical structure in lowermost "Potsdam"

STOP 3:. Soft-sediment deformation close to the Precambrian erosion surface.

Unusual columnar structures within the sandstones of this region have been described from a number of localities (Van Diver, 1976; Dietrich, 1953). They measure from a few inches in diameter to 10 feet or more. Characteristically they possess a cylindical or cone-like structure with a narrow structureless border zone that cross-cuts the bedding in the surrounding rocks. Concentric sub-vertical layering paralleling the margin may occur and, in the larger examples, the interior may be brecciated. This internal breccia may be comprised of laminated sandstone fragments set in a homogeneous sandstone matrix. This particular example, which must occur close to the Precambrian surface beneath well demonstrates these relationships. Abrupt truncation of bedding within the surrounding sandstone will be seen at the eastern margin of the structure and a brecciated central zone may be observed; individual clasts are typically poorly defined The origin of this and similar structures is not fully understood, but is thought most likely related to localized collapse of semi-consolidated sediment - that is the downward movement of a column of sand. A possible cause is settling or collapse of cavities in the underlying rocks - an hypothesis resulting from the observation that the location of these features is within sandstones seemingly overlying marbles within the underlying Proterozoic sequence. Subsequent stops will support this notion. The homogeneous sandstone matrix surrounding breccia fragments suggests a lack of grain coherence (and resulting aggregate fluidity) that may have been initiated by high pore fluid pressures. The details and mechanics of such an environment will be discussed at this and subsequent outcrops. Similar structures are common elsewhere within the Potsdam Sandstone of this region and in equivalent rocks of the Ottawa basin to the north (Grabs personal communication 1979).

Turn around and head back to Route 37:

57.5	0.3	Junction with Stein and Route 37. Turn left (south) and continue through Redwood on Route 37
61.25	3.75	Pass sign for Crystal Lake on left
62.25	1.0	Turn left onto Joyner Road (at sign for Thousand Islands Zoo)
63.2	0.95	Turn right onto County Route 21 and follow this, down a moderate hill onto a flat open area
64.15	0.95	Stop 4. Park as far on the limited shoulder as possible. Outcrop of deformed "Potsdam Sandstone" on the east side of the road across a disused railroad line.

STOP 4: Folds within the "Potsdam Sandstone" (Figure 2)

PLEASE NOTE THE POISON IVY AT THIS STOP

Further evidence of gentle large-scale folding within arenaceous rocks of presumed Potsdam age is exhibited here (Figure 2). These exposures of sandstone are typical for the area. Bedding is pronounced, with the rock taking on a 'flaggy' appearance locally. Hematite staining may accent layering, including cross-bedding, but also is apparently not controlled be internal structure inplaces cross-cutting the sedimentary structures. Such 'liesegang banding' is quite common throughout the Potsdam Sandstone in this region. Evidence for soft sediment deformation is present and a small monocline behind a pine tree in the center of the face could be a product of differential settling.

Barber and Bursnall (1978) described the folding in this outcrop as follows: "Bedding is folded in a manner typical of the lower part of the Potsdam Formation. Hinge -lines are tenuous and variable in orientation, and individual beds thicken and thin greatly through short distances. The most obvious fold at this locality is one of a series of irregular gentle undulations of bedrock, between which are small areas underlain by Grenville rocks or horizontal Potsdam strata. The hinge line of the fold trends approximately N40^{0}E. Other folds in the area exhibit a similar trend ....". They suggested that the spatial relationship of many of these folds and internal soft sediment disruption of bedding to topographic highs of the Precambrian basement (in this case caused by a possible west-side down northeast-trending fault 2 miles to the southeast near Theresa village) might have produced "rapid downslope movement during and closely following sedimentation" (Barber and Bursnall, op cit.).

