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New insights on the Cambrian carbonate platform, Percé area, Gaspésie, Quebec[1]

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[1] Contribution to the Appalachian Foreland and St. Lawrence Platform NATMAP Project

Abstract

The Percé area offers the unique occurrence of Middle Cambrian shallow-marine carbonate rocks in the Quebec Re-entrant. The Corner-of-the-Beach Formation of latest Middle Cambrian age consists of oolitic grainstone with subordinate lime mudstone and microbial thrombolite and is interpreted to record shallow-marine, carbonate platform margin facies. The overlying Murphy Creek Formation of early Late Cambrian (Dresbachian) age consists of a rhythmic succession of siliciclastic mudstone with minor sandstone, limestone, dolostone and two intervals of limestone conglomerate. The Murphy Creek Formation is interpreted as a below-wave-base slope deposit. The Corner-of-the-Beach Formation is time and facies correlative with the lower part of the Port au Port Group in western Newfoundland whereas the Murphy Creek Formation is time correlative with the lowermost unit of the Cow Head Group and with the Cooks Brook Formation although, with respect to facies, correlation is more straightforward with the Cooks Brook Formation.

Résumé

La région de Percé est le seul endroit où des roches carbonatées épicontinentales du Cambrien moyen se rencontrent dans le rentrant du Québec. La Formation de Corner-of-the-Beach (toute fin du Cambrien moyen) se compose de grainstone oolitique avec des quantités moindres de calcaire micritique et de thrombolite d'origine microbienne; elle représenterait des faciès de la marge d'une plate-forme carbonatée épicontinentale. La formation sus-jacente de Murphy Creek du début du Cambrien tardif (Dresbachien) est une succession rythmique de mudstone silicoclastique et de quantités mineures de grès, de calcaire, de dolomie et de deux intervalles de conglomérat calcaire. Elle représente un dépôt de talus sous le niveau de base des vagues. La Formation de Corner-of-the-Beach peut être mise en corrélation temporelle et faciologique avec la partie inférieure du Groupe de Port au Port de l'ouest de Terre-Neuve. La Formation de Murphy Creek peut être mise en corrélation temporelle avec la Formation de Cooks Brook et avec l'unité inférieure du Groupe de Cow Head; toutefois, pour ce qui est des faciès, la corrélation est plus directe avec la Formation de Cooks Brook.

INTRODUCTION

In 1999, a Geological Survey of Canada NATMAP project was initiated in Eastern Canada, with the collaboration of the New Brunswick Geological Survey Branch, the Geological Survey of Newfoundland and Labrador, the ministère des Ressources naturelles du Québec, Canadian universities, and industry. The Appalachian Foreland and Platform project aims to reconstruct the architecture and evolution of the ancient Paleozoic continental margin of Laurentia through new mapping and thematic studies on the Paleozoic platform, the accreted Taconian continental slope succession, and the various successor basins (**Fig. 1**). One of the major scientific objectives of the project is to reconstruct the evolution of the Lower Paleozoic platform and to integrate the information into a scenario that should prove useful to the resource industry.

REGIONAL TECTONOSTRATIGRAPHIC SETTING

In Cambrian, the eastern seaboard of Laurentia experienced major tectonic events that led to the formation of Iapetus. The Late Proterozoic rifting episode was followed by the establishment of a passive margin that rimmed the newly formed continent (**Table 1**). Early Cambrian sedimentation on the Grenvillian basement consisted of rift-related fluvial to marine clastics with interbedded volcanic rocks and shallow-marine limestone (James et al., 1989), this lower sequence is well known at the St. Lawrence promontory in western Newfoundland. The following Middle–Late Cambrian interval recorded an extensive shallow-marine carbonate platform (**Fig. 2**) known as the Port au Port Group (James et al., 1989). This carbonate platform is characterized by cyclic high-energy facies (Chow and James, 1987), with metre-scale shallowing-upward hemicycles arranged in lower order cycles correlated with the Cambrian Grand Cycles (Aitken, 1978). The Middle–Late Cambrian shallow-marine carbonate platform passes to deeper marine units of interbedded hemipelagic sedimentary rocks and coarse-grained carbonate rocks known as the (proximal) Cow Head (James and Stevens, 1986) and (distal) Northern Head (Botsford, 1988) groups. In latest Cambrian–Early Ordovician, the St. George Group in western Newfoundland was characterized by low-energy facies with metre-scale hemicycles (Pratt and James, 1986) part of low-order cycles. The St. George Group laterally passes to slope facies of the Cow Head Group.

CAMBRIAN PASSIVE MARGIN IN QUEBEC

The Lower Paleozoic marine platform that rimmed Laurentia is exposed in Quebec (Table 1). The central St. Lawrence platform (Globensky, 1987; Sandford, 1993) is a triangular element that stretches from the Quebec–Ontario border to the Québec area (Fig. 1, **3**) with small fault-controlled basins along the north shore of the St. Lawrence River (Lemieux et al., 2000) and outliers on the Grenvillian

craton (Lavoie and Asselin, 1998). The platform widens significantly in the Gulf of St. Lawrence forming the Anticosti Basin (Sandford, 1993) adjacent to the eastern St. Lawrence platform at the St. Lawrence promontory (**Fig. 1**).

