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GEOLOGICAL SURVEY OF CANADA
PAPER 90-7

GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES XXX

Collated by
R. McNeely and P.K. Jorgensen

1992



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This date list, GSC XXX, is the nineteenth to be published directly in the Geological Survey's paper series. Lists prior to GSC XII were published first in the journal *Radiocarbon* and were reprinted as GSC papers. The lists through 1967 (GSC VI) were given new pagination, whereas lists VII to XI (1968 to 1971) were reprinted with the same pagination.

GEOLOGICAL SURVEY OF CANADA

RADIOCARBON DATES XXX

Abstract

This list presents 247 radiocarbon age determinations made by the Radiocarbon Dating Laboratory, Geological Survey of Canada, plus 13 AMS dates done by other laboratories, and 22 dates made at the Alberta Environmental Centre in Vegreville. The total number (260) of samples from various areas are as follows: Newfoundland (19); Labrador (2); Nova Scotia (10); New Brunswick (3); Québec (37); Ontario (2); Manitoba (6); Alberta (4); British Columbia (34); Yukon Territory (8); Northwest Territories, mainland (51); Northwest Territories, Arctic Archipelago (76); U.S.A., New York (1); Denmark, Greenland (1). Seventeen samples were dated (eleven of which were counted in both the 2 L and 5 L counters) as part of an International Collaborative Study (Scott et al., 1990). Tables 1 and 2 summarize the details of background and standard counts for the 2 L and 5 L counters during the period from January 9, 1990, to January 8, 1991.

Résumé

Ce rapport présente les résultats de 247 datations effectuées par le laboratoire de datation au radiocarbone, Commission géologique du Canada, en plus de 13 datations AMS effectuées par d'autres laboratoires, et de 22 datation effectuées par le centre environnemental d'Alberta à Vegreville. Les échantillons datés, au nombre de 260, proviennent des régions suivantes: Terre-Neuve (19); Labrador (2); Nouvelle-Écosse (10); Nouveau-Brunswick (3); Québec (37); Ontario (2), Manitoba (6); Alberta (4); Colombie-Britannique (34); Territoire du Yukon (8); Territoires du Nord-Ouest, continent (51); Territoires du Nord-Ouest, archipel arctique (76); É.U., New York (1); Danemark, Groenland (1). Dix-sept échantillons ont été datés (onze d'entre eux ont été comptés à la fois dans les compteurs de 2 L et de 5 L) pour une étude coopérative internationale (Scott et al., 1990). Les tableaux 1 et 2 résument les valeurs de bruit de fond et d'étalonnage des compteurs de 2 L et 5 L, de la période allant du 9 janvier 1990 au 8 janvier 1991.

INTRODUCTION¹

This publication includes all the samples that have been dated more than 2 years ago and not published in a "date list". The presentation of dates within each section or subsection of this text is ordered from east to west. All GSC dates, up to and including GSC-4800, are now accessible on a computer database. The 'Date Locator File' provides convenient, fast access to our dates by allowing the user to interactively select indexed parameters, such as laboratory number, submitter, locality, material, age range, to retrieve samples (McNeely, 1988). Supplementary information on this database is available from Dr. J-S. Vincent, Director, Terrain Sciences Division, Geological Survey of Canada.

Sample gas preparation and purification were carried out as described in Lowdon et al. (1977). Carbon dioxide gas proportional counting techniques have been discussed by Dyck (1967). For a review of laboratory operations the reader is referred to Lowdon (1985).

During the period from January 1990 through December 1990, both the 2 L counter (Dyck and Fyles, 1963) and the 5 L counter (Dyck et al., 1965) were operated continuously. The 2 L counter was operated at 2 atmospheres (atm) throughout this period, and the 5 L counter was operated at 1 atm, except for September through November when the 5 L counter was operated at 4 atm (high pressure).

¹The date list has been compiled by R. McNeely and P.K. Jorgensen from descriptions of samples and interpretations of age determinations provided by the collectors and submitters.

On a monthly basis, the counting rates for backgrounds and standards were within statistical limits. The average background and oxalic acid standard counting rates, and the number of 1-day counts used to determine the average are shown in Tables 1 and 2, respectively.

Age calculations during the report period were done on a microcomputer (VICTOR 9000). Calculations are based on a ^{14}C half-life of 5568 ± 30 years and 0.95 of the activity of the NBS oxalic acid standard. Ages are quoted in radiocarbon years before present (BP), where "present" is taken to be 1950. The error assigned to each age has been calculated using only the counting errors of sample, background, and standard, and the error in the half-life of ^{14}C (Lowdon and Blake, 1973). Nonfinite dates (i.e., greater than ages) are based on a 4 sigma criterion (99.9% probability), whereas finite dates are based on a 2 sigma criterion (95.5% probability) and, therefore, are unconventionally reported with an error term of ± 2 sigma. In addition, all GSC dates are rounded according to the following criteria:

Age (years BP)	Significant figures
0 - 99	1
100 - 999	2
1000 - 9999	3
>10 000	3
nonfinite	2

If $^{13}\text{C}/^{12}\text{C}$ ratios ($\delta^{13}\text{C}$) were available, a "correction" for isotopic fractionation was applied to the sample age, and the $\delta^{13}\text{C}$ value reported. For terrestrial and nonmarine organic materials, and bones (both terrestrial and marine) the ages are conventionally corrected to a $\delta^{13}\text{C} = -25.0\text{‰}$ PDB, whereas, marine shell ages are unconventionally corrected to a $\delta^{13}\text{C} = 0.0\text{‰}$ PDB; freshwater shell ages are not corrected. All $\delta^{13}\text{C}$ determinations were made on aliquots of the sample gas used for age determinations. Since 1989, all $\delta^{13}\text{C}$ values have been determined under contract by the OCGS Stable Isotope Facility, Carleton University / University of Ottawa, Ottawa, Ontario. From 1975 to 1989, the $\delta^{13}\text{C}$ were determined under contract by R.J. Drimmie of the Department of Earth Sciences, University of Waterloo, Waterloo, Ontario, or by Waterloo Isotope Analysts, Inc., Kitchener, Ontario (R.J. Drimmie, chief analyst) using the same equipment as at the University of Waterloo. Prior to that time some $\delta^{13}\text{C}$ determinations were done by the GSC Geochronology Section (R.K. Wanless, Head) and by Teledyne Isotopes, Westwood, New Jersey.

Acknowledgments

Appreciation is expressed to S.M. Chartrand (1969 to 1976), J.E. Tremblay (1976 to 1980), A.M. Telka (1980 to 1986), L.M. Maillé (1986 to 1989, and 1991 to present) and M. Leflar (1990), I.M. Robertson (1964 to 1989), and J. Brennan (1989 to present) for the preparation, purification, and counting of samples in the laboratory. Supervision of laboratory operations has been as follows: W. Dyck (1960 to 1965), J.A. Lowdon (1965 to 1981), and R. McNeely (1981 to present).

Identification of materials used for dating or associated with the dated material has been carried out by the following specialists:

Algae (marine):	R.K.S. Lee and W.H. Adey
(freshwater):	J.P. Smol
Arthropods (fossil):	J.V. Matthews, Jr.
Barnacles:	C.G. Rodrigues
Diatoms:	S. Federovich and J.P. Smol
Macrofossils (plant):	J.V. Matthews, Jr., M. Kuc, and N.F. Alley
Molluscs:	A.H. Clarke, Jr., M.F.I. Smith, the late W.H. Dall, R. Hebda, F.J.E. Wagner, C.G. Rodrigues, and J.E. Dale
Mosses:	M. Kuc, J.A. Janssens, and W.A. Weber
Pollen:	R.J. Mott, S. Federovich, N.F. Alley, and J.E. Shepperd
Vertebrates:	C.R. Harington
Wood:	R.J. Mott, L.D. Wilson (née Farley-Gill), H. Jetté, and G. Argus

Ancillary Analyses:

Accelerator mass spectrometry	R.P. Beukens
(AMS) dating:	IsoTrace Laboratory, (U of T), Toronto
Amino acid ratios:	I. Moffat (N.W. Rutter), University of Alberta;
X-ray diffraction:	A.C. Roberts and R.N. Delabio,
(on shell material)	Mineralogy Section, GSC.

The GSC clientele extend their sincere thanks to them.

M. Lanoix, R.J. Richardson, J.A. Snider, J.E. Dale, and K.E. Rolko, all former summer students or technical assistants, assisted in the processing and examination of samples prior to submission to the laboratory. Since 1986 the submitters have been responsible for the (physical) preparation of their sample materials, with supervision from laboratory personnel, prior to submission.

W. Spirito, L. Brouillette, and J. Cousineau assisted in the development of the 'Date Locator File'. D. Atkinson, S. McCuaig, D. Russell, and P.K. Jorgensen assisted in the preparation of GSC date lists.

Table 1. Monthly average count rate for backgrounds and the number of individual counts (N) made during the period January through December 1990.

Month	2 L Counter (2 atm)		5 L Counter (1 or 4 atm)	
	cpm*	(N)	cpm*	(N)
January	1.083 ± 0.019	(4)	2.105 ± 0.027	(4)
February	1.026 ± 0.023	(3)	2.014 ± 0.032	(3)
March	1.030 ± 0.018	(4)	2.074 ± 0.030	(3)
April	1.013 ± 0.022	(3)	2.079 ± 0.032	(3)
May	1.013 ± 0.027	(3)	2.095 ± 0.026	(4)
June	0.990 ± 0.030	(4)	2.080 ± 0.026	(4)
July	1.032 ± 0.028	(3)	2.074 ± 0.027	(4)
August	1.049 ± 0.019	(4)	2.047 ± 0.042	(4)
September	1.020 ± 0.024	(2)	2.477 ± 0.021	(7)
October	1.003 ± 0.022	(2)		
November	1.029 ± 0.028	(5)	2.505 ± 0.029	(4)
December	1.108 ± 0.024	(2)	2.194 ± 0.037	(3)

* cpm = counts per minute.

Table 2. Monthly average net count rate for oxalic acid standards (No)** and the number of individual counts (N) made during the period January through December 1990.

Month	2 L Counter (2 atm)		5 L Counter (1 or 4 atm)	
	cpm*	(N)	cpm*	(N)
January	17.862 ± 0.102	(2)	28.136 ± 0.132	(2)
February	18.054 ± 0.143	(1)	28.290 ± 0.181	(1)
March	17.892 ± 0.101	(2)	28.375 ± 0.130	(2)
April	17.992 ± 0.133	(2)	28.127 ± 0.134	(2)
May	18.000 ± 0.102	(2)	28.326 ± 0.128	(2)
June	17.773 ± 0.104	(2)	28.377 ± 0.129	(2)
July	17.834 ± 0.163	(2)	28.244 ± 0.132	(2)
August	17.851 ± 0.099	(2)	28.236 ± 0.193	(2)
September	18.094 ± 0.144	(1)	102.221 ± 0.494	(2)
October	17.754 ± 0.102	(2)		
November	18.121 ± 0.154	(2)	101.529 ± 0.473	(1)
December	18.109 ± 0.241	(2)	28.307 ± 0.234	(2)

* cpm = counts per minute.
 ** No = 95% of the net activity of the NBS Oxalic Acid Standard

International Collaborative Study

The GSC Radiocarbon Dating Laboratory participated in a program that was designed to investigate exhaustively all aspects of ^{14}C dating (Scott et al., 1990). A three year study, with Dr. E.M. Scott as principal investigator, was undertaken by the University of Glasgow in 1986. The study had four main aims, namely:

- 1) to provide important information for ^{14}C users by quantifying the uncertainties on the results routinely obtained from ^{14}C laboratories;
- 2) to provide an objective cross-check and verification of different laboratory techniques;
- 3) to provide quantitative insight into the validity of routinely quoted errors; and
- 4) to assign and numerically assess the contribution of the various experimental processes to the overall error.

The study was carried out in three stages to assess systematically various aspects of the radiocarbon dating technique.

Stage 1 was designed to investigate variations in the different counting techniques (gas proportional, liquid scintillation, and accelerator mass spectrometry). The samples underwent no laboratory treatment, therefore only samples of calcium carbonate for gas proportional and AMS laboratories or benzene for the liquid scintillation laboratories were dated.

GSC-4308. Stage 1: Sample "E" 3610 ± 70
 $\delta^{13}\text{C} = -30.0\text{‰}$

Sample "E", carbonate, (35.0 g dry weight) received no treatment and yielded 6.3 L of CO_2 gas. The age estimate is based on two counts for 2490 minutes in the 2 L counter with a mixing ratio of 1.00.

The uncorrected age is 3690 ± 70 .

GSC-4308 Rep. Stage 1: Sample "E" 3600 ± 60
 $\delta^{13}\text{C} = -30.0\text{‰}$

This is a replicate count in the 5 L counter of the first preparation of sample "E". The age estimate is based on two counts for 2410 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 3680 ± 60 .

GSC-4308 2. Stage 1: Sample "E" 3620 ± 60
 $\delta^{13}\text{C} = -28.9\text{‰}$

This is a second preparation of sample "E". The sample (35.5 g dry weight) received no treatment and yielded 7.3 L of CO_2 gas. The age estimate is based on one count for 4150 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 3680 ± 60 .

GSC-4309. Stage 1: Sample "H" 3530 ± 60
 $\delta^{13}\text{C} = -29.7\text{‰}$

Sample "H", carbonate, is a duplicate of sample "E" (GSC-4308). The sample (35.2 g dry weight) received no treatment and yielded 7.5 L of CO_2 gas. The age estimate is based on one count for 4180 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 3610 ± 60 .

GSC-4312. Stage 1: Sample "V" $\delta^{13}\text{C} = -25.5\text{‰}$
modern

Sample "V", carbonate, (35.3 g dry weight) received no treatment and yielded 6.5 L of CO_2 gas. The age estimate is based on three counts for 4140 minutes in the 5 L counter with a mixing ratio of 1.00.

GSC-4314. Stage 1: Sample "K" $\delta^{13}\text{C} = -25.9\text{‰}$
modern

Sample "K", carbonate, is a duplicate of sample "V" (GSC-4312). The sample (35.0 g dry weight) received no treatment and yielded 6.5 L of CO_2 gas. The age estimate is based on one count for 4180 minutes in the 5 L counter with a mixing ratio of 1.00.

The four unknowns (E, H, V, and K) included replicates. The samples were prepared and dated in November and December 1986.

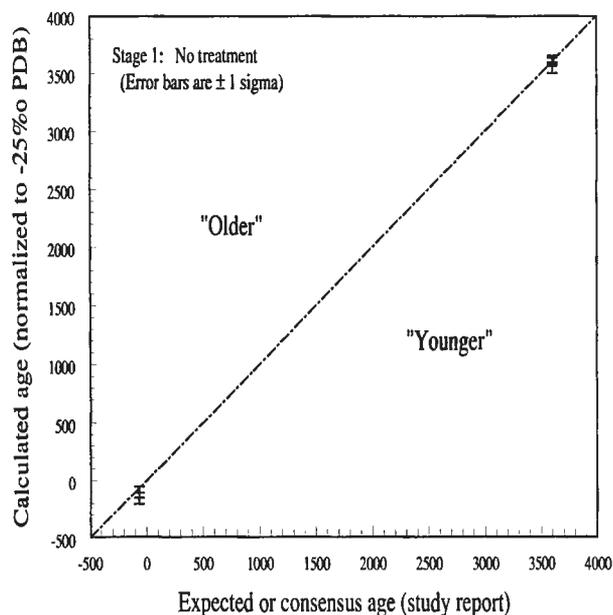


Figure 1. Comparison of the GSC age estimates with the expected or consensus age for Stage 1 samples.

