

UNIVERSITÉ DU QUÉBEC A MONTRÉAL GEOTOP RADIOCARBON DATES I

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INTRODUCTION

GEOTOP is the geochemistry and geochronology research center of the Université du Québec à Montréal (UQAM). The Radiocarbon Laboratory was established to meet the growing demand for radiocarbon dating in Québec. The laboratory was founded by Claude Hillaire-Marcel. The first measurements were completed in October 1978. The laboratory was managed by Pierre Pagé until May 1985. Serge Occhietti and Pierre Pichet are presently in charge. Technical maintenance is under the direction of Claude Jacob.

The laboratory is equipped with two liquid scintillation counters (Intertechnique) which are installed in sub-basement three of a seven-story building.

Carbonate samples (eg, shells) are cleaned by dissolving 10 to 20% weight with HCl. The CO₂ is released using phosphoric acid at room temperature. Collagen is extracted from bones, according to the method described by Longin (1971), and conversion to CO₂ is made by combustion bomb method (Switsur, 1974). Modern standard CO₂ is prepared by oxidation of NBS oxalic acid (SRM 4990C) with KMnO₄ in 2N H₂SO₄. $\delta^{13}\text{C}$ measurements are carried out at GEOTOP on CO₂ samples with a precision of $\pm 0.2\text{‰}$.

Carbon dioxide is purified by passing through acetone/dry-ice water traps and then reacted with lithium at 700°C. The Li₂C₂/Li mixture is cooled and C₂H₂ is obtained by adding water. The benzene is produced by trimerization of C₂H₂ on a Cr⁺³ catalyst at 60°C and trapped with liquid nitrogen and acetone/dry-ice. The benzene samples are stored for at least three weeks to ensure complete ²²²Rd decay. They are stored and counted in numbered bottles with lead caps and bottoms. It has been observed that the background values were reduced by half when using those bottles.

Each sample is counted at least 12 times for 100 minutes, at 6°C, alternating with 3 or 4 samples and commercial dead benzene used for background. The background values and the counting efficiencies are typically 4 cpm/58% and 2 cpm/53% for counters A and B, respectively. From these values a merit figure of 1400 and 900 is obtained. The modern standard CO₂ is regularly checked with a 100-year-old wood sample. Age calculations are based on the 5570 ± 30 yr Libby ¹⁴C half-life and on a contemporary value equal to 0.95 of the activity of the NBS oxalic acid standard. No corrections are made for ¹⁴C fractionation and/or reservoir effect. Deviations

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reported as $\pm 1\sigma$ include standard deviation of count rates on the background, the sample and modern standard. When the sample activity is below 2σ , the age is expressed as greater than the minimum calculated age.

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INTER-LABORATORY CHECK SAMPLES

Sample	GEOTOP date	Other lab no.	Other lab date	Ref
UQ-535 (wood)	36,000 \pm 2000	GSC-3563	>42,000	Blake, pers commun
-555 (wood)	25,200 \pm 450	GSC-1802-2	25,200 \pm 260	Lowdon & Blake (1979)
		WAT-199	25,320 \pm 400	
		BGS-303	25,620 \pm 300	
-133 (shell)	7395 \pm 80	SI-4089	7500 \pm 280	England (1978)
-134 (shell)	6790 \pm 410	SI-4029	6845 \pm 70	England (1983)

GEOLOGIC SAMPLES

Anticosti Island series

The Anticosti Island series (Gulf of St Lawrence), consists of 29 samples collected between 1981 and 1985 by members of a Univ de Sherbrooke research group. The main objectives of sampling program were to establish a sea-level curve for the island (Painchaud, 1984; Painchaud, Dubois & Gwyn, 1984) and chronologic framework for Late Quaternary glacial and non-glacial events (Gratton, Gwyn & Dubois, 1984). Detailed data and interpretations are pub in Bigras and Dubois (1987).