The oldest known platform sediments outcropping in the Quebec Re-entrant are present in southern Quebec where outcrops of fluvial to marginal marine siliciclastic rocks of the Potsdam Group are unconformably overlying the Grenvillian basement (Globensky, 1987; Salad Hersi and Lavoie, 2000a; **Table 1**). The poorly dated Potsdam Group is interpreted to straddle the Cambrian–Ordovician boundary and is referred to as a Late Cambrian unit. Logging of new wells near Montréal and re-examination of old wells resulted in the documentation of thin intervals of bioclastic impure limestone within the siliciclastic succession (Salad Hersi and Lavoie, 2000b); these represent the oldest (Late Cambrian) known occurrence of carbonate rocks on the St. Lawrence platform (Lavoie and Salad Hersi, 2000).

Continental slope sediments preserved in tectonic slices in the Humber Zone (Fig. 1), record a complete succession of the passive margin from the initial break-up of Laurentia in Late Precambrian to the initiation of subduction and closure of Iapetus in earliest Middle Ordovician (Table 1). The slope succession shares some similarities (fine-grained hemipelagic-dominated succession with local, huge carbonate debris flows) with its coeval Newfoundland counterpart (Lavoie and Salad Hersi, 2000) although, some distinctions warrant further research. Of significance is the presence of Early–Late Cambrian carbonate facies in clasts of debris flows punctuating the succession (Lavoie, 1997, 1998; Lavoie and Salad Hersi, 2000), testifying for a carbonate platform of that age in the Quebec Re-entrant. Slices of platform carbonate of likely Late Cambrian age occur in the Humber Zone of southern Quebec (Salad Hersi and Lavoie, 2001; Séjourne and Malo, 2001). In the Quebec Re-entrant, outcrops of Middle Cambrian platform are present at one locality, the Percé area at the eastern tip of Gaspésie (**Fig. 4**).

GEOLOGY OF THE PERCÉ AREA

The Percé area (**Fig. 4**) offers a complex geological framework with rocks ranging from Middle Cambrian to the Carboniferous, in an intensely tectonized area (Kirkwood, 1989) with possibly three major unconformities (Taconic, Salinic, and Acadian). Two of the major dextral strike-slip faults that shaped up Gaspésie merge in the Percé area (the Grande Rivière and Troisième Lac faults) resulting in complex tectonostratigraphic relationships. The Cambrian succession consists of the limestone of the Corner-of-the-Beach Formation and the overlying, mixed limestone-siliciclastic rocks of the Murphy Creek Formation.

Corner-of-the-Beach Formation

This term was given by Kindle (1942) to a succession of limestone beds only found at one locality, northwest of the town of Percé (Fig. 4). Fritz et al. (1970) described this unit as being composed of 168 feet (50.4 m) of interbedded fine-grained and crystalline limestone with oolite-rich intervals. In this succession, Fritz et al. (1970) described a trilobite fauna of the *Bolaspidella* Zone, characteristic of the end of Middle Cambrian.

This lithofacies is best developed in the lower part of the section. It consists of 1–6 cm thick beds of unfossiliferous, pale grey mudstone calcilutite with millimetre-thick shale partings (**Fig. 6A**). This lithofacies is interbedded with beds of the oolitic grainstone (*see* below) and progressively gives way to an interval dominated by the latter.

Thrombolite and associated channel-fill facies

This lithofacies was not recognized by previous workers although, it represents only a minor part of the formation (Fig. 5). The lithofacies consists of a metre-thick massive bed of clotted and self-encrusting millimetre-sized peloid clumps forming a thrombolite (**Fig. 6C**). Dark clots of possible *Renalcis*--*Epiphyton* microbes form a growth framework coated by marine cements and/or infiltrated by lime mud and small fragments. Laterally, the thrombolite passes into a rudstone calcarenite composed of millimetre- to centimetre-sized thrombolite-derived clasts. This lithofacies occurs in a succession dominated by oolite-rich limestone and is only found at one stratigraphic interval (**Fig. 5**).

Paleoenvironmental interpretation of the Corner-of-the-Beach Formation

The Corner-of-the-Beach Formation is dominated by crosslaminated oolite-rich limestone beds which clearly suggest shallow, subtidal agitated marine conditions. This general environment is also supported by the presence of thrombolite and associated mechanically abraded, intermound rudstone facies. Therefore, the Corner-of-the-Beach Formation is interpreted to represent a subtidal succession likely deposited on a high-energy, shallow-marine platform.