Stage 2 was designed to investigate the effects of different laboratory processing techniques on various sample materials (pretreated algal carbonate, wood cellulose, and humic acid). The GSC laboratory selected algal carbonate and wood cellulose to test our acid digestion and burning techniques, respectively. The samples were pretreated in Glasgow before aliquots were sent to the participating laboratories. The pre-treatment for carbonate and wood cellulose are noted below:

- a) carbonate: a bulk sample of a marine alga (*Lithothamnion*) was collected and hand sorted to remove shell fragments, leached with dilute (0.5M) HCl to remove about the outer 10% of the material, washed with distilled water, and dried. The sample was thoroughly mixed during washing and after drying; and
- b) wood cellulose: prepared from 20 rings (dated dendrochronologically) by successive boiling in 2M potassium hydroxide, followed by bleaching in sodium chlorite, then washed with distilled water, and dried. The sample was thoroughly mixed by tumbling.

GSC-4437. Stage 2: Sample "D" 2050 ± 60
 $\delta^{13}\text{C} = -2.6\text{‰}$

The marine alga (*Lithothamnion*) carbonate, from a coastal deposit in southwest Scotland, was provided pretreated by the University of Glasgow in 1986. Sample

"D" is a duplicate of sample "C" (GSC-4438). The GSC laboratory did not treat the material. The sample (39.6 g) yielded 7.2 L of CO_2 gas. The age estimate is based on two counts for 2490 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 1690 ± 60 .

GSC-4438. Stage 2: Sample "C" 2020 ± 60
 $\delta^{13}\text{C} = -2.8\text{‰}$

The pre-treated marine alga (*Lithothamnion*) carbonate (38.0 g) yielded 8.3 L of CO_2 gas. The age estimate is based on two counts for 4200 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 1660 ± 60 .

GSC-4439. Stage 2: Sample "R" 2150 ± 60
 $\delta^{13}\text{C} = -24.1\text{‰}$

The wood cellulose, sample "R", was provided pretreated by the University of Glasgow in 1986. The GSC laboratory did not treat the material. The pretreated sample (10.3 g) yielded 7.2 L of CO_2 gas. The age estimate is based on one count for 4200 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 2130 ± 60 .

GSC-4440. Stage 2: Sample "Z" 2160 ± 60
 $\delta^{13}\text{C} = -25.9\text{‰}$

The wood cellulose, sample "Z", is a duplicate of sample "R" (GSC-4439). The pretreated sample (10.0 g) yielded 6.8 L of CO_2 gas. The age estimate is based on two counts for 4200 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 2170 ± 60 .

The four unknowns (C, D, R, and Z) included replicates. The samples were prepared and dated in May and June 1987.

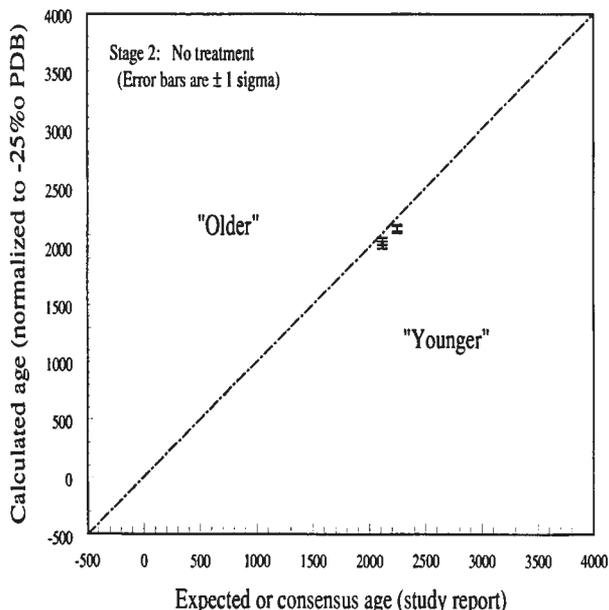


Figure 2. Comparison of the GSC age estimates with the expected or consensus ages for Stage 2 samples.

Stage 3 was designed to investigate the effects of complete laboratory treatment on the dating of natural samples of wood, shells, and peat. During Stage 3 of the study GSC dated all the types of material available, that is wood, peat, and shells, as well as a marine sediment. Each gas preparation was counted in both the 2 L and 5 L counters except for the marine sediment, and one of the shell samples (GSC-4666), because the gas leaked from the cylinder before it was re-counted. All the study data have been summarized at the end of this section.

Note: All ages in this study, including those for marine shells, have been normalized to -25.0‰ (cf. Introduction).

Shells

The marine shells (*Anadara antiquata*; identified by D.R. Harris) were enclosed in a midden, near the surface in an æolian sand facies of a beach fore dune. A bulk sample was excavated from 25-35 cm depth in a 1 m² quadrant (site code MOA MID/81/02) by D.R. Harris (University of London) in August 1981 on Moa Island, Torres Strait, northern Queensland, Australia. Modern specimens of this species have an aragonitic structure. The sample had no pretreatment prior to receipt in the GSC laboratory.

GSC-4666 5L. Stage 3: Sample "P" 700 ± 50
 $\delta^{13}\text{C} = +2.0\text{‰}$

The marine shell sample "P" (53 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (37.7 g) yielded 8.49 L of CO₂ gas. The age estimate is based on two counts for 2090 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 27.173 ± 0.120 , 2.150 ± 0.021 , and 28.081 ± 0.126 cpm, respectively.

The uncorrected age is 260 ± 50 .

GSC-4666 2L. Stage 3: Sample "P"
 Lost before re-counting.

GSC-4667 5L. Stage 3: Sample "X" 650 ± 50
 $\delta^{13}\text{C} = +0.2\text{‰}$

The marine shell sample "X" (46.3 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (37.4 g) yielded 8.43 L of CO₂ gas. The age estimate is based on one count for 2860 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 27.216 ± 0.104 , 2.150 ± 0.021 , and 28.081 ± 0.126 cpm, respectively.

The uncorrected age is 250 ± 50 .

GSC-4667 2L. Stage 3: Sample "X" 720 ± 60
 $\delta^{13}\text{C} = +0.2\text{‰}$

The age estimate is based on two counts for 2080 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.464 ± 0.099 , 1.059 ± 0.029 , and 18.169 ± 0.099 cpm, respectively.

The uncorrected age is 320 ± 60 .

The shell sample "X" (GSC-4667) is a duplicate of sample "P" (GSC-4666).

Peat

The peat samples were collected by G. Cook in Scotland for this International Collaborative Study. The bulk peat was dried then homogenized and pelletized. Fine rootlets were extracted. The samples were provided as fine powders (E.M. Scott, personal communication, 1988).

GSC-4674 2L. Stage 3: Sample "F" 340 ± 60
δ¹³C= -25.3‰

The age estimate is based on two counts for 2040 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.397 ± 0.100, 1.059 ± 0.029, and 18.169 ± 0.099 cpm, respectively.

The uncorrected age is 350 ± 60.

The wood sample "F" has a dendochronological age of 1521-1550 AD (i.e., 400-430 BP).

GSC-4677 5L. Stage 3: Sample "T" 2140 ± 60
δ¹³C= -25.6‰

The sample (13.8 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.5 g) yielded 8.24 L of CO₂ gas. The age estimate is based on two counts for 3635 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 21.475 ± 0.121, 2.150 ± 0.021, and 28.081 ± 0.126 cpm, respectively.

The uncorrected age is 2150 ± 60.

GSC-4676 5L. Stage 3: Sample "N" 2210 ± 50
δ¹³C= -26.1‰

The sample (13.7 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.5 g) yielded 8.20 L of CO₂ gas. The age estimate is based on two counts for 2440 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 21.267 ± 0.100, 2.150 ± 0.021, and 28.081 ± 0.126 cpm, respectively.

The uncorrected age is 2230 ± 50.

GSC-4677 X. Stage 3: Sample "T" 2180 ± 80
δ¹³C= -25.6‰

The age estimate is based on one count for 1130 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 21.423 ± 0.148, 2.166 ± 0.034, and 28.137 ± 0.173 cpm, respectively.

The uncorrected age is 2190 ± 80.

GSC-4676 2L. Stage 3: Sample "N" 2210 ± 60
δ¹³C= -26.1‰

The age estimate is based on one count for 3750 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.774 ± 0.069, 1.059 ± 0.029, and 18.169 ± 0.099 cpm, respectively.

The uncorrected age is 2220 ± 60.

GSC-4677 2L. Stage 3: Sample "T" 2290 ± 70
δ¹³C= -25.6‰

The age estimate is based on two counts for 2040 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.650 ± 0.090, 1.059 ± 0.029, and 18.169 ± 0.099 cpm, respectively.

The uncorrected age is 2300 ± 70.

The wood sample "T" has dendochronological age of 220-240 BC (i.e., 2170-2190 BP). Sample "T" (GSC-4677) is a duplicate of sample "N" (GSC-4676).

The wood sample "N" has a dendochronological age of 220-240 BC (i.e., 2170-2190 BP).

The eight unknown samples (F, L, N, P, T, W, and X) included duplicates. All samples were counted in both the 5 L and 2 L counters to provide an internal check of our complete counting system. All these samples were processed and dated between August and November 1988.

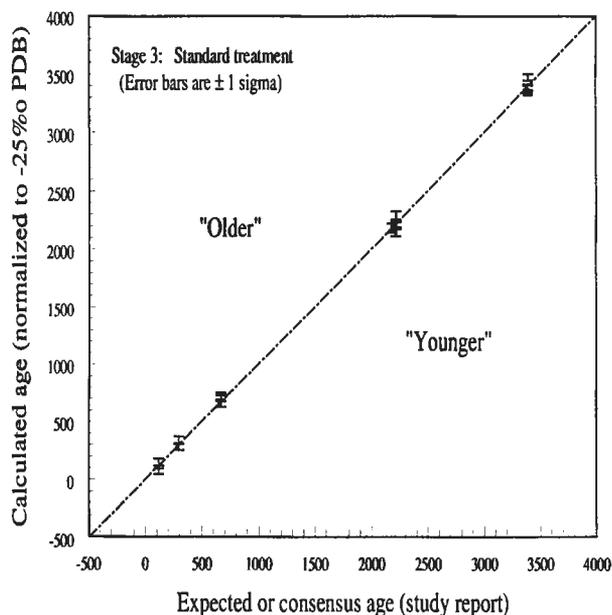


Figure 3. Comparison of the GSC age estimates with the expected or consensus age for Stage 3 samples.

The figures for each stage indicate that the GSC age estimates compare very favourably with the expected ages (cf. table listing). In stages 1 and 2 the GSC laboratory tended to provide ages slightly younger than the expected ages; but in stage 3 of the study, in which each laboratory carried out the complete treatment on natural samples, the GSC age estimates were excellent.

During the study, 27 age estimates were made and are listed below:

Table 3. International Collaborative Study Data.

Lab No.	Material	Age (BP)*			$\delta^{13}\text{C}$
		Expected	Corrected	Uncorrected	
Stage 1 No treatment					
GSC-4308	carbonate	3600	3610 ± 70	3690 ± 70	-30.0
GSC-4308 R.	carbonate	3600	3600 ± 60	3680 ± 60	-30.0
GSC-4308 2L	carbonate	3600	3620 ± 60	3680 ± 60	-28.9
GSC-4309	carbonate	3600	3530 ± 60	3610 ± 60	-29.7
GSC-4312	carbonate	-66	-100 ± 50	-90 ± 50	-25.5
GSC-4314	carbonate	-66	-160 ± 50	-150 ± 50	-25.9
Stage 2 No treatment					
GSC-4437	carbonate	2120	2050 ± 60	1690 ± 60	-2.6
GSC-4438	carbonate	2120	2020 ± 60	1660 ± 60	-2.8
GSC-4439	cellulose	2250	2150 ± 60	2130 ± 60	-24.1
GSC-4440	cellulose	2250	2160 ± 60	2170 ± 60	-25.9
Stage 3 Standard treatment					
5 L counter					
GSC-4666 5L shells		670	700 ± 50	260 ± 50	+2.0
GSC-4667 5L shells		670	650 ± 50	250 ± 50	+0.2
GSC-4671 5L peat		3395	3380 ± 60	3460 ± 60	-29.5
GSC-4672 5L peat		3395	3340 ± 50	3380 ± 50	-27.0
GSC-4673 5L wood		100 ± 15	70 ± 50	100 ± 50	-26.6
GSC-4674 5L wood		290 ± 15	280 ± 50	290 ± 50	-25.3
GSC-4676 5L wood		2185 ± 10	2210 ± 50	2230 ± 50	-26.1
GSC-4677 5L wood		2185 ± 10	2140 ± 60	2150 ± 60	-25.6
GSC-4677 X wood		2185 ± 10	2180 ± 80	2190 ± 80	-25.6
2 L counter					
GSC-4666 2L shells		670	lost	—	—
GSC-4667 2L shells		670	720 ± 60	320 ± 60	+0.2
GSC-4671 2L peat		3395	3370 ± 60	3440 ± 60	-29.5
GSC-4672 2L peat		3395	3470 ± 60	3500 ± 60	-27.0
GSC-4673 2L wood		100 ± 15	150 ± 60	180 ± 60	-26.6
GSC-4674 2L wood		290 ± 15	340 ± 60	350 ± 60	-25.3
GSC-4676 2L wood		2185 ± 10	2210 ± 60	2220 ± 60	-26.1
GSC-4677 2L wood		2185 ± 10	2290 ± 70	2300 ± 70	-25.6

*GSC errors are unconventionally $\pm 2\sigma$; all ages are conventionally corrected to -25‰

Figure 4a below which includes data from all three stages, compares the GSC laboratory with other laboratories worldwide.

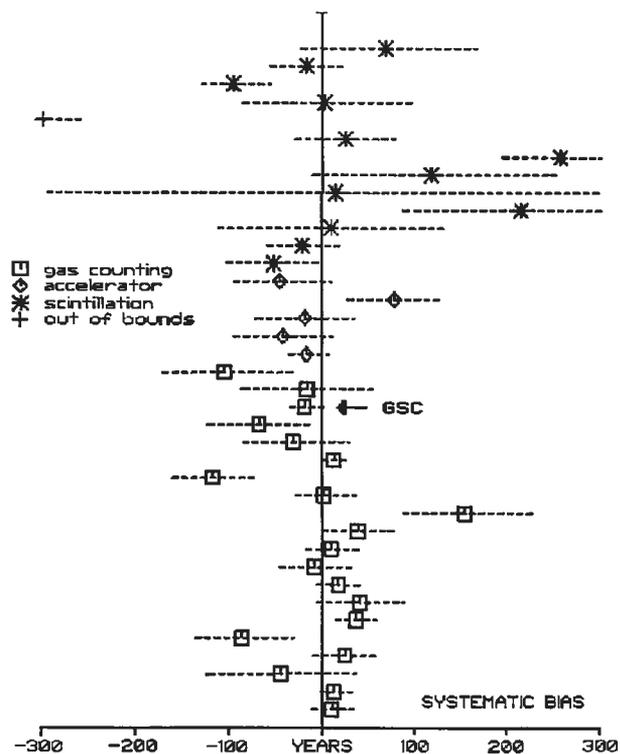


Figure 4a. Systematic Bias of Laboratories
(after Scott et al., 1990, figure 8)

The offset for the GSC laboratory, to the left of the Y-axis, indicates a negative bias of less than 20 years, thus GSC age estimates may be slightly younger than the true age of the sample. The very small confidence interval attests to the high precision of the GSC laboratory.