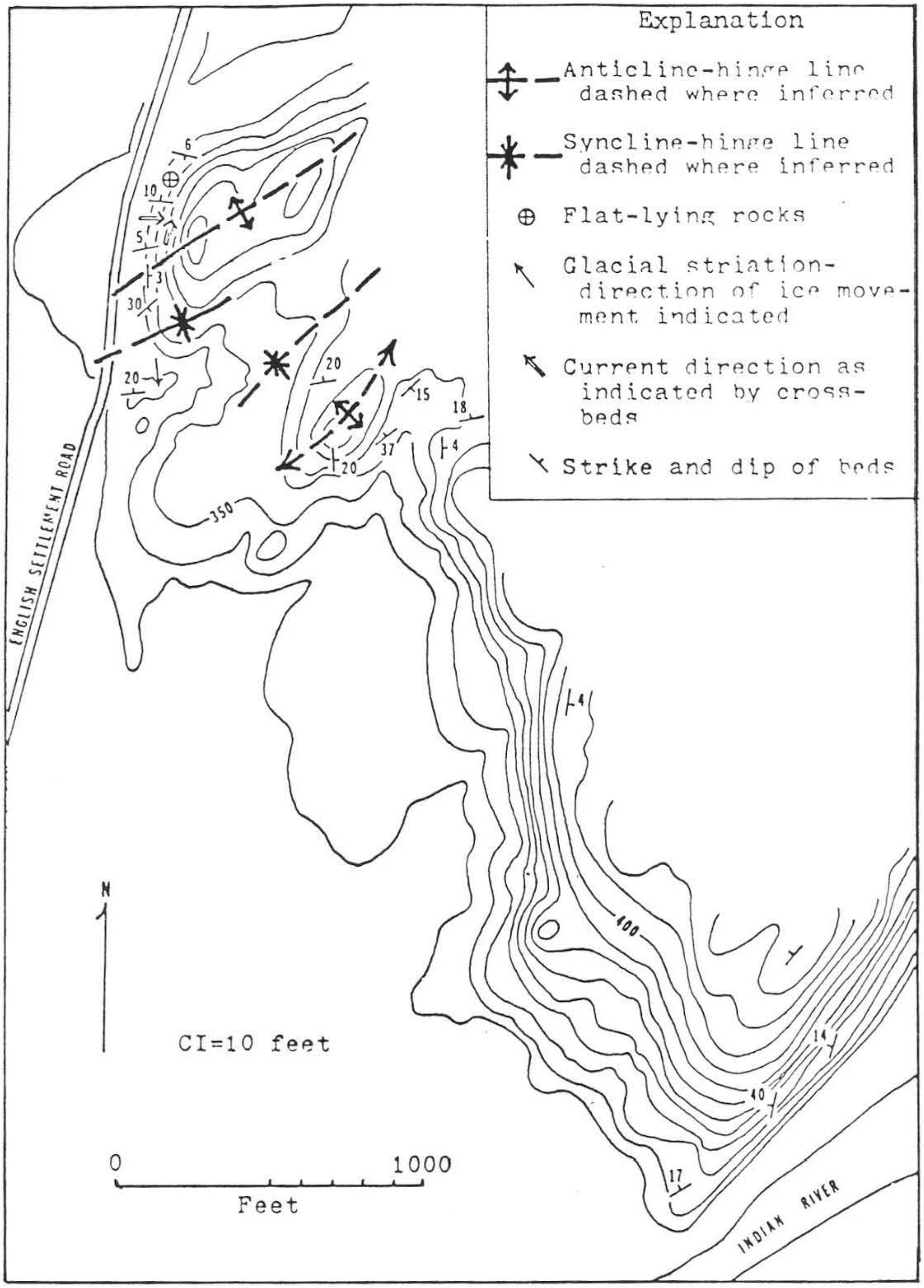

Figure 2: Fold trends within Potsdam Sandstone northwest of Theresa (from Barber and Bursnall 1977).

Continue south on Route 21:

66.25	2.1	T-junction. Turn left.
66.45	0.2	Intersection with State Route 26. Turn left and drive up the hill (fault scarp referred to above) into the center of Theresa.
67.0	0.55	Turn left at top of hill onto State Route 26 and proceed eastwards on Route 26 through the village.
67.2	0.2	Pass the reservoir for the Theresa village hydro plant and a large, overhanging outcrop on the right (unfortunately due for demolition).
		This is Stop 5, but parking is restricted so continue across a bridge, find a convenient parking space and walk back to the outcrop.

STOP 5: Contact between Grenville gneisses and non-typical "Potsdam" sandstones.

This area exhibits considerable relief of the Proterozoic surface (consider the elevation change between this locality and Stop 4) and the local configuration of the unconformity reflects this. The contact between sandstone and weathered basement gneiss dips moderately to the east from a high point at the western end of the outcrop. Significant discordance in bedding attitude exists between the low dip of well-bedded and color banded "typical Potsdam" at the highest parts of the outcrop to moderate easterly dips at road level. A bluff overhanging the road exhibits well-bedded sandstone overlying a heterogeneous breccia of quartz-arenite at the base. The larger clasts are of quartz and sandstone and towards the base, within a few feet of the unconformity, thin pebbly horizons are present. The weathered surface suggests the possibility of large sandstone blocks or rafts encased in an otherwise structureless mass and healed microfaults are present towards the top of this lower section.

These features suggest a period of instability and possible slumping prior to the deposition of the well-bedded sandstones in the upper part of the exposure. Barber (1977) suggested that penecontemporaneous faulting might be the cause for the lower disrupted material and, although the gneiss-sandstone relationship here might be explained by initial dip of the Precambrian erosion surface, the existence of non-typical basal Potsdam Sandstone at this stop raises the possibility of a pre-Potsdam but post-Grenville depositional period accompanying fault-related deformation. This interpretation requires the existence of a cryptic depositional break within the outcrop and that the presumed slumping is not intraformational with respect to the present exposed section.