Murphy Creek Formation

This term was given by Kindle (1942) to a succession of mudstone and sandstone together with fine-grained limestone and dolostone. Two distinct intervals of limestone conglomerate have also been stratigraphically recognized (Fig. 5). The Murphy Creek Formation outcrops over a wider area compared to the Corner-of-the-Beach Formation (**Fig. 4**). An early Late Cambrian (Dresbachian) age is

suggested by the presence of fauna belonging to the trilobite *Cedaria-Crepicephalus* Zone (Kindle, 1948). The contact with the underlying Corner-of-the-Beach Formation was not observed but was described as likely conformable by Fritz et al. (1970); its upper limit is unknown.

In the following section, the fine-grained lithofacies of the formation will be described according to their dominant characteristics, that is either siliciclastic- or carbonate-dominated. Limestone conglomerate beds are grouped under one lithofacies.

Siliciclastic facies

Mudstone and sandstone are arranged in rhythmic successions (**Fig. 7A**) although, the limited extent of outcrops preclude the recognition of granulometric and/or bedding trends.

The mudstone lithofacies dominates, representing roughly three-quarters of the total volume of the unit. The mudstone is either brown, greenish, or dark grey and occurs in decimetre-thick intervals; it commonly shows some fine parallel laminae of quartz-rich siltstone.

The sandstone lithofacies consists of fine- to medium-grained sublitharenite with a significant percentage of dark matrix. The sublitharenite is in 5–15 cm beds and consists of subrounded to subangular quartz and subrounded mudstone fragments. A significant amount of this sandstone is calcareous and, at places, the facies is close to a sandy calcarenite. The sandstone is frequently but not invariably characterized by rare granulometric normal grading followed by parallel laminations similar to ‘a’ and ‘b’ division of turbidite sequences. The sandstone forms roughly 10% of the total volume of the formation.

Fine-grained carbonate lithofacies

The fine-grained carbonate lithofacies consist of clayey lime mudstone, siliciclastic-free lime mudstone and dolomudstone. As a whole, these lithofacies form roughly 10% of the total formation volume and are associated with siliciclastics in rhythmic succession.

The unfossiliferous, clayey lime mudstone lithofacies consists of 2–8 cm thick beds of dark grey, parallel-laminated, clay-rich lime mudstone. Locally, this lithofacies can be silty and is at the limit of a limy mudstone.

The lime mudstone lithofacies consists of 1–6 cm thick beds of brownish lime mudstone. Siliciclastics and macrofossils are conspicuously absent in this lithofacies.

The dolomudstone lithofacies is made up of 2–10 cm thick beds of dark grey dolomitic mudstone. This rock type is locally parallel laminated and can be rich in clay and silt-sized quartz particles. Its dolomitic nature is the sole distinction from the clayey lime mudstone lithofacies.

Paleoenvironmental interpretation

The fine-grained siliciclastic and carbonate lithofacies form rhythmic successions dominated by siliciclastic mudstone. The facies are devoid of fairweather- or storm-induced wave sedimentary structures and slow suspension sedimentation is suggested by grain size. These represent below-storm-wave-base deposits in a setting affected by turbidity currents.

Limestone conglomerate

Even though this lithofacies is volumetrically minor, its paleogeographic significance is major at the regional scale. Two conglomerate intervals are recognized, although fine correlations between sections are difficult because of the lenticular nature of these conglomerate beds.

The limestone conglomerate lithofacies consists of lenticular beds ranging from 50 cm up to 5 m in thickness (**Fig. 7B**); these beds are embedded in the above described rhythmic successions. The conglomerate is commonly clast supported. The lithofacies is devoid of internal sedimentary structures and the conglomerate consists of a structureless chaotic accumulation. The lenticular nature of the conglomerate is well displayed at Cap Canon (Gulf of St. Lawrence shore at Percé; **Fig. 4**) where a 5 m thick conglomerate passes 100 m eastward, to a 1.5 m thick bed along the coastal cliff exposure, this conglomerate is capped by a 10 cm thick calcarenite.

The matrix of the conglomerate (average 20% of rock volume) consists of a sand-sized mixture of subangular carbonate particles, with subordinate quartz and mudstone fragments. The size of the fragments ranges from 2 mm up to 12 cm with an average of 8 cm. Most of these are roughly equant, and elongated clasts are few. Large clasts have well rounded margins, smaller size material is subrounded to subangular. The conglomerate is dominated by carbonate fragments with more than 95% of clasts being limestone and the remaining consisting of rare quartz, sandstone, and mudstone.

Four major lithofacies are recognized in the limestone fragments, these are, in decreasing order of abundance: thrombolite and microbial-derived limestone (40%), oolitic grainstone (35%), lime mudstone (15%), and bioclastic (trilobite, brachiopod, crinoid) wackestone to packstone (10%). Rare resedimented limestone conglomerate fragments are locally seen. The lime mudstone clasts consists of ribbon-like facies similar to fine-grained limestone beds found in the encasing succession. The other lithofacies are

not seen in the rhythmic succession and are exotic to the depositional setting. The dominant lithofacies is the thrombolite and associated microbial-derived limestone; these clasts are sometimes characterized by growth cavities filled by geopetal sediment and cement crusts.