Figure 4b provides an estimate of how well the reported laboratory error ($\pm 1\sigma$) accounts for interlaboratory variability (external error multiplier, EEM; Scott et al., opt. cit.), for all the laboratories involved in the study.

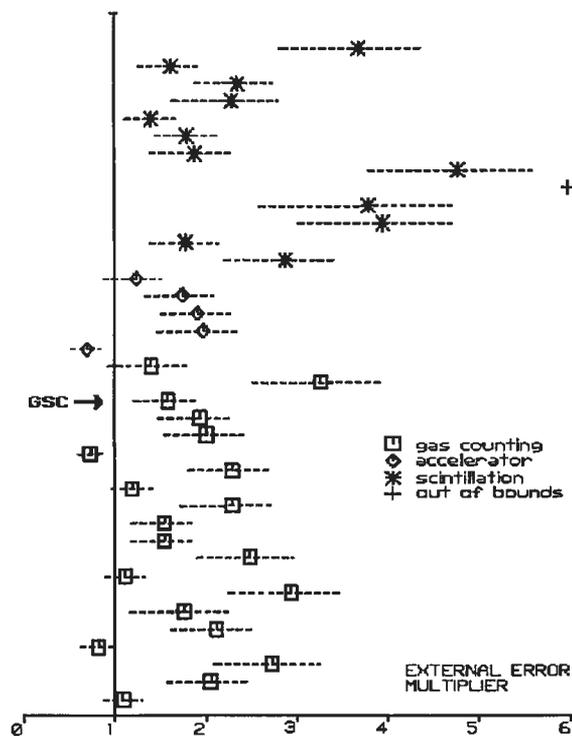


Figure 4b. External Error Multiplier
(after Scott et al., 1990, figure 9)

The GSC laboratory has an EEM of 1.6 and therefore $\pm 1\sigma$ on a GSC age estimate may not fully account for interlaboratory variability. Note that the GSC unconventionally reports its errors as $\pm 2\sigma$.

EASTERN CANADA

Newfoundland

Marine Sediment

GSC-4668 IP. Stage 3: $18\,100 \pm 190$
 $\delta^{13}\text{C} = +0.6\text{‰}$

The sediment, carbonate fraction (58% of the sample; 117.4 g dry weight) had no pretreatment prior to processing but lost 2.4% on drying. The treated sample (69.6 g) yielded 8.82 L of CO₂ gas. The age estimate is based on two counts for 2170 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.095 ± 0.060 , 2.221 ± 0.031 , and 28.121 ± 0.123 cpm, respectively.

The uncorrected age is $17\,700 \pm 190$.

GSC-4668 OP. Stage 3: $18\,600 \pm 440$
 $\delta^{13}\text{C} = -17.4\text{‰}$

The sediment, organic fraction (0.5% OC; 202.0 g dry weight) was treated with hot acid, and distilled water rinses; base treatment was omitted (very calcareous). The treated sample (65.7 g) yielded 1.44 L of CO₂ gas. The age estimate is based on two counts for 2360 minutes in the 2 L counter with a mixing ratio of 3.07. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 1.806 ± 0.096 , 1.053 ± 0.017 , and 18.090 ± 0.096 cpm, respectively.

The uncorrected age is $18\,500 \pm 440$.

Laboratory comment: Under normal operating conditions the GSC Laboratory would NOT have dated this material. The sediment was analyzed for carbon using a LECO Analyzer:

organic carbon = 0.5%; and
total carbon = 7.5% (i.e., CaCO₃ equivalent of 58%).

The GSC Laboratory does not date soils or sediments containing less than 2% organic carbon (i.e., 5% organic matter) because of a high possibility of contamination with "old" carbon, thereby generating an anomalous age.

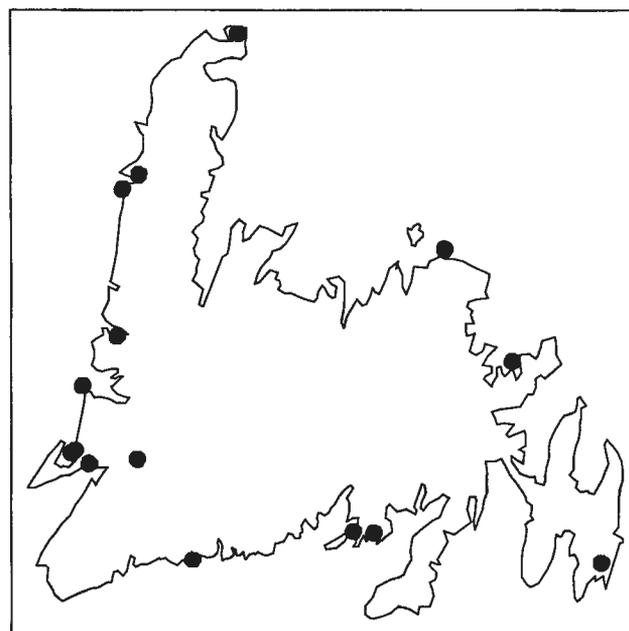


Figure 5. Radiocarbon dated sites in Newfoundland.

GSC-4606. Sandy Point Island modern
 $\delta^{13}\text{C} = -28.1\text{‰}$

The peat with disseminated sand was enclosed in peat and sand. Sample 8709-066 was collected by J. Shaw on September 22, 1987, from the west end of Sandy Point Island, about 5 km from the settlement of St. Georges, St. Georges Bay, Newfoundland ($48^{\circ}26.70'\text{N}$, $53^{\circ}32.51'\text{W}$), at an elevation of 2.05 m (mwl); submitted by D.L. Forbes.

The sample (47.6 g dry weight) was treated with cold base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (27.1 g) yielded 9.16 L of CO₂ gas. The age estimate is based on one count for 1110 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 28.418 ± 0.168 , 2.094 ± 0.026 , and 28.208 ± 0.143 cpm, respectively.

Comment (D.L. Forbes): This date is on freshwater peat overlying sandy beach ridges on Sandy Point, the island that forms the eastern section of the Flat Island barrier. The oldest date obtained hitherto on this part of the barrier is 470 ± 60 BP (Beta-19571). The oldest date from the western section of the barrier is 1350 ± 70 BP (Beta-19583) (Shaw and Forbes, 1987). It is clear that the peat is of very recent origin. Sandy Point is believed to be much older.

GSC-4739. Biscay Bay 1140 ± 50
 $\delta^{13}\text{C} = -26.2\text{‰}$

The wood (*Abies balsamea*; identified by H. Jetté (unpublished GSC Wood Report No. 88-02)) was enclosed in peat. Sample 8805-008 was collected by J. Shaw and D.L. Forbes on May 22, 1988, from on the barrier at Biscay Bay, 0.5 km east of the settlement of Biscay Bay, Avalon Peninsula, Newfoundland ($46^{\circ}44.70'\text{N}$, $53^{\circ}17.33'\text{W}$), at an elevation of 0.6 m (mwl); submitted by D.L. Forbes.

The sample (10.4 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.5 g) yielded 8.01 L of CO_2 gas. The age estimate is based on two counts for 2200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 24.506 ± 0.113 , 2.135 ± 0.026 , and 28.327 ± 0.120 cpm, respectively.

The uncorrected age is 1160 ± 50 .

Comment (D.L. Forbes): This date is on a rooted stump, contained in 1 m thick peat, which overlies gravel on the shore of the lagoon behind the barrier at Biscay Bay. The gravel forms a prograded series of beach ridges behind the contemporary barrier, a gravel ridge cresting at 3.4 m (mwl). The date shows that the progradation occurred prior to 1.1 ka BP. It is corroborated by a date of 1230 ± 70 BP (Beta-27232) on the lowest 5 cm of peat at a nearby site.

Doting Cove Series

A series of peat samples from about 4 km southeast of the settlement of Doting Cove, District of Fogo, Newfoundland ($49^{\circ}26.14'\text{N}$, $53^{\circ}54.00'\text{W}$), at an elevation of 2.41 m (mwl), and ($49^{\circ}26.05'\text{N}$, $53^{\circ}54.00'\text{W}$), at a depth of 0.1 m (mwl), was collected by J. Shaw on September 19, 1987; submitted by D.L. Forbes.

GSC-4604. Doting Cove (I) 210 ± 50
 $\delta^{13}\text{C} = -28.9\text{‰}$

The peat, with disseminated sand, sample 8709-043 (30.4 g wet weight), enclosed in peat and sand, was treated with cold base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (22.9 g) yielded 8.38 L of CO_2 gas. The age estimate is based on two counts for 2230 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 27.261 ± 0.118 , 2.094 ± 0.026 , and 28.208 ± 0.143 cpm, respectively.

The uncorrected age is 270 ± 50 .

Comment (D.L. Forbes): This date is on the uppermost 2 cm of thick (up to 3 m) peat overlying the Man Point beach-ridge foreland (Shaw and Forbes, 1990c). The date shows that the veneer of æolian sand, which overlies much of the peat, postdates 210 radiocarbon years. This would support the hypothesis that dune instability may have been linked to European settlement in the region.

GSC-4662. Doting Cove (II) 3060 ± 90
Man Point foreland $\delta^{13}\text{C} = -29.0\text{‰}$

The peat sample, 8709-035 (14 g dry weight), enclosed in peat and sand was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (12.0 g) yielded 8.01 L of CO_2 gas. The age estimate is based on two counts for 2090 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.178 ± 0.081 , 1.052 ± 0.017 , and 17.959 ± 0.159 cpm, respectively.

The uncorrected age is 3120 ± 90 .

Comment (D.L. Forbes): This date is one of a series used to establish the pattern of coastal events and of late Holocene relative sea-level changes on the northeast coast of Newfoundland, between Musgrave Harbour and Cape Freels (Shaw and Forbes, 1990c). The sample was from the basal 10 cm of peat overlying the Man Point beach-ridge foreland. The date confirms that the foreland was established prior to 3 ka BP.

GSC-4628. Forresters Point 8850 ± 110
 $\delta^{13}\text{C} = +0.9\text{‰}$

The marine shells (*Mya truncata*; identified by J-P. Guilbault) were enclosed in clay in a fresh face in a gravel pit. Sample WNF-3-3C Forresters Point was collected by J-P. Guilbault on October 15, 1981, from 87 km west-southwest of St. Anthony and 200 m east of highway 430, 2 km southwest of St. Barbe, on the west coast of the northern peninsula of Newfoundland (51°29.1'N, 55°32.4'W), at an elevation of 0-15 m; submitted by J-P. Guilbault.

The sample (27 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (27.1 g) yielded 4.88 L of CO₂ gas. The age estimate is based on three counts for 5190 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.018 ± 0.066, 1.038 ± 0.027, and 18.075 ± 0.093 cpm, respectively.

The uncorrected age is 8830 ± 110.

Comment (J-P. Guilbault): The dated shells, along with bryozoans, were found in life position in a clay deposit. Shells were anomalously soft and chalky, possibly from partial decalcification. This deposit is the only clay in a section otherwise dominated by sands and gravels whose macro- and micro-fossils are probably in good part redeposited. The foraminiferal fauna of the dated clay deposits is similar to that of the surrounding sandy deposits and resembles that of the Milan Arm (GSC-4649), except for the dominance of the attached foraminifera *Cibicides lobatulus*. This environment must have been shallow water along an open coastline, barely less open than at Milan Arm.

A series of dates from the west coast and the northern peninsula of Newfoundland were reported in a GSC Open File Report (Guilbault, 1984). Twenty-eight marine Quaternary sections were sampled during the fall of 1981. All the nearly 140 samples were studied for their foraminiferal content. The results can be found in Guilbault (1984). Macrofauna associated with some of these were dated. Also, many of the samples have had their ostracodal content discussed by Cronin (1988); these include the dated samples of Milan Arm, Forresters Point, and River of Ponds. Four of the dated samples (Milan Arm, Forresters Point, River of Ponds, and Glenburnie) gave ages of between 8.8 ka and 9.4 ka BP. The four sites are spread over a distance of 280 km along the Great Northern Peninsula of Newfoundland. All four samples yielded high diversity assemblages with a strong proportion of *Islandiella* spp. and *Elphidium* spp. and a lesser amount of *Cassidulina*

reniforme, abstraction made of the attached species *Cibicides lobatulus*, whose percentage is extremely variable (from 1 to 89%). This last species is not paleoecologically significant for the range of conditions represented here. This near-normal to normal marine assemblage indicates cold, Arctic-like conditions but does not suggest the presence of a nearby ice front. On the contrary, the Bottle Cove sample with its age of 12.6 ka BP yielded a low-diversity *Elphidium exavatum*–*Cassidulina reniforme* dominated assemblage suggesting less saline conditions and a greater glacial influence. A date of 12.5 ka BP was obtained by I.A. Brookes (Lowdon and Blake, 1980, GSC-2936) on a sample from Trout River (near Glenburnie), which was found by Guilbault (1984) to contain a similar assemblage indicating comparable glacial conditions. The present results demonstrate a definite environmental change over a 3.5 ka period during the late glacial and early postglacial times in northern Newfoundland.

GSC-4649. Milan Arm 9370 ± 110
 $\delta^{13}\text{C} = +1.9\text{‰}$

The marine shells (*Mya truncata*; identified by J-P. Guilbault) were enclosed in sandy clay. Sample WNF-1 Milan Arm was collected by J-P. Guilbault on October 14, 1981, from a coastal section 14 km due north of St. Anthony, Newfoundland, on the road to Raleigh, at the head of Milan Arm (Pistolet Bay), where Outardes River reaches the sea (51°29.1'N, 55°32.4'W), at an elevation of 1 m; submitted by J-P. Guilbault.

The sample (23.1 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (19.1 g) yielded 4.05 L of CO₂ gas. The age estimate is based on two counts for 2430 minutes in the 2 L counter with a mixing ratio of 1.11. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.638 ± 0.059, 1.035 ± 0.018, and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 9340 ± 110.

Comment (J-P. Guilbault): The dated shells were collected over two lithological units representing 1.2 m of stratigraphic thickness. Many were in life position. The foraminiferal assemblages collected at three points over those 1.2 m are extremely rich, up to 119 000 specimens per 100 g of dry sediment, and of high faunal diversity. They suggest a slight increase in water depth over the period of deposition of the dated units. This in turn could

mean that the measured age is a composite result. Water depth was probably never more than 30-40 m. The conditions were those of an open, shallow shelf, with a minimal influx of freshwater (polyhaline-stenohaline). An age of $10\,500 \pm 150$ BP (GSC-1343, collected by D.R. Grant, Lowdon and Blake, 1973) was obtained for *Mya truncata* from a similar deposit, rich in bryozoans and brachiopods, less than 2 km from the present site. A similar age was expected for the Milan Arm material because shell-rich sediments outcrop over a few kilometres around the present site. The reason for difference is not known, it could indicate time-transgressiveness of the deposit.