Return to vehicle and continue east on Route 26:

67.65	0.45	(measured from Stop 5) Turn left (northeast) onto Jefferson County 194.

67.9	0.25	Continue straight, onto Route 22 towards Oxbow.
76.8	8.9	Follow this to the junction with County Route 25, passing Payne Lake on the left at approximately 7.5 miles. The complexly deformed Payne Lake alaskite body underlies the topographic high to the north (see Tewksbury, Trip A5, this volume).
		Turn right and drive through the village of Oxbow.Continue on Route 25, which continues as Route 52 in St. Lawrence County, passing through Wegatchie and closely following the path of the Oswegatchie River. Note that the flow is to the southwest here - at a position upstream of a major change in direction at Oxbow, from where the river heads northeastwards to the St. Lawrence at Ogdensburg.
		Continue on Route 52 to the junction with Route 11 (traffic lights) in Gouverneur. Turn left, cross the Oswegatchie River and continue on Route 11, pass the "mint-with-the-hole" statue and the village park on your right.
77.4	0.6	Turn left onto Rock Island Road
81.1	3.7	Turn right onto Welch Road and park. Stop 6.

STOP 6: "The Rock Island Roadcut". Complex relationships of sandstone to gneiss.

This outcrop is perhaps one of the most intriguing in the North Country. It is featured in Van Diver's Rocks and Routes of the North Country and is a common stopping point for field parties visiting the area. Our main interest here is to characterize the relationship of the presumed Potsdam Sandstone to the Grenvillian gneisses which at the upper part of the roadcut are calcitic marbles. This deep roadcut provides magnificent exposure and is one of thebetter outcrops in illustrating the variety of marble - sandstone relationships present in the region.

At the southeast end of the cut, a well-bedded quartzarenite illustrates the attractiveness of the Potsdam sandstone erosional remnant interpretation. However, the very complex relationships of the sandstones with the "underlying" marbles invite alternative explanations to a simple erosional unconformity relationship. 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 (Van Diver, 1976). Some of the contact relationships in this section have ben used as evidence for structural control of deposition and basement remobilization (Bannerman *in* Carl and Van Diver, 1971).

Contact zones need to be carefully examined. Iron oxides and iron pyrites 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