Paleoenvironemental interpretation of the limestone conglomerate

The limestone conglomerate is embedded in a rhythmic succession and as such, was deposited under the same paleoenvironmental conditions characterized by the lack of fair-weather and storm waves.

These conglomerate units are the result of rapid debris-flow deposition, most likely on a slope, without subsequent remobilization. A significant amount of the fragments are exotic to the depositional setting and therefore, a shallow-marine upslope source has to be found.

A source for exotic limestone clasts

Exotic clasts are dominated by thrombolite and associated microbial-derived limestone as well as oolitic grainstone; the bioclastic limestone is less abundant. In Late Cambrian, shallow-marine carbonate platforms at the eastern seaboard of Laurentia were rimmed by a belt of high-energy facies such as thrombolite boundstone and oolitic sand shoals (James et al., 1989). Exotic clasts in the Murphy Creek Formation conglomerate were derived from these margin facies.

REGIONAL CORRELATION OF THE CORNER-OF-THE-BEACH AND MURPHY CREEK FORMATIONS

The Cambrian succession of the Percé area is unique in the Quebec Re-entrant: 1) the Corner-of-the-Beach Formation represents the only known Middle Cambrian shallow-marine carbonate in the Quebec segment of Laurentia continental margin and, 2) the transition from shallow-marine (Corner-of-the-Beach Formation) to slope (Murphy Creek Formation) Cambrian carbonate is also unique in the Quebec Re-entrant.

Corner-of-the-Beach Formation

On the basis of trilobite fauna, the Corner-of-the-Beach Formation is latest Middle Cambrian (*Bolaspidella* Zone). In the St. Lawrence platform, the oldest known sediments are the (?)Late Cambrian clastic rocks of the Potsdam Group (**Table 1**); moreover, on the nearby Anticosti platform, the Early Ordovician (Arenigian) Romaine Formation overlies the Grenvillian basement. At the St. Lawrence promontory, the latest Middle Cambrian occurs in the lower part of the Port au Port Group (James et al., 1989). The *Bolaspidella* Zone is found in the March Point Formation and the overlying Cape Ann Member of the Petit Jardin Formation (Chow and James, 1987; **Fig. 8**). These units mark the inception of the 'First Grand Cycle' in the Port au Port Group which follows a global lowstand event (the Hawke Bay "event" and Formation at the top of the Labrador Group; James et al. (1989)). The March Point Formation and Cape Ann Member consist of interbedded, cyclic shale and limestone (Chow and James, 1987; Cowan and James, 1993). Oolite shoal and thrombolite facies characterize the outboard segment of the carbonate shelf of both units and studies suggest that oolite coarsening-upward cycles with a muddy limestone base

and a thrombolite cap are typical of the outboard platform (Cowan and James, 1993); these are direct equivalent to the succession recognized in the Corner-of-the-Beach Formation. It is proposed to extend the latest Middle Cambrian outboard platform to the Percé area.

Murphy Creek Formation

The Murphy Creek Formation represents a below-wave-base, slope-dominated unit. The early Late Cambrian (Dresbachian) *Cedaria-Crepicephalus* Zone occurs in the succession.

Possibly coeval facies in the Humber Zone of the Quebec Re-entrant are the limestone conglomerate-rich units such as the Lauzon, Saint-Damase, Cap Enragé, and Grosses-Roches formations (Lavoie, 1997, 1998). These units are poorly dated and the age of their emplacement is loosely constrained by the youngest trilobite in limestone clasts in conglomerate (Rasetti, 1944, 1946, 1948). Palynomorphs data suggest that the Cambrian–Ordovician limit occurs in the overlying unit (upper member of the Grosses Roches Formation; E. Asselin, pers. comm., 1997).

The Upper Cambrian conglomerate units of the Humber Zone are lenticular units interbedded with fine- and coarse-grained siliciclastic rhythmic slope succession (Lavoie, 1997, 1998). The carbonate clasts in the conglomerate share similarities with those of the Murphy Creek Formation: thrombolite and microbial bioherm, oolitic grainstone, and bioclastic limestone dominate. It is significant that fragments range from the earliest Middle Cambrian (*Saltarella*-rich limestone) to the Late Cambrian. A significant number of fragments are derived from the basement (gneiss, volcanic, orthoquartzite). The conglomerate matrix has a high percentage of coarse-grained quartz clasts which are nearly absent in the Murphy

Creek Formation. The (?)Upper Cambrian conglomerate in the inner part of the Quebec Re-entrant records some distinctive tectonostratigraphic events compared with the Murphy Creek succession (research in progress).