GSC-4644. River of Ponds 9300 ± 100
 $\delta^{13}\text{C} = +2.2\text{‰}$

The marine shells (*Hemithyris psittacea*, *Venericardia borealis*, and *Chlamys islandicus*) were enclosed in stony clay. Sample WNF-5 River of Ponds was collected by J-P. Guilbault on October 16, 1981, from along the coast, 2 km north of the village of River of Ponds, on the west coast of the northern peninsula of Newfoundland ($50^{\circ}32.6'N$, $57^{\circ}23.4'W$), at an elevation of 5 m; submitted by J-P. Guilbault.

The sample (17.0 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (15.4 g) yielded 3.34 L of CO_2 gas. The age estimate is based on one count for 4090 minutes in the 2 L counter with a mixing ratio of 1.33. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.688 ± 0.054 , 1.035 ± 0.018 , and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 9270 ± 100 .

Comment (J-P. Guilbault): All the shells were collected within a 1 m stratigraphic unit that consists of an interstratification of sand and stony clay. Part of the dated material was in life position. The stony clay contains a distinctive macrofossil assemblage rich in byozoans and brachiopods in growth position, with numerous *Chlamys* and *Venericardium*. It is comparable to the dated assemblages of Forresters Point and Milan Arm except that the present site did not yield *Mya truncata*. The foraminiferal assemblage is extremely rich (up to 147 000 specimens per 100 g of dry sediment) and similar to the Forresters Point (GSC-4628) and Milan Arm (GSC-4649) localities, except for the even greater abundance (up to 89%) of the attached form *Cibicides lobatulus*. This assemblage suggests shallow, open coastline conditions, far from glacial fronts.

GSC-4654. Glenburnie 9340 ± 90
 $\delta^{13}\text{C} = +1.9\text{‰}$

The marine shells (*Mya truncata*; identified by J-P. Guilbault) were enclosed in silty and sandy clay. Sample WNF-13 Glenburnie was collected by J-P. Guilbault on October 20, 1981, from a road cut along highway 431, 1 km (straight line) west of Glenburnie at the head of the South Arm of Bonne Bay on the west coast of Newfoundland ($49^{\circ}26.0'N$, $57^{\circ}52.7'W$), at an elevation of less than 1 m; submitted by J-P. Guilbault.

The sample (40.3 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (32.3 g) yielded 7.07 L of CO_2 gas. The age estimate is based on one count for 4110 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.674 ± 0.044 , 1.053 ± 0.010 , and 18.090 ± 0.096 cpm, respectively.

The uncorrected age is 9310 ± 90 .

Comment (J-P. Guilbault): The dated shells were in life position. The associated foraminiferal assemblage is polyhaline (25-32‰), less open-marine than at Milan Arm, and represents a bathymetry of probably more than 20 m. Although cold, it does not suggest the presence of a nearby glacier. The assemblage of the underlying bed may be somewhat shallower (≤ 20 m) and less saline in character, whereas the overlying bed with its *Mytilus edulis* and low-diversity foraminiferal assemblage is clearly shallow, nearly emergent, and very hyposaline (maybe as low as 10‰). It may therefore be concluded that a regression took place after 9.3 ka BP, but it is more difficult to assert that a transgression took place before that time.

GSC-4669. Hawke Bay 7040 ± 70
 $\delta^{13}\text{C} = -24.5\text{‰}$

The wood fragments from a single piece (unidentifiable by H. Jetté (unpublished GSC Wood Report No. 88-25)) were enclosed in silt. Sample WNF-4-4 Hawke Bay was collected by J-P. Guilbault on October 16, 1981, from exposed banks of Little East River, downstream from highway 430 bridge, 1.2 km along the road north of Hawke Bay, west coast of northern peninsula, Newfoundland ($50^{\circ}37.2'N$, $57^{\circ}9.4'W$), at an elevation of 0 m; submitted by J-P. Guilbault.

calcareous). The treated sample (11.5 g) yielded 5.24 L of CO₂ gas. The age estimate is based on one count for 2345 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 16.412 ± 0.088, 1.072 ± 0.016, and 18.025 ± 0.147 cpm, respectively.

The uncorrected age is 750 ± 80.

Comment (D.L. Forbes): This is the lowest 5 cm of freshwater peat, 0.85 m thick, which partly infills the freshwater pond behind a small barrier. The date provides a minimum for the emplacement of a series of sandy beach ridges behind the barrier.

GSC-4875. Coombes Cove 1710 ± 70
 $\delta^{13}\text{C} = -25.4\text{‰}$

The peat was enclosed in sandy peat. Sample 87302-001 was collected by J. Shaw and D.L. Forbes on September 13, 1987, from Coombes Cove settlement on the north side of Fortune Bay, Fortune-Hermitage District, Newfoundland (47°27.56'N, 55°37.45'W), at an elevation of about 0.8 m; submitted by J. Shaw.

The sample (49.1 g wet weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (14.7 g) yielded 4.49 L of CO₂ gas. The age estimate is based on two counts for 2020 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.488 ± 0.090, 1.070 ± 0.019, and 17.936 ± 0.117 cpm, respectively.

The uncorrected age is 1720 ± 70.

Comment (J. Shaw): The sample is from the basal 0.1 m of saltmarsh, 1.3 m thick, which overlies sand and gravel in a salt marsh immediately behind the small barrier beach at Coombes Cove settlement. It is probably indicative of slowly rising sea level since 1.7 ka BP; a more precise estimate of sea level at that time awaits analysis of pollen and survey data from this site.

GSC-4629. Little Brook Pond 9620 ± 170
 $\delta^{13}\text{C} = +0.1\text{‰}$

The marine mollusc shells (see list below) were enclosed in silty clay. Sample 8709-045 was collected by D.L. Forbes, J. Shaw, and D. Frobel on September 20, 1987, from Little Brook Pond, about 10 km southwest of Port Saunders, St. Barbe South District, Newfoundland

(50°32.82'N, 57°23.46'W), at an elevation of 2.6 m (mwl); submitted by D.L. Forbes.

The sample (9.3 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (8.46 g) yielded 1.83 L of CO₂ gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 2.39. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.442 ± 0.106, 1.035 ± 0.018, and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 9620 ± 170.

List of taxa identified by F. Cole:

<i>Astarte crenata</i> (Gray)	5 valves	reworked
<i>A. elliptica</i> (Brown)	5 valves	reworked
<i>A. montagui</i> (Dillwyn)	3 valves	reworked
<i>Chlamys islandica</i> (Muller)	1 valve	reworked
<i>Cyclocardia borealis</i> (Conrad)	5 valves	reworked
<i>Hiatella arctica</i> (Linné)	1 valve	reworked
<i>Macoma moesta</i> (Deshayes)	3 valves	reworked
<i>Mya truncata</i> (Linné)	4 valves	reworked
<i>Nuculana minuta</i> (Fabricus)	2 valves	reworked
<i>N. temisulcata</i> (Courthuoy)	2 fragments	reworked
<i>Spisula polynyma</i> (Stimpson)	1 valve	reworked
<i>Yoldice thraciaeformis</i> (Storer)	1 valve	reworked
Mussel fragments		
<i>Colus</i> sp.	1 juvenile	reworked
<i>Lepeta caeca</i> (Muller)	4 shells	fresh specimens
<i>Trichotropis borealis</i> (Broderip and Sowerby)	1 shell	fresh specimen
Brachiopoda	1 valve	reworked
Miscellaneous mollusc fragments		
Barnacle fragments		
Bryozoan stems		

This sample was taken in the belief that it would shed some light on relative sealevel changes in the area during the past several thousand years. However, because of its relatively great age, it adds little to the known pattern of sealevel change in the region.

GSC-4631. Southwest Brook 11 100 ± 120
 $\delta^{13}\text{C} = -21.4\text{‰}$

The lake sediment, gyttja, was enclosed in buff-grey clay. Sample AP-86-9A (383-386 cm) was collected by T.W. Anderson on August 20, 1986, from a lake near Southwest Brook, 44 km east of Stephenville, Newfoundland (48°27'45"N, 57°59'32"W), at an elevation of 135 m; submitted by T.W. Anderson.

The sample (198.7 g wet weight) was treated with hot acid, and distilled water rinses; base treatment was omitted (noncalcareous). The treated sample (61.1 g) yielded 3.32 L of CO₂ gas. The age estimate is based on one count for 4200 minutes in the 2 L counter with a mixing ratio of 1.34. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.588 ± 0.056, 1.038 ± 0.027, and 18.075 ± 0.093 cpm, respectively.

The uncorrected age is 11 000 ± 120.

Comment (T.W. Anderson): This sample dates the resumption of gyttja deposition and associated climatic amelioration following a previous period of clay deposition and climatic deterioration that is equated with the Younger Dryas cooling of the North Atlantic Ocean (10-11 ka BP).

GSC-4767.	"Sandbanks" Provincial Park	120 ± 50 δ ¹³ C= -31.2‰
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The peat was enclosed in peat and sand. Sample 8808-002 was collected by J. Shaw and D.L. Forbes in August 1988, from "Sandbanks" Provincial Park, 2 km west of the town of Burgeo, Burgeo and La Poile District, Newfoundland (47°36.00'N, 57°39.20'W), at an elevation of 1.6 m (mwl); submitted by D.L. Forbes.

The sample (365.5 g wet weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (22.4 g) yielded 8.13 L of CO₂ gas. The age estimate is based on two counts for 1965 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 27.678 ± 0.126, 2.153 ± 0.022, and 28.455 ± 0.126 cpm, respectively.

The uncorrected age is 220 ± 50.

Comment (D.L. Forbes): This sample was collected as part of an effort to date prograding coastal beach-ridge series throughout the island of Newfoundland. It is the only dated sample from the Burgeo region and shows that the prograded sandy beach-ridge plain at this site predates 120 radiocarbon years. The peat probably began to accumulate on top of the low beach ridges at the rear of the system as a result of rising water tables.

GSC-4724.	Port au Port Bay	9570 ± 150 δ ¹³ C= +2.6‰
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The marine shells (*Spisula polynyna*; identified by A. Cole) were enclosed in muddy fine sand with pebbles and shells. Sample 88018-E-08-020 was collected by J. Shaw and D.L. Forbes on August 11, 1988, from about 15 km northwest of the town of Stephenville, Port au Port District, Port au Port Bay, Newfoundland (48°37.42'N, 58°42.53'W), at a depth of 34.5 m (mwl); submitted by D.L. Forbes.

The sample (12.9 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (10.6 g) yielded 2.19 L of CO₂ gas. The age estimate is based on two counts for 2110 minutes in the 2 L counter with a mixing ratio of 2.07. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.524 ± 0.096, 1.109 ± 0.018, and 18.080 ± 0.095 cpm, respectively.

The uncorrected age is 9520 ± 150.

Comment (D.L. Forbes): This radiocarbon date is one of three obtained on shell material from core 8-20, a 1.8 m long gravity core collected in East Bay, Port au Port Bay, in 34 m water depth (Forbes and Shaw, 1989). The shells were recovered from a sand layer 0.55 m downcore, unconformably overlying stratified mud interpreted as glacial marine and early paraglacial deposits. The date constrains the age of these materials and is interpreted to represent shoreface reworking of sand at the postglacial lowstand of relative sea level (Forbes et al., in press). AMS dates on *Astarte undata* (a paired valve) and on two pairs (one of *Astarte undata* and one of *Nuculana pernula*) at 1.02-1.08 m downcore were 10 920 ± 100 BP (Beta 3005/ETH 5043) and 10 755 ± 95 BP (Beta 3003/ETH 5041), respectively. The oldest date from the glaciomarine mud in Port au Port Bay was 13 300 ± 115 BP (Beta 3002/ETH 5040), on a paired valve of *Portlandia arctica* from 1.35 m below seabed in a nearby core collected in 41 m water depth (Shaw and Forbes, 1990a; Forbes et al., in press).

GSC-4730.	Stephenville	490 ± 70 δ ¹³ C= -28.4‰
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The peat and wood fragments (mainly conifer; identified by R.J. Mott (unpublished GSC Wood Report No. 89-13)) were enclosed in gravel and sand. Sample 8709-081 was collected by J. Shaw and D.L. Forbes on September 24,

1987, from beach-ridge plain 4 km southeast of the town of Stephenville, Port au Port District, Newfoundland (48°30.68'N, 58°32.40'W), at an elevation of 0.7 m (mwl); submitted by D.L. Forbes.

The sample (88 g dry weight) was treated with cold base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (49.6 g) yielded 8.38 L of CO₂ gas. The age estimate is based on one count for 1100 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 26.367 ± 0.163, 2.152 ± 0.026, and 28.221 ± 0.153 cpm, respectively.

The uncorrected age is 550 ± 70.

Comment (D.L. Forbes): This sample was submitted to date the prograded beach-ridge plain at Stephenville and was expected to be older than 1 ka BP, and possibly as much as 1.35 ka BP, which is the oldest of a series of dates on the nearby Flat Island barrier (Shaw and Forbes, 1987). It is believed that organic materials began to accumulate at the sample location some considerable period after the beach ridges were emplaced, possibly as a result of rising water tables.

GSC-4733. Two Guts Pond 9020 ± 100
δ¹³C = -29.1‰

The peat was enclosed in peat. Sample 8808-016 was collected by J. Shaw and D.L. Forbes on August 7, 1988, from Two Guts Pond about 12 km northwest of Stephenville, Port au Port District, Newfoundland (48°38.20'N, 58°40.00'W), at an elevation of 0.1 m (mwl); submitted by D.L. Forbes.

The sample (242.8 g wet weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (42.0 g) yielded 8.10 L of CO₂ gas. The age estimate is based on two counts for 2190 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.139 ± 0.094, 2.135 ± 0.026, and 28.327 ± 0.120 cpm, respectively.

The uncorrected age is 9090 ± 100.

Comment (D.L. Forbes): This sample was from the lowest 3 cm of freshwater peat, 1.80 m thick, exposed by coastal erosion on the shore of a tidal inlet. It provides another data point on the relative sea-level curve for the region (Brookes et al., 1985; Grant, 1987; Shaw and Forbes, 1990b) and confirms that relative sea level had dropped below present sea level by 9 ka BP.

Labrador

GSC-4651. Moran Lake (I) 6550 ± 80
δ¹³C = +1.1‰

The marine shells (mixed shell collection) were enclosed in marine silts and sands. Sample 87914 was collected by M. Batterson on July 8, 1987, from 12 km downstream from Moran Lake, central Labrador, Newfoundland (54°34'18"N, 60°43'30"W), at an elevation of 40 m; submitted by R.A. Klassen.

The sample (24.2 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (21.7 g) yielded 4.81 L of CO₂ gas. The age estimate is based on two counts for 2430 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.995 ± 0.064, 1.035 ± 0.018, and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 6530 ± 80.

TO-1123. Moran Lake (II) 7690 ± 60

The marine shells (*Nuculana*; identified by M. Batterson) were collected by M.J. Batterson on the Kaipokok River, 5 km downstream from Moran Lake, central Labrador, Newfoundland (54°34'N, 60°43'W), at an elevation of 58 m; submitted by M.J. Batterson.