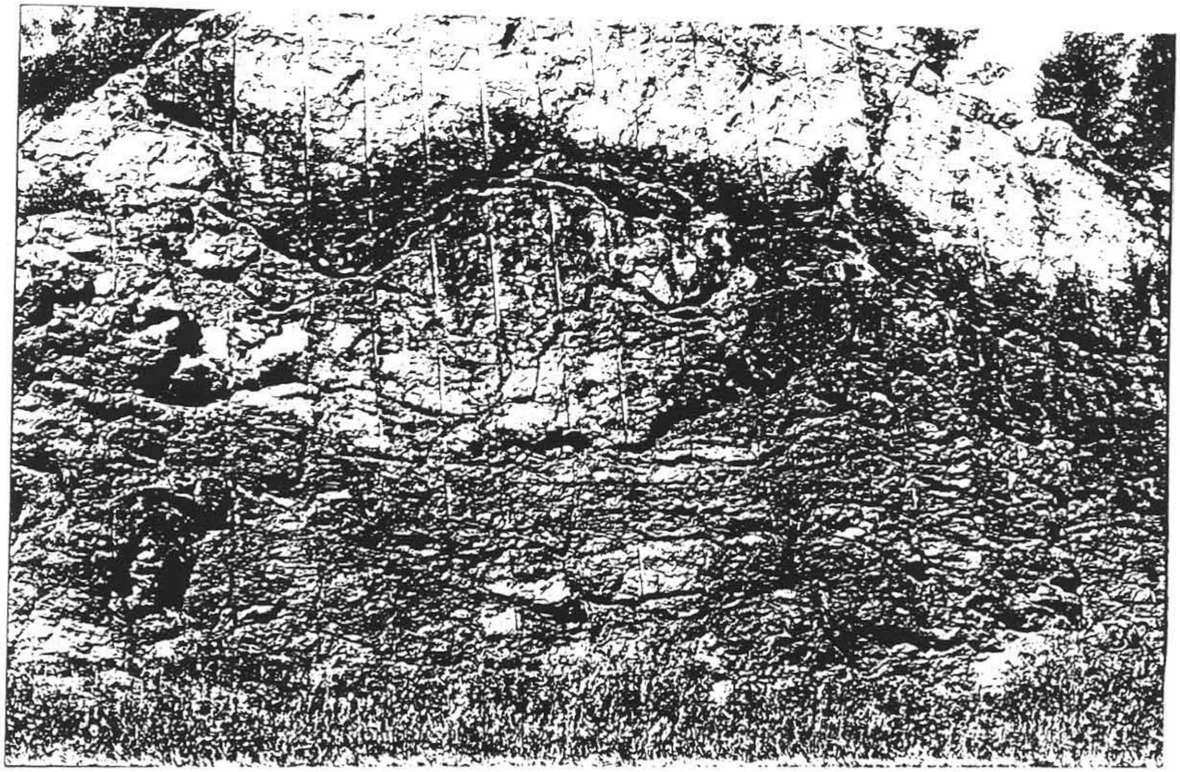

Figure 3: View of the western roadcut at Stop 7. Note quartzarenite and metaquartzite at top of outcrop and the overall structural grain. Breccia lenses are just discernible at bottom of outcrop.

conglomerates (upper west side of northern section), etc., are easily overlooked. A spectacular tourmaline-rich breccia in the latter area further suggest a protracted and complex history for this section. Evidence of significant post-arenite deformation is present at many localities.

Return to vehicle and continue east along Welch Road towards Richville.

84.0	2.9	Junction with Route 11. Turn left and park on the shoulder. Stop 6 includes the outcrops on both sides of the road

BEWARE OF FAST MOVING TRAFFIC !

STOP 7: The Richville breccias.

Please note that description of this stop is repeated in Trip B2

Cross the road and visit the moderately high exposures on the northwest side first.

Karboski et al. (1983) described this outcrop this as containing a "flow breccia" at its base, followed 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 metaquartzite. The breccias contain quartz clasts set in a hematite stained, medium grained arenite. Large (0.5 m) phacoidal blocks of the breccia are enveloped by thin shaly borders, the whole giving the impression of a shear zone.

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

Points to concentrate on are:

1) Possible shear fabrics in the lower part of the outcrop, in part defining the borders of coherent blocks of breccia
2) Compositional variation of clasts in the breccias
3) The relationship between and the textural character of the each of the recognized rock types

If the upper part of this outcrop is indeed comprised of rocks which are part 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 (Van Diver, 1976) as seems possible at Rock Island Road. It is possible, however, that the wall collapse of a large solution depression may have allowed a slab of basement to slide into the argillite 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.

Cross over to the vehicle 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?

[Note: if time permits an outcrop of marble on the nortwest side of Route 11, a few hundred yards to the south should be visited. It contains narrow subvertical veinlets of arenite at the northeast end, which provide good evidence for solution cavity infill]

Return to vehicles and continue northeastwards on Route 11.

88.9	4.9	Junction with Route 812.
89.5	0.6	Stop 8. Outcrops on both sides of road.

STOP 8: Southwest of East Dekalb.

Please note that description of this stop is repeated in Trip B2

Roadcuts due south of Dekalb further illustrate the complexities within these post-Grnville rocks. A long series of low exposures on the northwest side of the road contain well-layered marble (reclined folds at the north end) to the north which in the central section give way to a complex steep contact with rusty weathered arenaceous rocks. A number of small sandstone breccia wedges penetrate downwards into the marble in the vicinity, again supporting the solution-pocket infill model for the larger scale relationships seen elsewhere (*e.g.* Rock Island Road). Evidence for sulfide mineralization is present at some contacts, in common with the Rock Island Road locality (Elberty and Romey, 1990).

Bedding in the sandstone is irregular and breccia/conglomerates are common, particularly lower in the section a hundred yards to the south and at the base of the southernmost outcrop on the northwest side of the road. A poorly defined cylindrical structure exists in the latter section and may be seen on the top of a low outcrop of compect, rusty weathered, quartz-arenite (compare with Stop 3).

Similar conglomerate and breccia occur in a large outcrop on the southeast side of Route 11. Quartz, quartz-arenite, and metaquartzite are common clast compositions and are similar to those at Stop B3 (Stop 9 in Fig. 1). In both the western and southeastern outcrops shaly zones could have been generated by shear and at the northern end of the latter bedding dips are steep (> 60°; Karboski, 1977), yet again supporting the notion of significant post-depositional deformation .

Continue northeast on Route 11

93.15	3.65	Dekalb center
101.0	7.85	Junction with Route 68. Turn right.
101.3	0.3	Canton Town Park

END OF TRIP

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TRIP A3

CAMBRO-ORDOVICIAN STRATIGRAPHY, SEDIMENTATION, AND ICHNOBIOLOGY OF THE ST. LAWRENCE LOWLANDS - FRONTENAC ARCH TO THE CHAMPLAIN VALLEY OF NEW YORK

Note: The following four articles constitute Trip A3. The first of these is the roadlog whilst the subsequent three provide essential supporting information.