More straightforward correlations can be proposed with the Cow Head Group in western Newfoundland (Fig. 8) where the *Cedaria-Crepicephalus* Zone occurs in the Downes Point Member of the Shallow Bay Formation at the base of the Cow Head Group (James and Stevens, 1986). The Shallow Bay Formation is a 300 m thick succession of limestone conglomerate, calcarenite, and shale (James and Stevens, 1986). At the base of this formation, the 100 m thick Downes Point Member ranges from late Middle Cambrian to early Late Cambrian. At its type section, the Downes Point Member is mostly conglomerate and significant finer grained lithofacies only occur towards the southeast, in a more distal paleogeographical setting. A correlation is also proposed with the Cooks Brook Formation (Botsford, 1988), the lowermost unit at the base of the Northern Head Group (Botsford, 1988; Waldron and Palmer, 2000). The Cooks Brook Formations is about 350 m thick and consists of interbedded ribbon limestone, calcarenite, shale, and subordinate limestone conglomerate; the age of this unit is assumed to be late Middle Cambrian to Early Ordovician (Botsford, 1988; Boyce et al., 1992). The Cooks Brook Formation is a distal, time-correlative unit of the Cow Head Group.

For both units (Downes Point Member and Cooks Brook Formation), exotic clasts in the limestone conglomerate are dominated by thrombolite and associated microbial facies, oolite grainstone, and bioclastic limestone. A time correlation is proposed between the Murphy Creek Formation and the Downes Point Member of the Shallow Bay Formation and the lower part of the Cooks Brook Formation, although paleoenvironmental conditions recorded in the Murphy Creek Formation are more similar to those of the distal Cooks Brook Formation.

Platform (Corner-of-the-Beach Formation) to slope (Murphy Creek Formation) transition

In western Newfoundland, the transition between platform (Labrador, Port au Port, St. George, and Table Head groups) and deeper marine (Cow Head, Curling, Northern Head groups) units was tectonic.

In Quebec, the contact between the latest Middle Cambrian Corner-of-the-Beach Formation (platform) and the earliest Late Cambrian Murphy Creek Formation (slope) has been described as conformable by Fritz et al. (1970) although, my recent field survey failed to see that contact.

The Corner-of-the-Beach Formation represents shelf-margin facies that were deposited at the onset of a major transgressive event ('First Grand Cycle'). The slightly younger Murphy Creek is distal-slope facies with conglomerate beds representing basinward shedding of margin-facies clasts. With respect to facies, it correlates well with the distal-slope succession recognized in the Cooks Brook Formation. The Murphy Creek Formation is time-correlative with the Big Cove and Felix members of the Petit Jardin Formation (Chow and James, 1987) and forms the 'Second Grand Cycle' in the Port au Port Group. A conformable transition between the Corner-of-the-Beach and Murphy Creek formations would require a significant and rapid transgressive phase which, with respect to time, could correlate to the transgressive event at the inception of the 'Second Grand Cycle'. Although the absolute magnitude of sea-level rise can hardly be related to that single phase, tectonic collapse of the platform in the Percé area has to be invoked if the transition is conformable.

CONCLUSIONS

The Percé area is unique in the Quebec Re-entrant as it offers the only known occurrence of shallow-marine latest Middle Cambrian carbonate rocks (Corner-of-the-Beach Formation) and a transition with early Late Cambrian slope succession (Murphy Creek Formation). The Corner-of-the-Beach Formation consists of oolite limestone with subordinate thrombolite and lime mudstone. This unit is similar to the coeval March Point Formation and Cape Ann Member of the Petit Jardin Formation (Port au Port Group) in western Newfoundland. The Murphy Creek Formation consists of rhythmic succession of mudstone-sandstone-limestone with some limestone conglomerate. This unit is time-correlative with the Downes Point Member of the Shallow Bay Formation (Cow Head Group) and with the Cooks Brook Formation (Northern Head Group) although, with regard to facies, it would more properly correlate with Cooks Brook Formation.

The transition between the Corner-of-the-Beach and Murphy Creek formations represents a change from a shallow-marine platform to a distal slope. If conformable, then a major and rapid sea-level rise has to be invoked with subsequent rapid re-establishment of the carbonate platform to supply material deposited on the slope; however, this contact was not observed in the field and a tectonic contact between platform and slope successions can not be ruled out.