UQ-493. Rivière du Brick

12,400 \pm 140

$\delta^{13}C = +1.9\text{‰}$

Shell fragments and a few complete specimens in growth position (*Mya truncata ovata*, *Hiatella arctica*) subm 1982 by J M M Dubois and coll 1981 by D Gratton and QHJ Gwyn from 4m depth in prodeltaic sand and silt overlying marine silt and clay (49° 21' 28" N, 63° 23' 22" W). Alt of sample 18m asl; same unit as UQ-498, -499, -508 and same site as UQ-512. *Comment:* age of prodeltaic sediments of Goldthwait Sea.

UQ-496. Côte Verte 13,250 ± 400

Shell fragments (*Hiatella arctica*) subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 8m depth in glaciomarine cobbly silts containing striated pebbles (49° 24' 00" N, 63° 34' 48" W). Alt of sample 4m asl; same site and same unit as UQ-502, same unit as UQ-505 and same sample as UQ-551. *Comment:* age for proximal glacio-marine sediments of Goldthwait Sea. In spite of low benzene volume used for counting, this date is more reliable than UQ-551.

UQ-498. Rivière Jupiter 11,700 ± 270
 $\delta^{13}C = +5.1\text{‰}$

Shell fragments and a few complete specimens in growth position (*Mya truncata ovata*) subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 5m depth in deltaic sand (49° 29' 31" N, 63° 31' 53" W). Alt of sample 23m asl; same unit as UQ-493, -499, -508. *Comment:* age of deltaic sediments of Goldthwait Sea.

UQ-499. Rivière Jupiter 12,000 ± 190
 $\delta^{13}C = +2.2\text{‰}$

Shell fragments and a few complete specimens in growth position (*Mya truncata ovata*) subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 2m depth in prodeltaic sand (49° 29' 26" N, 63° 32' 20" W). Alt of sample 18m asl; same unit as UQ-493, -498, -508 (same site). *Comment:* age of prodeltaic sediments of Goldthwait Sea.

UQ-502. Côte Verte 13,570 ± 200
 $\delta^{13}C = +3.6\text{‰}$

Shell fragments (*Balanus* sp) subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 3m depth in glacio-marine cobbly silt containing striated pebbles (49° 24' 00" N, 63° 34' 48" W). Alt of sample 9m asl; same unit and same site as UQ-496, -551, and same unit as UQ-505. *Comment:* age of proximal glaciomarine phase of Goldthwait Sea.

UQ-505. Côte Verte 13,200 ± 200

Shell fragments and a few complete valves (*Hiatella arctica*) subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 3m depth in glaciomarine sandy and cobbly silt with striated pebbles (49° 24' 47" N, 63° 34' 42" W). Alt of sample 15m asl; same unit as UQ-496, -502, -551. *Comment:* age of a proximal glaciomarine phase of Goldthwait Sea.

UQ-508. Rivière Jupiter 12,080 ± 280
 $\delta^{13}C = +7.7\text{‰}$

Shell fragments and a few complete specimens in growth position (*Balanus crenatus*, *Hiatella arctica*) subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 3m depth in prodeltaic sand and silt (49° 29' 26" N, 63° 32' 20" W). Alt of sample 17m asl; same unit as UQ-493, -498 and same site as UQ-499. *Comment:* age of prodeltaic sediments of Goldthwait Sea.

UQ-509. Côte Verte 28,100 ± 1200

Shell fragments (*Buccinum*, *Balanus* spp) subm by 1982 J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 11m depth in glaciomarine cobbly sand containing striated pebbles (49° 24' 36" N, 63° 34' 40" W). Alt of sample 7m asl; same unit as UQ-553. *Comment:* this age for proximal glaciomarine phase agrees with UQ-510, -514 (obtained from shell material included in till).

UQ-510. Pointe du Sud-Ouest 29,060 ± 1050
 $\delta^{13}C = +4.1\text{‰}$

Unid. shell fragments subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 1m depth in silty clay till, 2m thick, containing Precambrian clasts and overlying bedrock (49° 24' 08" N, 63° 30' 50" W). Alt of sample 116m asl; same unit as UQ-514. *Comment:* max age for glacial advance assoc with Anticosti Island Till; this date agrees with UQ-514. Shells are probably derived from glacio-marine sediments in the Trois-Milles brook (NW of site) which are correlatives of glacio-marine sediments at Côte Verte (UQ-509).