Comment (R.A. Klassen): The shells were exposed following a river-bank failure along the Kaipokok River. Shells were a mixed collection containing *Macoma calcarea*, *Mytilus edulis*, *Clinocardium*, and *Ponopea norvegia* (identified by E. Burden). The age likely reflects the position of sea level during coastal emergence from the marine limit of about 125 m above sea level. The date falls close to the emergence curve for the area presented by Clark and Fitzhugh (1990). Shells (*Nuculana* sp.), found 7 km upstream at 58 m above sea level, were dated at 7690 ± 60 BP (TO-1123) and were used to infer a minimum age for marine deltas near Moran Lake at 125 m above sea level (Awadallah and Batterson, 1990). This date is also consistent with the Clark and Fitzhugh (1990) emergence curve.

Nova Scotia



Figure 6. Radiocarbon dated sites in Nova Scotia.

GSC-4967. Benacadie 4 Site $10\ 800 \pm 120$
 $\delta^{13}\text{C} = -27.9\%$

The wood (*Salix*; identified by R.J. Mott (unpublished GSC Wood Report No. 90-24)) was enclosed in organic silt/sand. Sample 84-MS-24 was collected by R.J. Mott on June 29, 1984, from Benacadie 4 Site, about 10 km southwest of Eskasoni, on north shore of East Bay, Bras D'Or Lake, Cape Breton Island, Nova Scotia ($45^{\circ}54'15''\text{N}$, $60^{\circ}41'20''\text{W}$), at an elevation of 6-7 m; submitted by R.J. Mott.

The sample (9.2 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (5.4 g) yielded 5.51 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.620 ± 0.056 , 1.030 ± 0.018 , and 17.892 ± 0.101 cpm, respectively.

The uncorrected age is $10\ 900 \pm 120$.

Comment (R.J. Mott): A coastal section shows a small V-shaped valley eroded in till, with a lag of coarse boulders at the base, that has been infilled with organic and mineral sediments. Overlying the boulders is a banded silt/sand

sequence up to 1.6 m thick with organic seams and intrusive layers of diamicton buried by less than 1.5 m of coarse sand, gravel, and diamicton. Willow (*Salix*) twigs from a dark organic horizon mid-way up the sand/silt sequence were used for dating. Wedges of diamicton (reworked local till) appear to have slumped into the depression and parted the organic horizon. Pollen analysis shows a succession from herb dominated spectra to shrub tundra spectra with abundant *Salix* and *Betula* (birch) below the dated level. Above, *Betula* declines abruptly and herbaceous taxa regain prominence suggesting reversion to colder conditions after 10.8 ka BP. The site is one of many in the Maritimes that represent a late-glacial interstadial interval and reversion to colder stadial (Younger Dryas) conditions (Mott et al., 1986; Stea and Mott, 1989).

Amaguadees Site Series

A series of sandy peat samples from Amaguadees Site, about 7 km southwest of Eskasoni, East Bay, Bras D'Or Lake, Cape Breton Island, Nova Scotia ($45^{\circ}54'45''\text{N}$, $60^{\circ}40'20''\text{W}$), at an elevation of about 7 m, was collected by R.J. Mott on July 1, 1982; submitted by R.J. Mott.

A late-glacial buried organic deposit was exposed in a coastal site along East Bay. The section showed dark red till at the base that was leached (gleyed) to grey to a depth of about 30 cm below overlying organic sediments. The overlying organic sediment package had at its base about 70 cm laminated silty organics with some thin peat layers below grey silt and sand with sand lenses. Compressed, matted fibrous peat up to 1 m thick overlay the silt and sand and was overlain by 10 cm of organic silt and 1 m or more of bouldery colluvium. A wedge of red bouldery diamicton (reworked till) intruded the peat layer. The basal part of sediment package below the diamicton was highly disturbed. The site was originally discovered by S. Occhietti.

GSC-4063. Amaguadees Site (I) $10\ 400 \pm 120$
 $\delta^{13}\text{C} = -27.4\%$

The peat and silty peat, sample MS-82-31 (Top 2 cm; 75.3 g wet weight) enclosed in peat and colluvium, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The age estimate is based on two 1-day counts (2080 minutes) in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is $10\ 400 \pm 120$.

GSC-4974. Amaguadees Site (II) 11 700 ± 130
 $\delta^{13}\text{C} = -27.0\text{‰}$

The sandy peat, sample 82-MS-31 (39.5 g wet weight) enclosed in laminated organic silt and bouldery diamicton, was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (11.1 g) yielded 4.75 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.155 ± 0.054 , 1.030 ± 0.018 , and 17.892 ± 0.101 cpm, respectively.

The uncorrected age is 11 700 ± 130.

GSC-4973. Amaguadees Site (III) 12 200 ± 140
 $\delta^{13}\text{C} = -26.3\text{‰}$

The sandy peat, sample 82-MS-31 (51.5 g wet weight) enclosed in laminated organic silt and bouldery diamicton, was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (12.6 g) yielded 4.66 L of CO_2 gas. The age estimate is based on two counts for 2010 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.891 ± 0.053 , 1.030 ± 0.018 , and 17.892 ± 0.101 cpm, respectively.

The uncorrected age is 12 300 ± 140.

GSC-4062. Amaguadees Site (IV) 12 600 ± 120
 $\delta^{13}\text{C} = -27.5\text{‰}$

The peaty stringers in sand and silt, sample MS-82-31 (243.8 g wet weight) enclosed in sand and silt, were treated with hot base, hot acid, and distilled water rinses (noncalcareous). The age estimate is based on one 3-day count (4200 minutes) in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 12 600 ± 120.

Comment (R.J. Mott): The dates indicate that the area was deglaciated early, about 12.6 ka BP and that a considerable thickness of peat accumulated over the following 2.2 ka as the climate warmed and plants migrated into the region. If the dates are valid, the site spans the late-glacial interstadial interval (Alleröd) and the transition to colder climates of the Younger Dryas as seen in numerous deposits throughout the Maritimes (Mott et al., 1986). The peat was subsequently intruded and buried by colluvium that appears to be reworked till similar to that below the organic sediments. Preliminary pollen analysis shows that herb

tundra followed by shrub tundra characterized the site and trees had not yet migrated into this area of Cape Breton Island by the end of the late-glacial interstadial about 11 ka BP.

GSC-4656. MacInnis Lake 10 900 ± 110
 $\delta^{13}\text{C} = -26.7\text{‰}$

The lake sediment, basal gyttja, had gyttja above and gravelly sand below. Sample MS-86-21 (442-445 cm) was collected by R.J. Mott and H. Jetté on August 1, 1986, from MacInnis Lake near Skir Dhu, Cape Breton Island, Nova Scotia ($46^\circ 29' \text{N}$, $60^\circ 26.8' \text{W}$), at an elevation of about 16 m; submitted by R.J. Mott.

The sample (134.7 g wet weight) was treated with hot acid, and distilled water rinses; base treatment was omitted (slightly calcareous). The treated sample (55.9 g) yielded 3.71 L of CO_2 gas. The age estimate is based on one count for 3740 minutes in the 2 L counter with a mixing ratio of 1.20. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.619 ± 0.048 , 1.035 ± 0.018 , and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 10 900 ± 110.

Comment (R.J. Mott): The lake formed in a small kettle hole in glacial outwash deposits along the east coast of Cape Breton Island where a narrow coastal lowland abuts the escarpment of the Cape Breton Highlands. The date marks the onset of organic accumulation at the site. It may be a minimum for deglaciation of the area or to melting of the ice block and formation of the depression that the lake occupies. The site does not apparently record the warm interval prior to the Younger Dryas cooling that is prevalent throughout Atlantic Canada (Mott et al., 1986; Stea and Mott, 1989). Accumulation of organic matter at the site may have begun during the cold period, but pollen analysis is required to determine the climatic changes recorded in the core.

GSC-4762. Lismore Section 10 600 ± 100
 $\delta^{13}\text{C} = -27.1\text{‰}$

The sandy peat was enclosed in sand and peat. Sample MS-85-19 was collected by R.J. Mott and R. Stea on August 13, 1985, from the Lismore section, 1 km west of village of Lismore, Northumberland Strait coast, about 24 km west-northwest of Antigonish, Nova Scotia ($45^\circ 42.2' \text{N}$, $62^\circ 16.7' \text{W}$), at an elevation of about 4-6 m; submitted by R.J. Mott.

The sample (68.9 g wet weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (26.3 g) yielded 8.13 L of CO₂ gas. The age estimate is based on two counts for 2180 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.526 ± 0.072, 2.152 ± 0.026, and 28.221 ± 0.153 cpm, respectively.

The uncorrected age is 10 600 ± 100.

Comment (R.J. Mott): A freshly exposed coastal section along Northumberland Strait revealed sand with cobbles grading into laminated red sand overlying bedrock at about 2 m a.s.l. Sandy peat and peaty sand 40 cm thick overlies the red sand and is overlain by up to 1.5 m of coarsely laminated red sand with clay seams and pods (Stea and Mott, 1989). The sand beneath the peat is part of an outwash delta complex that may have been reworked in places to form the overlying waterlain sand. Pollen analysis indicates that the peat accumulated in a wet sedge meadow surrounded by tundra vegetation dominated by shrub birch, willow, and grasses beginning about 11.9 ka BP (GSC-4153, McNeely and McCuaig, 1991; Stea and Mott, 1989). Birch increased until just prior to 10.6 ka BP (GSC-4762), and pollen values suggest that spruce trees migrated closer to the area but were probably not present locally. A decline in shrub birch and increase in willow, grasses, and sedge and a change to peaty sand marked a return to cooler climate correlated with the Younger Dryas event. This cooling event culminated with the burial of the site by sand.

Gilbert Lake Series

A series of lake sediment samples from Gilbert Lake, about 7.5 km north of Parrsboro, Nova Scotia (45°28.7'N, 64°20.4'W), at an elevation of 29 m, was collected by R.J. Mott and H. Jetté on July 22, 1986; submitted by R.J. Mott.

GSC-4641. Gilbert Lake (I) 9460 ± 90
δ¹³C= -29.9‰

The lake sediment, gyttja, sample MS-86-10 (1384-1390 cm; 133.7 g wet weight) enclosed in gyttja, was treated with hot acid, and distilled water rinses; base treatment was omitted (slightly calcareous). The treated

sample (20.6 g) yielded 5.17 L of CO₂ gas. The age estimate is based on one count for 4180 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.501 ± 0.043, 1.035 ± 0.018, and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 9540 ± 90.

GSC-4432. Gilbert Lake (II) 10 900 ± 100
δ¹³C= -32.4‰

The lake sediment, basal silty gyttja, sample MS-86-10 (1427-1433 cm; 132.2 g wet weight) enclosed in gyttja and clay, was treated with hot acid, and distilled water rinses; base treatment was omitted (slightly calcareous). The age estimate is based on one count for 4200 minutes in the 2 L counter with a mixing ratio of 1.00.

The uncorrected age is 11 000 ± 100.

TO-807. Gilbert Lake (III) 11 360 ± 80

The wood, a twig of willow (*Salix*; identified by R.J. Mott) sample MS-86-10 (1530 cm; 0.4 g dry weight) was enclosed in clay.

Comment (R.J. Mott): The lake occupies a kettle hole behind the Gilbert Lake moraine formed by ice from the Cobequid Highlands that blocked the Hebert and Parrsboro Rivers valley north of the Parrsboro delta (Stea, 1987). The core showed 1433 cm of gyttja that grades into silty, clayey gyttja, overlying about 90 cm of reddish clay, 10 cm of slightly organic clay and pebbly gravel and sand. GSC-4641 is third and youngest of a series of three dates from the basal part of the sediment sequence. This sample is considerably younger than GSC-4432 (10 900 ± 100 BP) only 30 cm below at the base of the organic sediments. GSC-4432 is probably somewhat anomalous as a result of the hardwater effect. An AMS date of 11 360 ± 80 BP (TO-807) was obtained on wood (willow) from the slightly organic clay zone near the base of the core. This organic zone may represent the preYounger Dryas warm interval that is widely represented throughout the Atlantic region, or it may be a detrital layer of organic material from sediments deposited elsewhere during the warm interval that were reworked by the ice that formed the Gilbert Lake moraine.

Québec

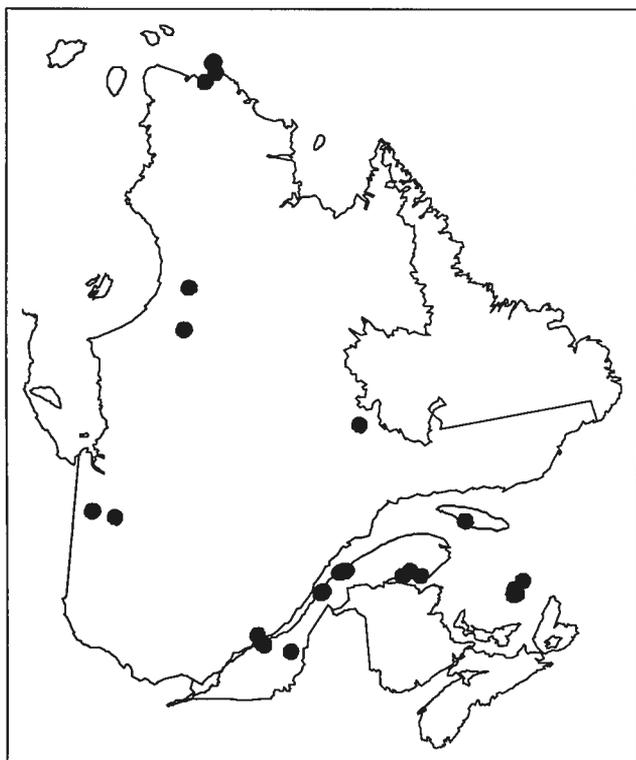


Figure 8. Radiocarbon dated sites in Québec.

GSC-4188. Cap aux Meules
uncorrected 2370 ± 70

The humified (sedge?) peat, sample AGE-02 (275-280), was collected by M. Parent and J-M.M. Dubois on August 7, 1985, from 1.8 km south 36° west from Cap aux Meules, Iles de la Madeleine, Québec ($47^\circ 21.93'N$, $61^\circ 52.43'W$), at a depth of 2.50 m; submitted by M. Parent and J-M.M. Dubois.

The sample (16.0 g wet weight) was treated with hot acid, and distilled water rinses; base treatment was omitted (noncalcareous). The treated sample's (11.1 g) age estimate is based on one count for 4200 minutes in the 2 L counter with a mixing ratio of 1.31.

GSC-4633 HP. Portage-du-Cap
uncorrected $42\ 900 \pm 720$

The fragmented marine shells were enclosed in sand. Sample 87-DU-029 was collected by L.A. Dredge and

R.J. Mott on September 15, 1987, from a sand and gravel pit about 0.8 km south of Portage-du-Cap, Ile du Havre Aubert, Iles de la Madeleine, Québec ($47^\circ 14'N$, $61^\circ 54'W$), at an elevation of about 2 m; submitted by L.A. Dredge and R.J. Mott.

The sample (200.4 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (160.3 g) yielded 34.41 L of CO_2 gas. The age estimate is based on two counts for 8540 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.515 ± 0.044 , 2.777 ± 0.039 , and 107.073 ± 0.257 cpm, respectively.