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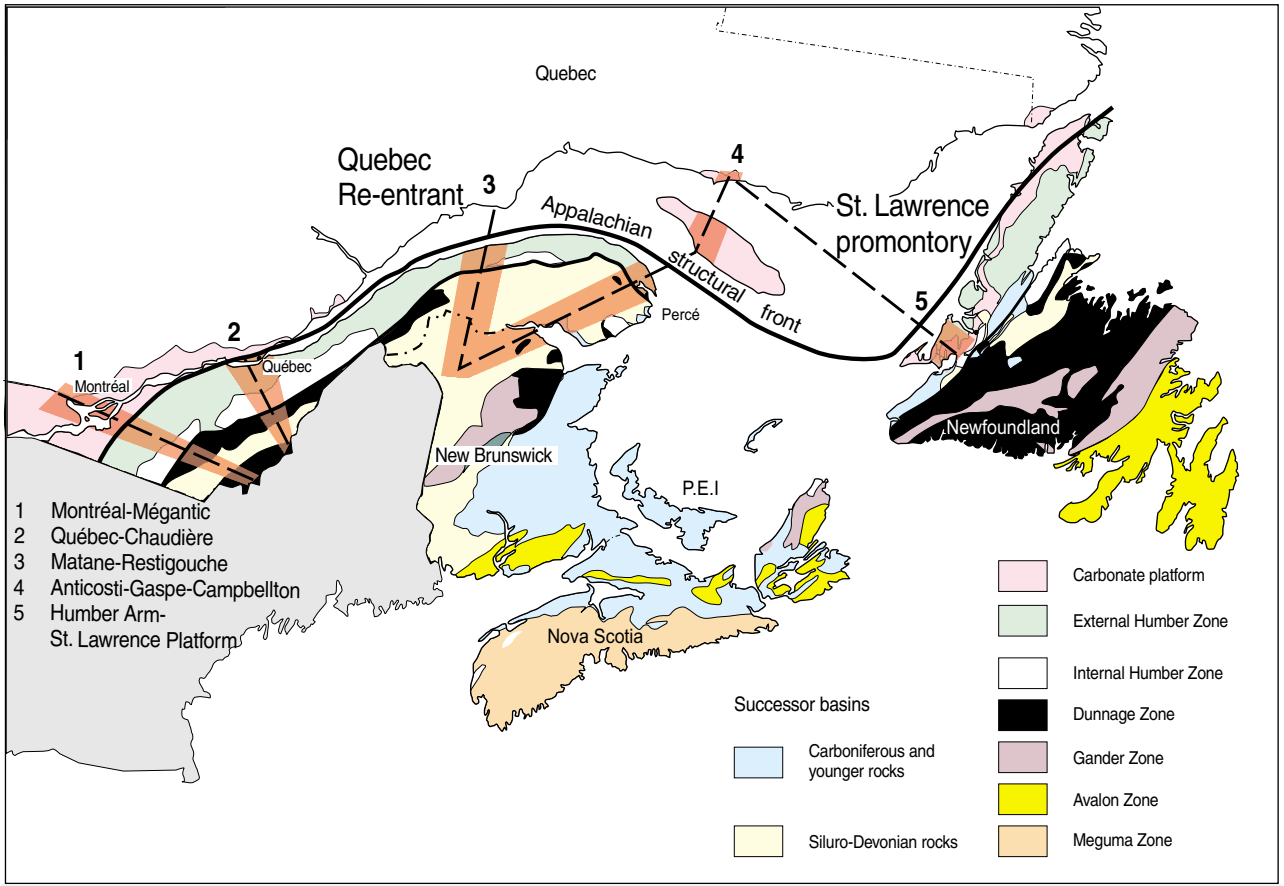

Figure 1. Simplified geological map of Eastern Canada with tectonostratigraphic domains and location of the five transects of the Appalachian Foreland and Platform NATMAP Project. The Percé area is located at the eastern tip of Gaspésie.

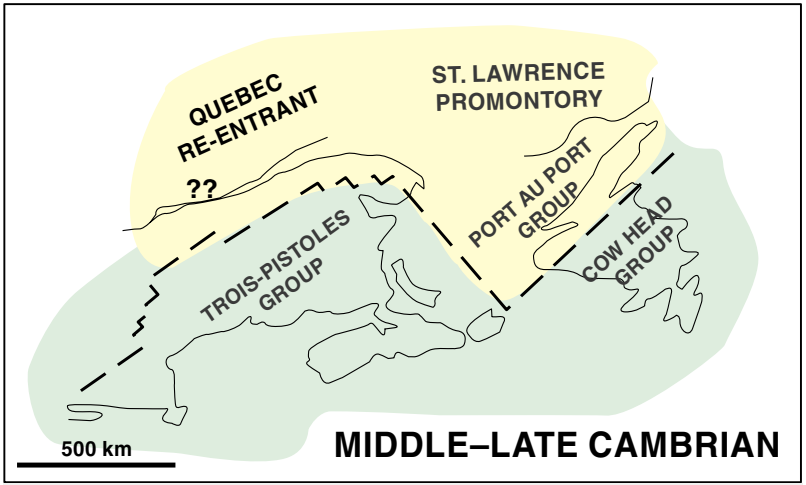

Figure 2. Regional paleogeographic reconstruction for the Middle–Late Cambrian interval. At the St. Lawrence promontory, the shallow-marine carbonate rocks of the Port au Port Group and deep-marine Cow Head Group are well known. In the Quebec Re-entrant, no shallow marine carbonate rocks are known although, deep-marine sedimentary rocks of the Trois Pistoles Group are documented (*modified from* Lavoie and Salad Hersi, 2000).