UQ-512. Rivière du Brick 13,100 ± 150
 $\delta^{13}C = +1.5\text{‰}$

Shell fragments and a few complete specimens in growth position (*Mya truncata*) subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 8m depth in marine silt and clay overlain by prodeltaic sediments (49° 21' 28" N, 63° 23' 22" W). Alt of sample 14m asl; same unit as UQ-712 and same site as UQ-493. *Comment:* age of deepwater phase of Goldthwait Sea.

UQ-514. Pointe du Sud-Ouest 30,000 ± 1200

Shells (*Hiatella arctica*) subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 2m depth in silty clay till containing Precambrian clasts (49° 23' 47" N, 63° 31' 14" W). Alt of sample 84m asl; same unit as UQ-510. *Comment:* same interpretation as UQ-510.

UQ-515. Côte Verte 11,950 ± 150

Shell fragments and a few unbroken valves (*Mya truncata*, *Mya arenaria*, *Buccinum terrae-novae*, *Hiatella arctica*) subm 1982 by J M M Dubois and coll 1981 by D Gratton and Q H J Gwyn from 9m depth in glaciomarine silty and cobbly sand (49° 24' 16" N, 63° 34' 38" W). Alt of sample 3m asl; same unit as UQ-738. *Comment:* age of proximal glaciomarine phase assoc with readvance of Anticosti I. residual ice cap.

UQ-551. Côte Verte 14,500 ± 800
 $\delta^{13}C = +7.4\text{‰}$

Shell fragments (*Hiatella arctica*) subm 1982 by J M M Dubois and coll 1982 by D Gratton and Q H J Gwyn from 8m depth in glaciomarine cobbly silt containing striated pebbles (49° 24' 00" N, 63° 34' 38" W). Alt of sample 4m asl; same site as UQ-502, same unit as UQ-505 and same sample as UQ-

496. Same interpretation as UQ-496. *Comment:* this date may be less reliable than UQ-496 because of less benzene recovery.

UQ-553. Baie Bonsecours **≥36,000**
 $\delta^{13}C = +0.6\text{‰}$

Shell fragments (*Balanus* sp) subm 1982 by J M M Dubois and coll 1982 by D Gratton and Q H J Gwyn from 5m depth in glaciomarine silty and cobbly sand containing striated pebbles (49° 28' 45" N, 63° 36' 50" W). Alt of sample 1–2m asl; same unit as UQ-509. *Comment:* oldest date on Anticosti I., age of proximal glaciomarine phase. Sample should be cross-checked on proportional counter because of less benzene recovery. Date was previously considered finite (36,000 ± 3500 BP; Gratton, Gwyn & Dubois, 1984), age seems consistent with available amino acid ratios (Bigras, Gwyn & Dubois, 1988).

UQ-712. Ruisseau Martin **13,400 ± 140**
 $\delta^{13}C = +5.5\text{‰}$

Shell fragments and a few complete specimens in growth position (*Hiattella arctica*) subm 1983 by J M M Dubois and coll 1982 by D Gratton and Q H J Gwyn from 3m depth in cobbly glaciomarine silt overlying till and underlying littoral gravel (49° 10' 34" N, 62° 46' 58" W). Alt of sample 9m asl; same unit as UQ-512. *Comment:* same interpretation as UQ-512.

UQ-719. Rivière à l'Huile **9010 ± 60**

Shell fragments and a few unbroken valves (*Zirphaea crispata*) subm 1983 by J M M Dubois and coll 1981 by A Painchaud in cobbly matrix-dominated resedimented diamicton overlain by 6m of littoral sandy gravel (49° 50' 12" N, 63° 33' 30" W). Alt of sample 12m asl. *Comment:* located on distal side of Rivière à l'Huile Moraine, date is min for moraine.