Comment (L.A. Dredge and R.J. Mott): The fragile shells were collected from sands stratigraphically underlying a red diamicton believed to be a Wisconsinan till. Despite the finite age obtained, the enclosing sands are thought to be Sangamonian marine deposits. The shell assemblage included oyster valves, indicating water temperatures warmer than those today.

Laboratory comment: Although the age of these shells is finite, the antiquity of the date should be interpreted as indicating that the shells are very old and are probably of pre-Wisconsinan age.

Cap Rouge Series

A series of wood samples from 2.0 km north 75° west from Cap Rouge, Québec ($47^\circ 21.05'N$, $61^\circ 54.50'W$), at an elevation of 0.3 m, was collected by M. Parent and J-M.M. Dubois on August 6, 1985; submitted by M. Parent and J-M.M. Dubois.

GSC-4170. Cap Rouge (I) 560 ± 50
 $\delta^{13}C = -24.8\text{‰}$

The wood (root), sample 850806-1 (12.0 g wet weight; *Abies balsamea*; identified by H. Jetté (unpublished GSC Wood Report No. 85-100)) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (10.4 g) yielded 10.2 L of CO_2 gas. The age estimate is based on two counts for 2320 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 560 ± 50 .

GSC-4165. Cap Rouge (II) 690 ± 50
 $\delta^{13}\text{C} = -26.0\text{‰}$

The wood, sample 850806-2 (Bois 45-46; 11.3 g dry weight; *Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 85-101)) enclosed in peat, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (10.1 g) yielded 9.78 L of CO₂ gas. The age estimate is based on two counts for 4200 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 700 ± 50.

Iles de la Madeleine Series

A series of organic samples was collected on Iles de la Madeleine by M. Parent and J-M.M. Dubois between August 1986 and July 1988.

GSC-4638 HP. Millerand (I) >51 000
 $\delta^{13}\text{C} = -28.7\text{‰}$

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 88-21)) was enclosed in deformed clay. Sample 870878-1-A was collected by M. Parent and J-M.M. Dubois on August 18, 1987, from 280 m south 12° east of the three-way intersection in Millerand (Ile du Havre Aubert), Iles de la Madeleine, Québec (47°12'59"N, 61°58'46"W), at an elevation of about 1 m; submitted by M. Parent.

The sample (61.4 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (38.4 g) yielded 36.63 L of CO₂ gas. The age estimate is based on two counts for 10 710 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.010 ± 0.043, 2.777 ± 0.039, and 107.073 ± 0.257 cpm, respectively.

GSC-4640 HP. Millerand (II) 39 000 ± 500
 $\delta^{13}\text{C} = -29.8\text{‰}$

The organic mud was enclosed in till. Sample 870827-1-B was collected by M. Parent and J-M.M. Dubois on August 27, 1987 from 1175 m due west of three-way intersection in Millerand (Ile du Havre Aubert), Iles de la Madeleine, Québec (47°13'10"N, 61°50'45"W), at an

elevation of about 19 m; submitted by M. Parent.

The sample (598.9 g wet weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (108.7 g) yielded 35.49 L of CO₂ gas. The age estimate is based on two counts for 7380 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.822 ± 0.046, 2.777 ± 0.039, and 107.073 ± 0.257 cpm, respectively.

The uncorrected age is 39 100 ± 500.

Millerand wharf (Iles de la Madeleine) Series

GSC-4737. Millerand wharf (I) 4140 ± 60
 $\delta^{13}\text{C} = -27.9\text{‰}$

The peat was enclosed in peat. Sample 880706-2 (base) was collected by M. Parent and J-M.M. Dubois on July 6, 1988, from a coastal cliff, about 710 m east of Millerand wharf, Iles de la Madeleine, Québec (47°12'56"N, 61°58'40"W), at an elevation of 10 m; submitted by M. Parent.

The sample (159.9 g wet weight) was treated with hot base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (14.1 g) yielded 8.01 L of CO₂ gas. The age estimate is based on one count for 4200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 16.747 ± 0.072, 2.152 ± 0.026, and 28.221 ± 0.153 cpm, respectively.

The uncorrected age is 4190 ± 60.

GSC-4763. Millerand wharf (II) 7210 ± 70
 $\delta^{13}\text{C} = -31.2\text{‰}$

The peat was enclosed in peat. Sample MiL-01 (125-128 cm) was collected by M. Parent and J-M.M. Dubois on August 8, 1985, from a coastal cliff, about 900 m east of Millerand wharf, Iles de la Madeleine, Québec (47°12'52"N, 61°58'34"W), at an elevation of 12.5 m; submitted by M. Parent.

The sample (165.4 g wet weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (39.1 g) yielded 8.86 L of CO₂ gas. The age estimate is based on one count for 3655 minutes in the

5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.444 ± 0.066 , 2.157 ± 0.026 , and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 7310 ± 70 .

GSC-4796. Ile Boudreau 6750 ± 70
 $\delta^{13}\text{C} = -25.1\text{‰}$

The wood (*Abies balsamea*; identified by H. Jetté (unpublished GSC Wood Report No. 88-49)) was enclosed in peat. Sample 860807-1A was collected by M. Parent and J.-M.M. Dubois on August 7, 1986, from east shore of Ile Boudreau, Iles de la Madeleine, Québec ($47^{\circ}32'46''\text{N}$, $61^{\circ}31'11''\text{W}$), at an elevation of 0.5 m; submitted by M. Parent.

The sample (17.1 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.4 g) yielded 8.40 L of CO_2 gas. The age estimate is based on one count for 3710 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.277 ± 0.066 , 2.153 ± 0.022 , and 28.455 ± 0.126 cpm, respectively.

The uncorrected age is 6750 ± 70 .

GSC-4714. Ruisseau Trois Milles
modern
 $\delta^{13}\text{C} = -2.7\text{‰}$

The marine shells (*Ostrea procyon* Holmes = *Crassica? virginica* (Gmelin); identified by A.A. Petryk) were collected from the surface of a soil. Sample A86AP5-2-1F was collected by A.A. Petryk on July 2, 1986, on a road to Galiote River, south of Ruisseau Trois Milles, about 8.14 km east-southeast of main road to Juniper la Mer, and 6.3 km north of south shore of Anticosti Island, Québec ($49^{\circ}24.30'\text{N}$, $63^{\circ}24.17'\text{W}$), at an elevation of about 130 m; submitted by A.A. Petryk.

The sample (6.5 g dry weight) was not pretreated. The sample (6.5 g) yielded 1.46 L of CO_2 gas. The age estimate is based on one count for 3950 minutes in the 2 L counter with a mixing ratio of 3.13. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 21.938 ± 0.153 , 1.094 ± 0.019 , and 18.531 ± 0.106 cpm, respectively.

Comment (J.J. Veillette): The modern age of shells at this elevation probably results from human intervention some time in the recent past.

GSC-4615. Bonaventure $12\ 500 \pm 120$
 $\delta^{13}\text{C} = +1.7\text{‰}$

The marine shells (*Hiatella arctica* and *Mya truncata*; identified by J.J. Veillette) were enclosed in gravelly sand. Sample VJ-87-61 was collected by J.J. Veillette and M. Cloutier on October 22, 1987, from 3 km north of Bonaventure, Baie des Chaleurs, Gaspésie, Québec ($48^{\circ}04'25''\text{N}$, $65^{\circ}29'50''\text{W}$), at an elevation of 35 m; submitted by J.J. Veillette.

The sample (35.9 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (28.6 g) yielded 5.72 L of CO_2 gas. The age estimate is based on one count for 4140 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.839 ± 0.040 , 0.994 ± 0.021 , and 18.078 ± 0.096 cpm, respectively.

The uncorrected age is $12\ 400 \pm 120$.

Comment (J.J. Veillette): This date on shells (some of which were still in life position) buried in beach gravels dates an early Goldthwait sea transgression in Baie des Chaleurs. It is one of two oldest dates from eight dates obtained from samples collected in 1987 on the north shore of Baie des Chaleurs in an effort to date the marine limit.

GSC-4601. New Richmond $12\ 500 \pm 130$
 $\delta^{13}\text{C} = +1.4\text{‰}$

The marine shells (*Hiatella arctica*; identified by J.J. Veillette) were enclosed in pebbly clay. Sample VJ-87-52 was collected by J.J. Veillette and M. Cloutier on October 21, 1987, from 7 km northwest of New Richmond, Baie des Chaleurs, Gaspésie, Québec ($48^{\circ}13'39''\text{N}$, $65^{\circ}53'51''\text{W}$), at an elevation of 32 m; submitted by J.J. Veillette.

The sample (14.4 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (13.4 g) yielded 2.79 L of CO_2 gas. The age estimate is based on one count for 5640 minutes in the 2 L counter with a mixing ratio of 1.64. The count rates for the sample (net) and for monthly backgrounds and standards

(net) were 3.856 ± 0.050 , 1.016 ± 0.018 , and 18.217 ± 0.097 cpm, respectively.

The uncorrected age is $12\,500 \pm 130$.

Comment (J.J. Veillette): This date provides a minimum age for an early Goldthwait sea transgression in Baie des Chaleurs. Shells were obtained from a fossiliferous pebbly clay (glaciomarine diamicton) that overlies glaciofluvial sediments at this site. It is one of two oldest dates from a group of eight obtained from samples collected in 1987 on the north shore of Baie des Chaleurs in an effort to date the marine limit.

GSC-4609. Saint-Omer $12\,300 \pm 120$
 $\delta^{13}\text{C} = +3.8\text{‰}$

The marine shells (*Hiatella arctica*; identified by J.J. Veillette) were enclosed in pebbly clay. Sample VJ-87-48 was collected by J.J. Veillette and M. Cloutier on October 21, 1987, from 0.75 km east of Saint-Omer, Baie des Chaleurs, Gaspésie, Québec ($48^{\circ}06'46''\text{N}$, $66^{\circ}12'45''\text{W}$), at an elevation of 17 m; submitted by J.J. Veillette.

The sample (21.2 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (19.2 g) yielded 4.17 L of CO_2 gas. The age estimate is based on two counts for 3460 minutes in the 2 L counter with a mixing ratio of 1.06. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.980 ± 0.046 , 1.016 ± 0.018 , and 18.217 ± 0.097 cpm, respectively.

The uncorrected age is $12\,200 \pm 120$.

Comment (J.J. Veillette): The dated shells were obtained from a fossiliferous pebbly clay (glaciomarine diamicton) that overlies gravely sand in a marine terrace. It dates an early Goldthwait sea transgression in Baie des Chaleurs.

GSC-4764. Fire Lake 7660 ± 100
 $\delta^{13}\text{C} = -27.9\text{‰}$

The lake sediment, basal silty gyttja, had clay below and gyttja above. Sample PL-88-89 was collected by R.A. Klassen and R.J. Mott on July 26, 1988, from Fire Lake, about 70 km south-southwest of Labrador City / Wabush, Labrador - Québec ($52^{\circ}21'\text{N}$, $67^{\circ}22'\text{W}$), at an elevation of 600 m; submitted by R.A. Klassen.

The sample (136.3 g wet weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (54.5 g) yielded 6.00 L of CO_2 gas. The age estimate is based on two counts for 2030 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.920 ± 0.065 , 1.092 ± 0.018 , and 18.072 ± 0.097 cpm, respectively.

The uncorrected age is 7710 ± 100 .

Comment (R.A. Klassen): The sample was collected from a 2 m exposure in mine workings at Fire Lake, Québec. 'Old' carbon is present in bedrock of the region as metamorphosed equivalents of graphite shales and dolomite, and it could constitute a component of the Quaternary sediments as the result of glacial erosion and transport. The date represents a minimum age for deglaciation.

GSC-4698. Rimouski $13\,900 \pm 170$
 $\delta^{13}\text{C} = +1.0\text{‰}$

The marine shells were enclosed in clayey till. Sample 88-RAP-1147 was collected by H. Russell and M. Rappol in June 1988, from 6 km south of Rimouski, Québec ($48^{\circ}23'00''\text{N}$, $68^{\circ}32'30''\text{W}$), at an elevation of 107 m; submitted by M. Rappol.

The sample (28.0 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (21.9 g) yielded 4.69 L of CO_2 gas. The age estimate is based on two counts for 3850 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.216 ± 0.059 , 1.059 ± 0.029 , and 18.169 ± 0.099 cpm, respectively.

The uncorrected age is $13\,900 \pm 170$.

See Rappol, 1993 for comments.

GSC-4707. Bic $12\,400 \pm 100$
 $\delta^{13}\text{C} = +0.8\text{‰}$

The marine shells were enclosed in marine clay. Sample 88-RAP-1140 was collected by H. Russell and M. Rappol in June, 1988, from 2 km southeast of Bic, Québec ($48^{\circ}21'30''\text{N}$, $68^{\circ}41'40''\text{W}$), at an elevation of 137 m; submitted by M. Rappol.

The sample (47.6 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (33.3 g) yielded 7.52 L of CO₂ gas. The age estimate is based on one count for 5580 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.028 ± 0.049, 2.221 ± 0.031, and 28.121 ± 0.123 cpm, respectively.

The uncorrected age is 12 400 ± 100.

See Rappol, 1993 for comments.

GSC-4726. Sainte-Blandine 12 700 ± 130
δ¹³C= +0.7‰

The marine shells were enclosed in marine clay. Sample 88-RAP-1142 was collected by H. Russell and M. Rappol in June 1988, from 4.5 km northeast of Sainte-Blandine, Québec (48°23'50"N, 68°26'00"W), at an elevation of 122 m; submitted by M. Rappol.

The sample (35.8 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (28.1 g) yielded 6.11 L of CO₂ gas. The age estimate is based on one count for 2790 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.719 ± 0.045, 1.103 ± 0.016, and 18.125 ± 0.099 cpm, respectively.

The uncorrected age is 12 700 ± 130.

See Rappol, 1993 for comments.

TO-947. St. Antoinein 11 720 ± 80
Moraine complex

The marine shell fragments were enclosed in deltaic outwash with shelly till and ice-contact deltaic deposits below. Sample 87-RAP-633 was collected by M. Rappol on July 21, 1987, from a gravel pit in the Saint Antoinein Moraine complex, 5 km north of St. Modeste, Québec (47°52'30"N, 69°24'00"W), at an elevation of about 110 m; submitted by M. Rappol.

See Rappol, 1993 for comments.

TO-948. Riviere du Loup 12 450 ± 80

The marine shell fragments were enclosed in glaciomarine clay with dropstones with red till above and grey till below. Sample 87-RAP-574 was collected by M. Rappol on July 20, 1987, from about 1.5 m below the surface in a construction site in Riviere du Loup, Québec (47°50'00"N, 69°30'00"W), at an elevation of 115 m; submitted by M. Rappol.

See Rappol, 1993 for comments.

GSC-4728 HP. Rivière des Plante >53 000
δ¹³C= -26.8‰

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 90-25)) was enclosed in peat. Sample 88-SCA-50 was collected by W.W. Shilts on August 18, 1988, from the right (north) bank of Rivière des Plante, 10 km northeast of Beauceville, Québec (46°17'50"N, 70°45'W), at an elevation of 272 m; submitted by W.W. Shilts.