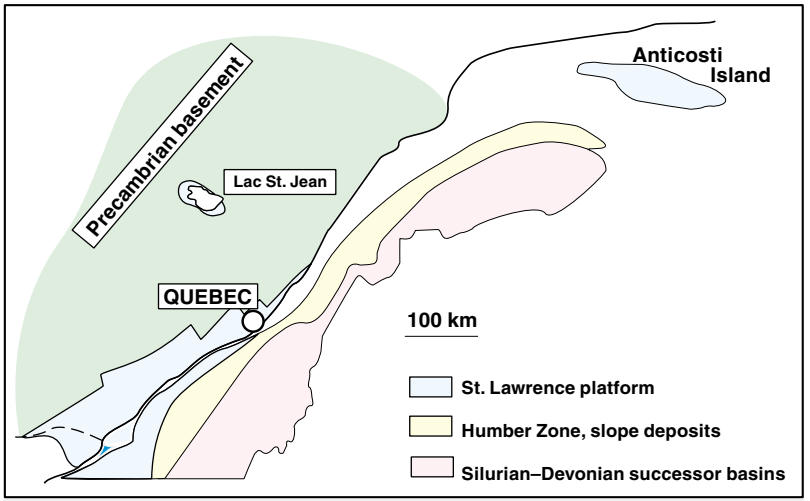

Figure 3. Simplified geological map of southern Quebec with the location of the St. Lawrence platform together with the adjacent Appalachian accreted continental slope successions of the Humber Zone.

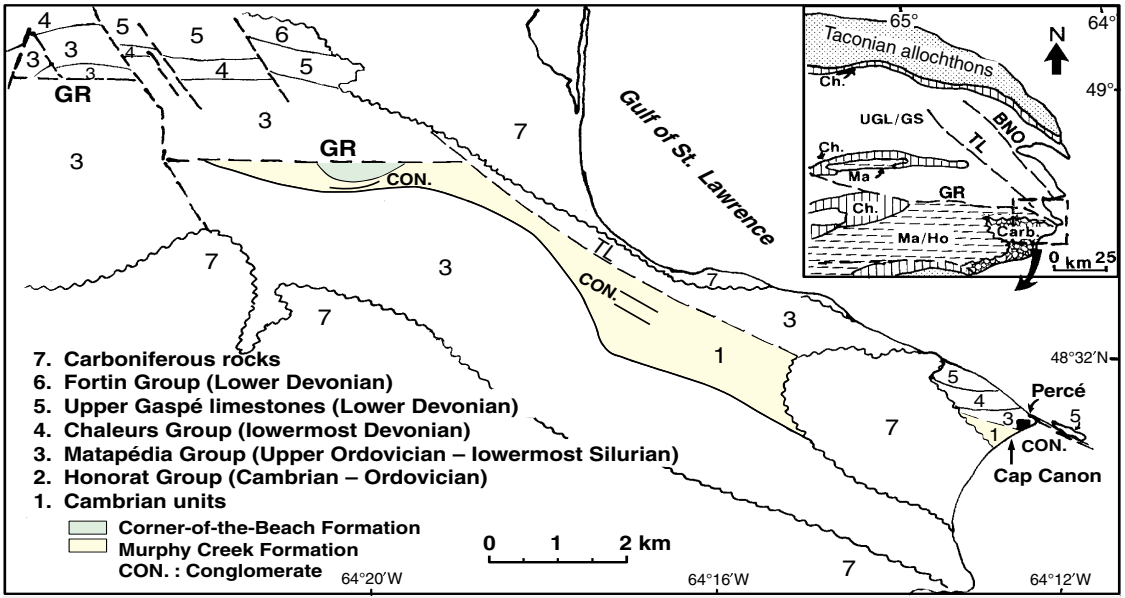

Figure 4. Geology of the Percé area with localization of Cambrian units (*modified from* Kirkwood, 1989). GR = Grande Rivière Fault, TL = Troisième Lac Fault, BNO = Bassin Nord-Ouest fault, Ma/Ho = Matapédia and Honorat groups, Carb = Carboniferous, ch.= Chaleurs Group, UGL/GS = Upper Gaspé Limestones and Gaspé Sandstones groups.