UQ-738. Ruisseau Box **12,190 ± 170**
 $\delta^{13}C = +0.7\text{‰}$

Shells (*Mya truncata*, *Hiattella arctica*) subm 1983 by J M M Dubois and coll 1982 by D Gratton and Q H J Gwyn from 2m depth in glaciomarine sandy and cobbly silt (49° 06' 21" N, 62° 24' 00" W). Alt of sample 2 to 3m asl; same unit as UQ-515. *Comment:* same interpretation as UQ-515.

UQ-776. Baie Martin **9450 ± 200**

Shell material (mainly *Mya truncata*) subm 1983 by J M M Dubois and coll 1981 by A Painchaud in glaciomarine sandy silt incorporated in till (49° 52' 25" N, 63° 52' 10" W). Alt of sample 10m asl. *Comment:* sample coll within Rivière à l'Huile Moraine. Date is considered suspect because of low sample weight and small benzene recovery.

UQ-778. Rivière Sainte-Marie **10,150 ± 100**

Shells in growth position (*Mya truncata*) subm 1983 by J M M Dubois and coll 1981 by A Painchaud at surface of till overlain by 1.5m of littoral gravel (49° 40' 10" N, 63° 54' 48" W). Alt of sample 5m asl; same unit as

UQ-1018 and QU-1262 (11,680 ± 190), -1263 (12,400 ± 230), -1264 (11,830 ± 180), -1265 (12,090 ± 210), -1268 (12,300 ± 180), -1269 (12,470 ± 170), -1270 (11,940 ± 190) and -1271 (12,200 ± 190) (Bigras & Dubois, 1987). *Comment:* age of regressive level of Goldthwait Sea at alt ca 35 to 50m asl according to mean depth range of this species.

UQ-1018. Rivière aux Becs-Scie **13,450 ± 300**
 $\delta^{13}C = +1.06\text{‰}$

Unbroken shell valves (*Macoma calcarea*) subm and coll 1984 by J M M Dubois in thin till derived from glaciomarine sediments and overlain by 1 to 2cm of littoral sand and 1.5m of terrestrial peat (49° 42' 09" N, 64° 05' 10" W). Alt of sample 3.3m asl; same unit as UQ-778 and QU-1262 to -1265 and -1268 to -1271 (Bigras & Dubois, 1987). *Comment:* age of Goldthwait Sea proximal glaciomarine sediments deposited prior to fm of Sainte-Marie Moraine.

UQ-1036. Baie du Petit Makasti **470 ± 80**
 $\delta^{13}C = +1.7\text{‰}$

Shells in growth position (*Mya arenaria*) subm and coll 1984 by J M M Dubois from veneer of Goldthwait Sea marine clay on modern intertidal rock-platform (49° 55' 30" N, 64° 22' 15" W). Alt of sample 0m asl; sampled in immediate vicinity of site of sample UQ-1376. *Comment:* this shallow-water species probably burrowed into older marine clay (UQ-1376) during Late Holocene phase of littoral erosion. Age of regressive level of Goldthwait Sea at site alt. Small benzene recovery.

UQ-1056. Rivière aux Saumons **10,200 ± 200**

Shell fragments (*Hiatella arctica*, *Macoma* sp) subm 1984 by L St-Pierre and coll 1984 by Q H J Gwyn, P Bigras and L St-Pierre from 13m depth at base of prodeltaic silt and sand overlying marine or glaciomarine silt and clay (49° 24' 55" N, 62° 15' 05" W). Alt of sample 6m asl. *Comment:* dates 42m asl surface of Rivière aux Saumons delta into receding Goldthwait Sea.

UQ-1063. Port-Menier Airport **11,600 ± 200**

Shell fragments (mainly *Mytilus edulis*) subm 1984 by L St-Pierre and coll 1984 by L St-Pierre and D Côté from 2m depth in prodeltaic sand and gravel (49° 50' 05" N, 64° 15' 50" W). Alt of sample 61m asl; same unit as QU-1272 (12,450 ± 190), -1273 (12,510 ± 200) and GSC-89 (12,940 ± 150) (Bigras & Dubois, 1987). *Comment:* date is youngest date for fm of Trois-Milles brook outwash plain; outwash body which formed during sea-level stand at site alt is contemporaneous with Sainte-Marie Moraine.