The sample (50.3 g dry weight) was treated with hot base, hot acid, and distilled water rinses. The treated sample (40.0 g) yielded 42.13 L of CO₂ gas. The age estimate is based on one count for 4275 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were -0.037 ± 0.032, 2.477 ± 0.021, and 102.221 ± 0.494 cpm, respectively.

Comment (W.W. Shilts): This sample is from a nonglacial fluvial sequence that is overlain by the Chaudière and Lennoxville Tills. It is probably equivalent to the Missinabbi Formation and in spite of the boreal characteristics of the associated organics (unpublished GSC Palynology Report Nos. 87-8 and 87-12), is thought to be of interglacial rather than interstadial age. The peat is the only known in situ subaerial deposit of the Missinabbi Formation. Other sites have organics that have been reworked in a fluvial environment or organics that occur in growth position in a glaciolacustrine environment.

GSC-4752. Saint-Edouard-de-Lotbiniere 10 400 ± 90
 $\delta^{13}\text{C} = -2.3\text{‰}$

The marine shells (*Portlandia arctica*; identified by P. LaSalle) were enclosed in marine silty clays. Sample Riv. du Chene 6a was collected by P. LaSalle on September 21, 1988, from 4 km west of Saint-Edouard-de-Lotbiniere, north of bridge on Rivière du Chene, Québec (46°33.3'N, 71°53.0'W), at an elevation of about 38 m; submitted by P. LaSalle.

The sample (46.3 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (36.2 g) yielded 7.81 L of CO₂ gas. The age estimate is based on one count for 3820 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.757 ± 0.057, 2.157 ± 0.026, and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 10 400 ± 90.

Comment (P. LaSalle): Shells of *Portlandia arctica* form a well-defined and clearly visible layer that can be followed across the section. *Portlandia arctica* is a high arctic species. Its widespread presence in such an abundance in the Champlain Sea basin indicates frigid conditions at the time but not necessarily closeness to an ice front which must have been at some distance. Both GSC-4783 and -4752 give the same age. Equivalent ages for *Portlandia arctica* have been reported in the western part of the Champlain Sea basin. Ecological conditions at that time may have been linked to the Younger Dryas event(?).

GSC-4769. "Les Trois Fourches" 10 500 ± 120
 $\delta^{13}\text{C} = -0.5\text{‰}$

The marine shells (*Balanus hameri*; identified by P. LaSalle) were enclosed in marine silts. Sample Riv. du Chene 22 was collected by P. LaSalle on August 20, 1988, from 8.5 km west of Joly on Rivière du Chene, north of a site called "Les Trois Fourches", Québec (46°29.8'N, 71°46.7'W), at an elevation of 60 m; submitted by P. LaSalle.

The sample (33.1 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (26.4 g) yielded 5.77 L of CO₂ gas. The age estimate is based on one count for 2730 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards

(net) were 4.888 ± 0.049, 1.072 ± 0.016, and 18.025 ± 0.147 cpm, respectively.

The uncorrected age is 10 500 ± 120.

Sainte-Anne Rivière Series

A series of marine shell samples from 20 km northeast of Saint-Alban along Sainte-Anne Rivière, Québec (46°45.8'N, 72°0.8'W), at an elevation of 60 m, were collected by P. LaSalle on August 15, 1988; submitted by P. LaSalle.

GSC-4783. Sainte-Anne Rivière (I) 10 400 ± 100
 $\delta^{13}\text{C} = -2.4\text{‰}$

The marine shells, sample Sainte-Anne 2 (47.4 g dry weight; *Portlandia arctica*; identified by P. LaSalle), were treated with an acid leach to remove the outer 20% of the sample. The treated sample (39.9 g) yielded 8.01 L of CO₂ gas. The age estimate is based on one count for 2260 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.722 ± 0.070, 2.153 ± 0.022, and 28.455 ± 0.126 cpm, respectively.

The uncorrected age is 10 500 ± 100.

Comment (P. LaSalle): Shells of *Portlandia arctica* form a well-defined and clearly visible layer that can be followed across the section. *Portlandia arctica* is a high arctic species. Its widespread presence in such an abundance in the Champlain Sea basin indicates frigid conditions at the time but not necessarily closeness to an ice front, which must have been at some distance. Both GSC-4783 and -4752 give the same age. Equivalent ages for *Portlandia arctica* have been reported in the western part of the Champlain Sea basin. Ecological conditions at that time may have been linked to the Younger Dryas event(?).

GSC-4799. Sainte-Anne Rivière (II) 10 200 ± 90
 $\delta^{13}\text{C} = -0.7\text{‰}$

The marine shells, sample Sainte-Anne 3 (42.8 g dry weight; *Macoma calcarea*; identified by C.G. Rodrigues), enclosed in silty marine clays, were treated with an acid leach to remove the outer 20% of the sample. The treated sample (34.0 g) yielded 7.33 L of CO₂ gas. The age estimate is based on one count for 3370 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards

(net) were 7.899 ± 0.059 , 2.172 ± 0.022 , and 28.325 ± 0.122 cpm, respectively.

The uncorrected age is $10\,300 \pm 90$.

Comment (P. LaSalle): Shells of *Macoma calcarea* also found in a well-defined layer that seem to run for several metres across the section. *Macoma calcarea* is a more boreal species than *Portlandia arctica*. The presence of *Macoma* certainly appears to suggest warmer conditions than when *Portlandia* was thriving. The ice front was, therefore, far away from this site, probably already in the Lac-Saint-Jean basin area.

GSC-4800. Cap Briard 1800 ± 50
 $\delta^{13}\text{C} = -22.4\text{‰}$

The organic matter (algal remains) was enclosed in silty sand. Sample VH-1A was collected by D. Bruneau and J.T. Gray on July 21, 1988, from 2 km northeast of Cap Briard, southwest of Cap de Nouvelle France, Ungava, Québec ($62^{\circ}21'40''\text{N}$, $73^{\circ}59'55''\text{W}$), at an elevation of 2 m; submitted by J.T. Gray.

The sample (45.0 g dry weight) was treated with hot base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (19.0 g) yielded 8.24 L of CO_2 gas. The age estimate is based on one count for 2135 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 22.747 ± 0.110 , 2.172 ± 0.022 , and 28.325 ± 0.122 cpm, respectively.

The uncorrected age is 1760 ± 50 .

Comment (J.T. Gray): This date provides excellent control for the lowest, most recent part of the postglacial emergence curve, for the Cap de Nouvelle France sector of northern Ungava. The date represents littoral algae thrown up to high tide level on a former beach and subsequently buried by storm beach, and/or eolian sands. The date suggests that recent net emergence of this sector of the coast has been very slight during the last two millennia — in the range of about 1 m/ka. In other words, glacio-isostatic recovery of this sector of the Ungava coastline, appears to be almost complete, in distinct contrast to more southerly coasts of the Peninsula (Gray et al., in press).

Charles Island Series

Two marine shell samples were collected by J.T. Gray, D. Bruneau, and B. Lauriol on July 7, 1988, from Charles Island, 20 km west-northwest of Cap de Nouvelle France, Hudson Strait, Ungava, Québec

GSC-4745. Charles Island (I) 7320 ± 100
 $\delta^{13}\text{C} = +1.8\text{‰}$

The marine shells (*Hiatella arctica* and *Mya truncata*; identified by J.T. Gray) were enclosed in sandy silt. Sample CHA-16 ($62^{\circ}40'\text{N}$, $74^{\circ}06'\text{W}$), was collected at an elevation of 113 m; submitted by J.T. Gray.

The sample (28.2 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (19.0 g) yielded 2.24 L of CO_2 gas. The age estimate is based on one count for 4200 minutes in the 2 L counter with a mixing ratio of 1.99. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.288 ± 0.076 , 1.092 ± 0.018 , and 18.072 ± 0.097 cpm, respectively.

The uncorrected age is 7300 ± 100 .

Comment (J.T. Gray): This date, for almost in situ shells from the highest definable marine terrace and situated only 8 m below the postglacially established marine wave washing limit of 121 m, indicated final deglaciation of Charles Island and the central sector of Hudson Strait shortly prior to 7.3 ka BP. It also provides an excellent control for the oldest part of the postglacial emergence curve constructed for Charles Island (Gray et al., in press). A second wave washing limit, situated at a higher elevation (145-155 m), is thought to be associated with an event that may have occurred prior to the last glacial advance on the island, because neither marine shells, nor foraminifera were noted in sediments between the two limits.

GSC-4756. Charles Island (II) 7030 ± 100
 $\delta^{13}\text{C} = +1.5\text{‰}$

The marine shells (*Hiatella arctica*; identified by J.T. Gray) were enclosed in sandy silts with clay. Sample CHA-22 ($62^{\circ}38'\text{N}$, $74^{\circ}11'\text{W}$), was collected at an elevation of 60 m; submitted by J.T. Gray.

The sample (31.4 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (22.0 g) yielded 4.76 L of CO_2 gas. The age

estimate is based on two counts for 1965 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.537 ± 0.069 , 1.072 ± 0.016 , and 18.025 ± 0.147 cpm, respectively.

The uncorrected age is 7000 ± 100 .

Comment (J.T. Gray): This date provides a second control point for the postglacial emergence curve for Charles Island (see GSC-4745 and Gray et al., in press). The shells were in situ and represent a relative sea level situated between 65 m and 121 m in elevation. As they are not in littoral sediments and have a fairly wide depth range, it is hard to be more specific in describing their environment.

Deception Bay Series

A series of marine shell samples from 2.5 km southwest of Deception Bay airstrip, Ungava, Québec ($62^{\circ}06'N$, $74^{\circ}36'W$), at an elevation of 100 m, was collected by J.T. Gray on July 15, 1988; submitted by J.T. Gray.

GSC-4780. Deception Bay (I) 7130 ± 100
 $\delta^{13}C = +1.2\text{‰}$

The marine shells, sample LDU 6b (31.3 g dry weight; *Mya truncata*; identified by J.T. Gray) enclosed in medium and coarse textured sands, were treated with an acid leach to remove the outer 20% of the sample. The treated sample (24.8 g) yielded 5.27 L of CO₂ gas. The age estimate is based on one count for 2260 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.435 ± 0.063 , 1.072 ± 0.016 , and 18.025 ± 0.147 cpm, respectively.

The uncorrected age is 7110 ± 100 .

Comment (J.T. Gray): This date forms part of a local sequence that indicates a minimum age of 7.1 ka BP for retreat of the Ungava ice cap and its outlet glaciers which filled the tributary Duquet Valley to the south of the lower Deception River Valley.

GSC-4782. Deception Bay (II) 7130 ± 90
 $\delta^{13}C = +1.4\text{‰}$

The marine shells, sample LDU 6a (27.0 g dry weight; *Hiatella arctica* and *Mya truncata*; identified by J.T. Gray)

enclosed in silty clay, were treated with an acid leach to remove the outer 20% of the sample. The treated sample (21.5 g) yielded 4.60 L of CO₂ gas. The age estimate is based on one count for 3910 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.444 ± 0.049 , 1.072 ± 0.016 , and 18.025 ± 0.147 cpm, respectively.

The uncorrected age is 7100 ± 90 .

Comment (J.T. Gray): This date provides a good minimum age for the final retreat of the Ungava ice cap and its valley glacier tongues from the south side of the lower Deception River Valley, shortly prior to 7.1 ka BP. The local marine limit is situated at 130 m, about 20 m above a large marine sandspit immediately adjacent to the shell site, associated with the shell assemblages. Because of the exposed nature of the coast, the local marine environment likely only became favourable to the development of a shell population, when a) an ice tongue had retreated to the south from the mouth of the Duquet Valley in the vicinity, and b) when construction of the large sandspit at 106 m elevation provided a sheltered environment on the eastern leeward side. This interpretation is confirmed by the contemporaneous nature of the date GSC-4780, obtained from in situ shells from sand layers in the spit itself. The two dates from this site, along with other dates in the middle and lower Deception River Valley, permit the establishment of a reliable interval of 7-8 ka for final retreat of the Ungava ice sheet from a quasi-stable position, represented by thick glaciomarine subaqueous deposits, and by moraine deposits in the Deception River Valley (Gray et al., 1985; Ricard, 1989).

GSC-4736. Falaise Kakshaw 5610 ± 160
 $\delta^{13}C = -29.1\text{‰}$

The lake sediment, gyttja, was enclosed in gyttja. Sample GB1 (95-106 cm) was collected by K. Gajewski and M. Caouette on August 27, 1987, from just to the south of Grande Rivière de la Baleine, inland from Poste de la Baleine Station, above Falaise Kakshaw, Québec ($55^{\circ}07'N$, $75^{\circ}15'W$), at an elevation of 325 m; submitted by J.C. Ritchie and K. Gajewski.

The sample (61.0 g wet weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (6.6 g) yielded 1.24 L of CO₂ gas. The age estimate is based on two counts for 2210 minutes in the 2 L counter with a mixing ratio of 3.70. The count rates for the sample (net) and for monthly backgrounds and standards

(net) were 8.846 ± 0.163 , 1.114 ± 0.019 , and 17.921 ± 0.095 cpm, respectively.

The uncorrected age is 5670 ± 160 .

GSC-4655. Lac à l'Eau Claire 5790 ± 130
 $\delta^{13}\text{C} = -26.4\text{‰}$

The lake sediment, basal gyttja, had gyttja above and clay below. Sample EC (95-105 cm) was collected by K. Gajewski and M. Caouette on August 30, 1987, from a small unnamed lake, 15 km west of Baie Kapakwach Iyatiwakami, west of Lac à l'Eau Claire, Québec ($56^{\circ}17'\text{N}$, $75^{\circ}06'\text{W}$), at an elevation of 250 m; submitted by J.C. Ritchie and K. Gajewski.

The sample (71.2 g wet weight) was treated with hot acid, and distilled water rinses; base treatment was omitted (noncalcareous). The treated sample (22.4 g) yielded 1.53 L of CO_2 gas. The age estimate is based on two counts for 2560 minutes in the 2 L counter with a mixing ratio of 2.88. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.748 ± 0.126 , 1.035 ± 0.018 , and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 5810 ± 130 .

Lac Atitkwapustasich Series

A series of lake sediment (gyttja) samples from south of Grande Rivière de la Baleine, 8 km east-northeast of Lac Kukamaw, and 6 km west-northwest of Lac Atitkwapustasich, Québec ($55^{\circ}06'\text{N}$, $75^{\circ}17'\text{W}$), at an elevation of 300 m, was collected by K. Gajewski and M. Caouette on August 28, 1987; submitted by J.C. Ritchie and K. Gajewski.

GSC-4716. Lac Atitkwapustasich (I) 2960 ± 100
 $\delta^{13}\text{C} = -29.2\text{‰}$

The lake sediment, gyttja sample GB2 (55-62 cm; 109.0 g wet weight), enclosed in gyttja, was treated with hot acid, and distilled water rinses; base treatment was omitted (slightly calcareous). The treated sample (9.3 g) yielded 2.56 L of CO_2 gas. The age estimate is based on two counts for 2350 minutes in the 2 L counter with a mixing ratio of 1.76. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.408 ± 0.139 , 1.109 ± 0.018 , and 18.080 ± 0.095 cpm, respectively.

The uncorrected age is 3020 ± 100 .