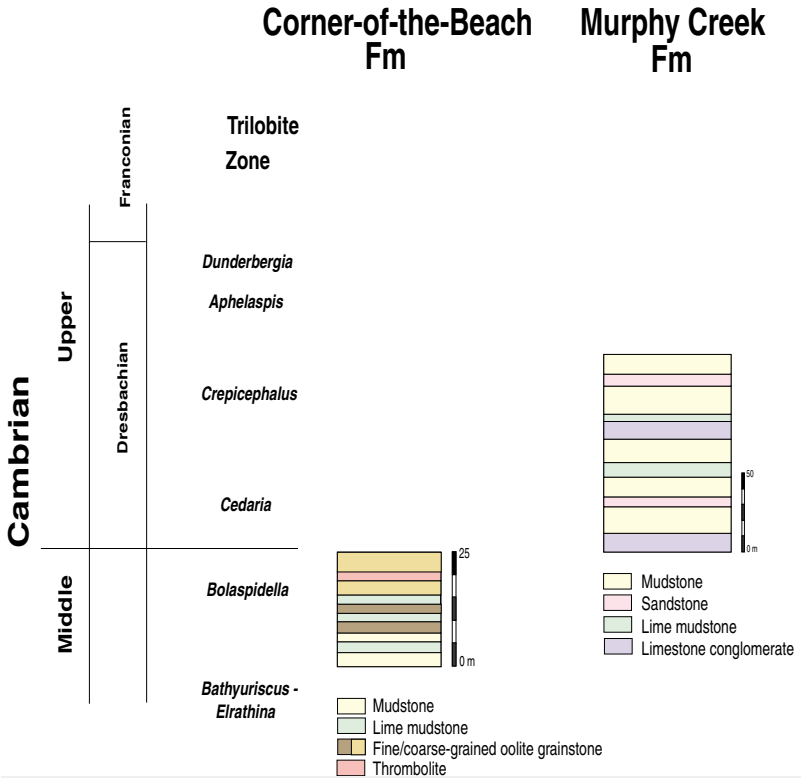

Figure 5. Stratigraphic sections for the Corner-of-the-Beach (one locality) and Murphy Creek (composite from three localities identified as bearing conglomerate on Fig. 4) formations. The biostratigraphy is from Kindle (1948) and Fritz et al. (1970) and the trilobite zones are reproduced from James and Stevens (1986).

Figure 6. Corner-of-the-Beach Formation. **A)** Field photograph of finely laminated lime mudstone calcilutite in the lowermost metres of the formation. **B)** Cross-section view of amalgamated, parallel- and crosslaminated oolitic grainstone. **C)** Poorly exposed massive bed of thrombolitic limestone.

Figure 7. Murphy Creek Formation. **A)** Rhythmic succession of fine-grained sandstone and mudstone at Cap Canon, Percé. **B)** Five metre thick limestone conglomerate exposed onshore at Cap Canon, this unit laterally passes to a 1.5 m thick interval at the shore cliff.

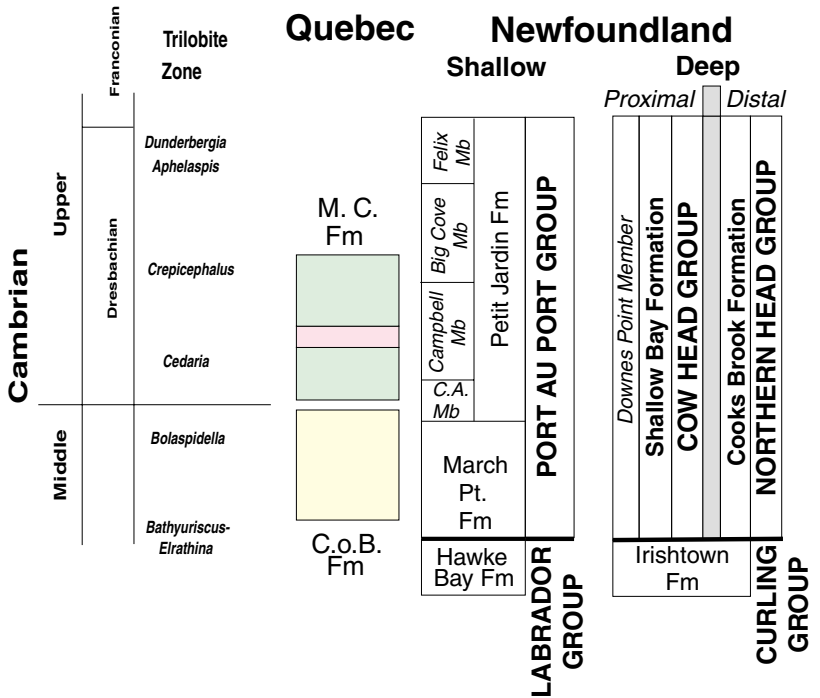

Figure 8. Regional correlation for the latest Middle–earliest Late Cambrian interval in eastern Canada. *See* text for details of correlations. Trilobite zones and Cow Head Group stratigraphy are from James and Stevens (1986), Port au Port Group stratigraphy is from Cowan and James (1993), and Northern Head Group stratigraphy is from Botsford (1988) and Waldron and Palmer (2000). M.C. = Murphy Creek, C.o.B. = Corner-of-the-Beach, C.A. = Cape Ann.

Table 1. Summary of Lower Paleozoic continental margin stratigraphy in Eastern Canada. Passive margin units are dark shaded (*modified from* James et al., 1989; Globensky, 1987; and Lavoie, 1997).

		NEWFOUNDLAND		QUEBEC	
		SHALLOW	DEEP	SHALLOW	DEEP
ORDOVICIAN	UPPER			Trenton Group	Cloridorme Formation
				Black River Group	Deslandes Formation
	MID.	Table Head Group	Lower Head Sandstone / Eagle Island Formation	Chazy Group	Tourelle Formation
	LOWER	St. George Group	Cow Head Group / Northern Head Group	Beekmantown Group	Rivière-Ouelle Formation
CAMBRIAN	UPPER	Port au Port Group		Potsdam Group	Trois-Pistoles Group
	MID.	Labrador Group	Curling Group	? ?	St. Roch Group
	LOWER				