UQ-1064. Pointe Carleton **9500 ± 100**

Shell fragments (mainly *Mytilus edulis* and *Mya* sp) subm 1984 by L St-Pierre and coll 1984 by P Bigras, L St-Pierre and D Côté from 2m depth in littoral sand and gravel at surface of raised rock platform (49° 43' 57" N,

62° 58' 47" W). Alt of sample 26 to 29m asl. *Comment:* age of regressive level of Goldthwait Sea at site alt.

UQ-1066. Rivière à la Patate **10,600 ± 200**
 $\delta^{13}C = +2.8\text{‰}$

Shell fragments and a few unbroken specimens (mainly *Mya truncata*, *Mya arenaria*, *Hiatella arctica*) subm 1984 by L St-Pierre and coll 1984 by J M M Dubois, P Bigras and L St-Pierre from depth 17m in marine silty clay overlain by 10m of deltaic sand and gravel (49° 42' 20" N, 62° 56' 00" W). Alt of sample 13 to 17m asl; same unit as QU-1375, -1376 (Bigras & Dubois, 1987). *Comment:* min age of deglaciation in E part of Jacques-Cartier Passage. Complete starfish (*Ophiuroidea*) specimen, probably *Asterias vulgaris* or *Henricia sanguinolenta*, was also found at this site.

UQ-1068. Pointe Carleton **1300 ± 100**
 $\delta^{13}C = +1.3\text{‰}$

Shell fragments (mainly *Buccinum undatum*, *Mytilus edulis*) subm 1984 by L St-Pierre and coll 1984 by P Bigras, L St-Pierre and D Côté from 2 to 3m depth in beach sand and gravel at surface of raised littoral rock platform (49° 43' 58" N, 62° 59' 01" W). Alt of sample 3 to 6m asl. *Comment:* dates regressive level of Goldthwait Sea at site alt.

UQ-1082. Port-Menier Airport **9850 ± 300**

Whale vertebra (restored and exposed in Mus Nat Sci, Ottawa) subm 1984 by J M M Dubois and coll 1984 by Q H J Gwyn in beach gravel overlying fluvio-deltaic sediments (49° 50' 00" N, 64° 17' 30" W). Alt of sample 49m asl. *Comment:* dates regressive level of Goldthwait Sea at site alt.

UQ-1375. Baie du Petit Makasti **9900 ± 100**

Shells (*Hemithyris psittacea*, *Mya truncata*, *Macoma balthica*) in growth position subm 1986 and coll 1985 by J M M Dubois at 6m depth in marine clay overlain by deltaic sand and gravel (49° 55' 20" N, 64° 21' 30" W). Alt of sample 3m asl; same unit as UQ-1066, -1376. *Comment:* same interpretation as UQ-1066, -1376. Site provides first recorded occurrence of *Crassostrea virginica* this far N of its modern distribution area, boundary of which now lies near 47° N.

UQ-1376. Baie du Petit Makasti **13,900 ± 300**

Shells in growth position (*Hiatella arctica*, *Mya truncata*) subm 1986 and coll 1985 by J M M Dubois from 25cm depth in marine clay in depression of modern littoral rock platform (49° 55' 30" N, 64° 22' 15" W). Alt of sample 0m asl; near UQ-1036 and same unit as UQ-1066, -1375. *Comment:* min age of deglaciation of W part of Jacques-Cartier Passage. Late Wisconsinan marine clays at surface of modern platform indicates platform was formed prior to Late Wisconsinan time, possibly during Sangamonian stage.

Baie-Comeau series

Baie-Comeau series (North Shore of St Lawrence estuary) consists of 15 samples coll 1985 and subm 1986 by J M M Dubois. Samples were dated

to document relative sea-level changes in this part of Goldthwait Sea (Dubois, 1979; Bigras & Dubois, 1987) and to date marine limit; thus to provide min age for deglaciation of area. Most samples were coll in two secs exposing thick coquina beds with minor sand and gravel. These deposits underlay well-defined offlap terraces in small bays of former Rivière aux Anglais estuary. Site 1 is Rivière des Anglais-A (49° 17' 25" N, 68° 09' 45" W); 60m asl; samples UQ-1229, -1230, -1360 and QU-573 (9600 ± 130) (Bigras & Dubois, 1987) were coll in coquina beds which has exposed thickness of 1.7m. Site 2 is Rivière des Anglais-B (49° 19' 15" N, 68° 09' 20" W) 76m asl; samples UQ-1231 to -1235, -1361 and QU-574 (9970 ± 130) (Bigras & Dubois, 1987) were coll in coquina beds thickness of which exceed 8m. Detailed data and interpretations are pub in Bigras and Dubois (1987).

UQ-1229. Rivière des Anglais-A 9350 ± 100

Well-preserved shells (*Balanus crenatus*) from depth 40cm assoc with *Hiatella arctica*, *Mytilus edulis*, *Hemithyris psittacea* and foram, *Elphidium incertum*. *Comment*: age of regressive sea level at 60m asl; date agrees with GSC-1565 (9280 ± 140), QU-73 (10,000 ± 170) and QU-573 (9600 ± 130).

UQ-1230. Rivière des Anglais-A 8600 ± 100
 $\delta^{13}C = +1.2\text{‰}$

Well-preserved shells (*Balanus crenatus*) from depth 0.4 to 1.7m; same faunal assemblage as UQ-1229. *Comment*: date slightly too young for regressive sea level at 60m asl (5 dates).

UQ-1360. Rivière des Anglais-A 11,600 ± 300

Comment: this date, intended as cross-check of UQ-1230, same species, should be used with caution since only 0.947g benzene was used for counting. Date seems somewhat too old relative to other dates at same alt in area.

UQ-1231. Rivière des Anglais-B 9850 ± 100

Well-preserved shells (*Mytilus edulis*) from depth 40 to 50cm assoc with *Balanus balanus*, *Balanus crenatus*, *Mya truncata*, *Natica clausa*, *Hiatella arctica*, *Buccinum tenue*, a few *Chlamys islandicus*, *Macoma balthica*, *Astarte montaguui striata*, *Balanus hameri*, *Hemithyris psittacea* and one valve of *Zirphaea crispata*. *Comment*: age for regressive sea level stand at 76m asl. UQ-1231, -1232, -1233 show expected age increase with depth, but UQ-1234, -1235, -1361, at greater depth, are more problematic.

UQ-1232. Rivière des Anglais-B 10,000 ± 100

Well-preserved shells (*Mytilus edulis*) from depth 2.2 to 2.4m. *Comment*: age for regressive sea level at 76m asl; age agrees with strat position.

UQ-1233. Rivière des Anglais-B **10,350 ± 100**
 $\delta^{13}C = 0.4\text{‰}$

Well-preserved shells (*Mytilus edulis*) from depth 2.8 to 3.1 m. *Comment:* age for regressive sea level at 76m asl; agrees with strat position.

UQ-1234. Rivière des Anglais-B **10,200 ± 100**
 $\delta^{13}C = 0.1\text{‰}$

Well-preserved shells (*Mytilus edulis*) from depth 4m. *Comment:* age for regressive sea level at 76m asl; if stated errors ($\pm 1\sigma$) are considered, this date may be identical to or slightly older than UQ-1233.

UQ-1235. Rivière des Anglais-B **9600 ± 200**

Well-preserved shells (*Balanus crenatus*) often fixed on other shells from depth 4m; same sample as UQ-1234. *Comment:* this date is significantly younger than UQ-1233 and -1234; date may be suspect, particularly since low benzene volume was used for counting.

UQ-1361. Rivière des Anglais-B **12,600 ± 200**

Comment: this date was intended as cross-check of UQ-1235, but on mixed species (see assemblage UQ-1231); same problem as UQ-1360. Apparent antiquity of this date may be caused by reworked shells from older sediments; however, only small amount of benzene was used for counting; date should be used with caution.

UQ-1236. Baie-Comeau **9050 ± 100**
 $\delta^{13}C = +0.4\text{‰}$

Shells (*Mya arenaria*) coll from depth 0 to 1m in silty marine sediment (49° 13' 00" N, 68° 11' 40" W). Alt of sample 60m asl; same site as GSC-1565 (Bigras & Dubois, 1987) and same unit as UQ-1237; thanacoenotic assemblage also contains *Balanus crenatus*, *Mytilus edulis*, *Hiatella arctica*, *Hemithyris psittacea* and a few *Astarte montagui*, *Macoma balthica*, *Venericardia borealis*. *Comment:* age slightly too young for regressive level of Goldthwait Sea at site alt; date is consistent with UQ-1229, -1237, QU-573 and GSC-1565.

UQ-1237. Baie-Comeau **10,000 ± 100**
 $\delta^{13}C = +2.3\text{‰}$

Shells (*Mya truncata*) coll near surface in veneer of silty marine sediment on bedrock (49° 13' 00" N, 68° 11' 40" W). Alt of sample 56m asl; same unit as UQ-1236 and GSC-1565 (Bigras & Dubois, 1987); thanacoenotic assemblage also contains *Chlamys islandicus*, *Macoma calcarea*, *Balanus hameri* and a few *Cyrtodaria siliqua*, *Astarte montagui*, *Hemithyris psittacea*, *Venericardia borealis*, *Buccinum hancocki*. *Comment:* date is too old for regressive level of Goldthwait Sea at site alt, presumably because shells were reworked from sediments deposited earlier during marine invasion; min age for marine invasion in area.

UQ-1238. Baie-Comeau (Pointe Saint-Gilles) **9950 ± 100**
 $\delta^{13}C = +1.6\text{‰}$

Shells (*Balanus crenatus*) coll near surface in marine silty and clayey sand containing pebbles and cobbles (49° 11' 55" N, 68° 10' 25" W). Alt of sample 30m asl; same unit as UQ-1239 and GSC-1746 (8890 ± 150); thanacoenotic assemblage also contains *Chlamys islandicus*, *Hemithyris psittacea* and a few *Astarte montagui*, *Macoma balthica*, *Mya truncata*, *Hiatella arctica*, *Buccinum hancocki*, *Natica clausa*. *Comment*: same interpretation as UQ-1237.

UQ-1239. Chute-aux-Outardes **7800 ± 500**
 $\delta^{13}C = -1.6\text{‰}$

Thin, dwarf shells in growth position (*Macoma balthica*) coll at the base of 4.9m of compact marine sediment overlain by 4m of deltaic sand and gravel (49° 07' 40" N, 68° 22' 20" W). Alt of sample 21m asl; same unit as UQ-1238 and GSC-1746. *Comment*: age is mainly indicative because only 0.3g of benzene were recovered from this 5g sample; age for marine sediments underlying part of delta of Rivière aux Outardes ca 30m asl.

UQ-1362. Baie-Comeau **9900 ± 200**

Shells (*Balanus crenatus*) coll from depth 60cm in beach sand and fine gravel at the contact with underlying marine sediment (49° 12' 00" N, 68° 11' 15" W). Alt of sample 23m asl; probably same site GSC-1746 (8890 ± 150); assemblage also contains *Clinocardium ciliatum*, *Astarte montagui*, *Macoma balthica*, *Macoma calcarea*. *Comment*: age too old for regressive level of Goldthwait Sea at site alt. This date should be used with caution because of small benzene recovery.

UQ-1363. Pointe-aux-Outardes **7600 ± 150**

Shells in growth position (*Mya arenaria*) coll from depth 0.4m in compact marine sediment overlain by 3.7m of beach sand and 0.9m of aeolian sand (49° 02' 30" N, 68° 27' 45" W). Alt of sample 2m asl. *Comment*: same interpretation as UQ-1239. This date should be used with caution because of small benzene recovery.

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