GSC-4682. Lac Atitkwapustasich (II) 3640 ± 120
 $\delta^{13}\text{C} = -27.9\text{‰}$

The lake sediment, gyttja sample GB2 (117-123 cm; 47.2 g wet weight), enclosed in gyttja, was treated with hot acid, and distilled water rinses; base treatment was omitted (noncalcareous). The treated sample (4.5 g) yielded 1.63 L of CO_2 gas. The age estimate is based on two counts for 2400 minutes in the 2 L counter with a mixing ratio of 2.72. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.351 ± 0.135 , 1.052 ± 0.017 , and 17.959 ± 0.159 cpm, respectively.

The uncorrected age is 3680 ± 120 .

GSC-4663. Lac Atitkwapustasich (III) 5300 ± 120
 $\delta^{13}\text{C} = -26.2\text{‰}$

The lake sediment, gyttja sample GB2 (205-212 cm; 52.4 g wet weight), enclosed in gyttja, was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (6.6 g) yielded 1.65 L of CO_2 gas. The age estimate is based on two counts for 2470 minutes in the 2 L counter with a mixing ratio of 2.69. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.333 ± 0.125 , 1.053 ± 0.017 , and 18.090 ± 0.096 cpm, respectively.

The uncorrected age is 5320 ± 120 .

GSC-4632. Lac Atitkwapustasich (IV) 6240 ± 160
 $\delta^{13}\text{C} = -25.9\text{‰}$

The lake sediment, gyttja sample GB2 (235-245 cm; 72.6 g wet weight), with gyttja above, and clay below, was treated with hot acid, and distilled water rinses; base treatment was omitted (noncalcareous). The treated sample (22.7 g) yielded 1.24 L of CO_2 gas. The age estimate is based on two counts for 2600 minutes in the 2 L counter with a mixing ratio of 3.57. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.299 ± 0.160 , 1.038 ± 0.027 , and 18.075 ± 0.093 cpm, respectively.

The uncorrected age is 6250 ± 160 .

GSC-4729. Lac Matagami 3310 ± 60
 $\delta^{13}\text{C} = -28.2\text{‰}$

The basal peat, sample 3070-B, was collected by P. Buteau on July 30, 1985, from west of Lac Matagami, Québec ($49^{\circ}49'53''\text{N}$, $77^{\circ}50'26''\text{W}$), at an elevation of 260 m; submitted by J.J. Veillette.

The sample (21.8 g dry weight) was treated with hot base, hot acid, and distilled water rinses (slightly calcareous). The age estimate is based on two counts for 2020 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 18.621 ± 0.104 , 2.189 ± 0.023 , and 28.283 ± 0.127 cpm, respectively.

The uncorrected age is 3360 ± 60 .

Comment (J.J. Veillette): This sample provides a minimum age for onset of paludification at this site. The sample is from the lowermost level of peat bog and was collected with a Hiller sampler.

GSC-4718. Abitibi $>39\ 000$
 $\delta^{13}\text{C} = -27.0\text{‰}$

The wood (chips from borehole cuttings; coniferous mixture; identified by R.J. Mott (unpublished GSC Wood Report No. 88-39)) was enclosed in sandy varved clays. Sample XG-86-34 (48 m) was collected by J.A. Dixon on October 6, 1986, from 1.5 km northeast of Harricana River, Gaudet Township, Abitibi, Québec ($49^{\circ}57'26''\text{N}$, $78^{\circ}47'00''\text{W}$), at an elevation of about 274 m; submitted by J.J. Veillette.

The sample (23.9 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (10.6 g) yielded 8.38 L of CO_2 gas. The age estimate is based on one count for 2790 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.028 ± 0.044 , 2.166 ± 0.034 , and 28.137 ± 0.173 cpm, respectively.

Comment (J.J. Veillette): The presence of preHolocene wood chips at the base of a glaciolacustrine sediments sequence associated with Lake Ojibway suggests that the chips were recycled from older deposits.

Ontario



Figure 9. Radiocarbon dated sites in Ontario.

GSC-4614 HP. Kwataboahagan River $>51\ 000$

The peat was enclosed in silty clay. Sample 85-SCA-0065 was collected by W.W. Shilts and S.L. Smith on September 13, 1985, on the Kwataboahagan River about 100 km west-southwest of Moosonee, Ontario ($51^{\circ}09'\text{N}$, $82^{\circ}03'\text{W}$), at an elevation of 85.4 m; submitted by W.W. Shilts.

The sample (719.7 g wet weight) was treated with cold base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (119.2 g) yielded 36.6 L of CO_2 gas. The age estimate is based on four counts for 6720 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.057 ± 0.031 , 2.695 ± 0.020 , and 107.110 ± 0.259 cpm, respectively.

WESTERN CANADA

Manitoba

GSC-4738. Sawyer Lake >39 000
 $\delta^{13}\text{C} = -26.5\text{‰}$

The wood fragments (*Picea* or *Larix*; identified by R.J. Mott (unpublished GSC Wood Report No. 88-41)) were enclosed in peaty silt. Sample 88-SJB-2809 was collected by S.L. Smith on July 18, 1988, from 32 km northeast of Kapuskasing, 4 km west of Sawyer Lake at the bridge over a small river, Torrance Township, Ontario ($49^{\circ}38'30''\text{N}$, $82^{\circ}10'20''\text{W}$), at an elevation of 190 m; submitted by S.L. Smith.

The sample (5 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (3.2 g) yielded 3.26 L of CO_2 gas. The age estimate is based on one count for 4995 minutes in the 2 L counter with a mixing ratio of 1.41. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.003 ± 0.034 , 1.114 ± 0.019 , and 17.921 ± 0.095 cpm, respectively.

Comment (S.L. Smith): The wood samples were from a peat-bearing horizon about 15 m below the ground surface in an overburden drill core. Stratigraphically it occurred at the base of Barlow-Ojibway laminated and sandy sediments, below about 12 m of Cochrane Formation. The possibility that organic material may represent a hiatus between deposition of Barlow-Ojibway sediments and the interpreted rapid readvance of Cochrane ice front is not supported by this date, rather the wood is likely reworked older (Missinaibi?) material.

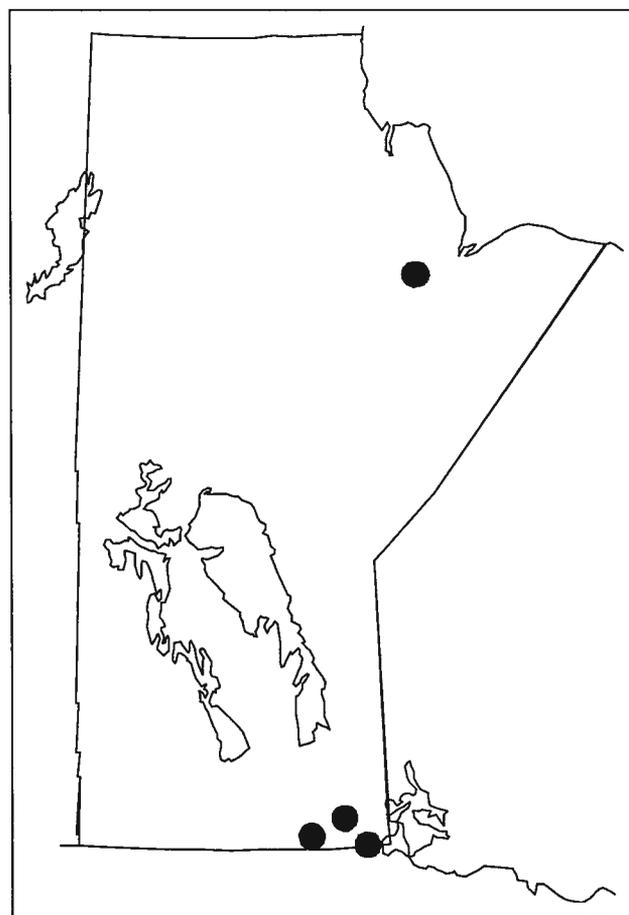


Figure 10. Radiocarbon dated sites in Manitoba.

Conawapa Dam site Series

A series of marine shells samples from Conawapa Dam site on the Nelson River, northeastern Manitoba ($56^{\circ}41'30''\text{N}$, $93^{\circ}46'40''\text{W}$), at an elevation of 62 m, were collected by E. Nielsen on August 20, 1988; submitted by E. Nielsen.

GSC-4725. Conawapa Dam site (I) 6810 ± 80
 $\delta^{13}\text{C} = +1.9\text{‰}$

The marine shells, sample CON-88-5 (45.1 g dry weight; *Hiatella arctica*; identified by E. Nielsen) enclosed in silty clay, were treated with an acid leach to remove the outer

20% of the sample. The treated sample (36.0 g) yielded 7.85 L of CO₂ gas. The age estimate is based on two counts for 2100 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.187 ± 0.087, 2.135 ± 0.026, and 28.327 ± 0.120 cpm, respectively.

The uncorrected age is 6780 ± 80.

Comment (E. Nielsen): Small paired valves, in growth position, were collected from the base of a 6 m thick silty clay unit deposited in the Tyrrell Sea. The presence of *Mytilus* shells and the fine texture indicates deposition in a nearshore, possibly lagoonal environment.

GSC-4746. Conawapa Dam site (II) 7290 ± 80
δ¹³C= +3.0‰

The marine shells, sample CON-88-6 (50.4 g dry weight; *Hiatella arctica*; identified by E. Nielsen) enclosed in sand, were treated with an acid leach to remove the outer 30% of the sample. The treated sample (34.3 g) yielded 4.22 L of CO₂ gas. The age estimate is based on one count for 4080 minutes in the 2 L counter with a mixing ratio of 1.08. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.279 ± 0.051, 1.114 ± 0.019, and 17.921 ± 0.095 cpm, respectively.

The uncorrected age is 7240 ± 80.

Comment (E. Nielsen): The relatively large, mostly single valves were collected from the bedding plane surfaces of crossbedded sand underlying fine textured, nearshore, lagoonal Tyrrell Sea sediments exposed at the top of the section and dated at 6810 ± 80 BP (GSC-4725). The shells were reworked and deposited possibly in offshore tidal or estuarine channels at an unknown water depth. The current directions in the channels were toward the east and northeast parallel to the present Nelson River.

GSC-4833. Conawapa Dam site (III) 6710 ± 110
δ¹³C= +3.2‰

The sampling site was 2.5 km upstream from sample site CON-88-5 (GSC-4725), (56°41'25"N, 93°48'30"W) at an elevation of 64 m. The marine shells, sample CON-88-9 (14.1 g dry weight; *Hiatella arctica*; identified by E. Nielsen) enclosed in silty clay, were treated with an acid leach to remove the outer 10% of the sample. The treated sample (12.9 g) yielded 2.72 L of CO₂ gas. The age estimate is based on two counts for 2160 minutes in the 2 L

counter with a mixing ratio of 1.61. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.843 ± 0.092, 1.090 ± 0.023, and 17.970 ± 0.101 cpm, respectively.

The uncorrected age is 6660 ± 110.

Comment (E. Nielsen): The shells were collected from the base of a 6 m thick silt unit overlying about 2 m of fossiliferous sand and gravel. The shells were in growth position. The presence of *Mytilus*, gastropods, and brachiopods, as well as the fine texture of the enclosing sediment, suggests deposition in a near tidal, possibly lagoonal environment. The sample dates the regression of the Tyrrell Sea from the area. Also see GSC-3904 (Blake, 1988) and GSC-4725 and GSC-4746.

GSC-4732. Sprague 9940 ± 80
δ¹³C= -26.1‰

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 88-36)) was enclosed in an organic layer and sand. Sample G560 was collected by G. Matile on August 22, 1988, from 2.4 km east of Sprague on highway 12, southeastern Manitoba (49°01'19"N, 95°36'35"W), at an elevation of 328 m; submitted by G. Matile.

The sample (12.1 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.5 g) yielded 8.88 L of CO₂ gas. The age estimate is based on one count for 3795 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.238 ± 0.058, 2.135 ± 0.026, and 28.327 ± 0.120 cpm, respectively.

The uncorrected age is 9920 ± 80.

Comment (G. Matile): This sample dates a Lake Agassiz shoreline, equal in elevation to the Lower Campbell strandline, at the end of the Moorhead Phase of Lake Agassiz.

GSC-4712. Saint Labre 420 ± 60
δ¹³C= -25.0‰

The wood (*Salix*; identified by H. Jetté (unpublished GSC Wood Report No. 88-37)) was enclosed in sand. Sample G468F was collected by G. Matile on June 19, 1986, from 7 km north-northwest of Saint Labre,

2250 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 19.741 ± 0.101 , 2.113 ± 0.024 , and 28.204 ± 0.118 cpm, respectively.

The uncorrected age is 2870 ± 60 .

GSC-4665. Peyto Lake (II) 2860 ± 50
 $\delta^{13}\text{C} = -24.5\text{‰}$

The wood, sample P87-2a (13.8 g dry weight; *Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 88-19)) from the surface of till outwash, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.5 g) yielded 8.31 L of CO₂ gas. The age estimate is based on one count for 4110 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 19.740 ± 0.077 , 2.113 ± 0.024 , and 28.204 ± 0.118 cpm, respectively.

The uncorrected age is 2870 ± 50 .

GSC-4680. Peyto Lake (III) 2800 ± 80
 $\delta^{13}\text{C} = -22.6\text{‰}$

The wood, sample P87-1a (10.2 g dry weight; *Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 88-18)) from the surface of till/outwash, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (7.6 g) yielded 7.44 L of CO₂ gas. The age estimate is based on one count for 3870 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.734 ± 0.062 , 1.052 ± 0.017 , and 17.959 ± 0.159 cpm, respectively.

The uncorrected age is 2760 ± 80 .

Comment (G. Holdsworth): These samples are part of a series being collected between the present Peyto Glacier terminus and the Little Ice Age maximum moraine. A piece of the same wood (P87-1) was submitted to Saskatchewan Research Council's Radiocarbon Laboratory in Saskatoon and an age of 2990 ± 70 BP (S-2949) was obtained. The age estimates overlap at the 2σ level.

GSC-4646 HP. Amber Mountain $>48\ 000$
 $\delta^{13}\text{C} = -24.2\text{‰}$

The wood (*Picea* probably; identified by R.J. Mott (unpublished GSC Wood Report No. 88-23)) was enclosed in silt and fine sand. Sample 87-17-3 was collected by V. Levson on September 3, 1987, from 15 km southeast of Jasper townsite on an unnamed creek on Amber Mountain, Alberta ($52^{\circ}47'00''\text{N}$, $117^{\circ}55'30''\text{W}$), at an elevation of 1400 m; submitted by V. Levson and N. Rutter.

The sample (50.3 g dry weight) was treated with hot base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (40.1 g) yielded 34.34 L of CO₂ gas. The age estimate is based on one count for 3600 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.064 ± 0.048 , 2.777 ± 0.039 , and 107.073 ± 0.257 cpm, respectively.

Comment (V. Levson and N. Rutter): This sample was collected from a silt and fine sand bed at a depth of about 25 m below the surface. The woodbearing bed occurs within a thick (40 m) sequence of cobble to boulder gravels of local provenance interpreted as alluvial fan deposits. Fine grained facies that potentially contain organics are rare in these coarse clastic sequences. They are overlain by matrix-supported diamicton interpreted to be a till deposited during the last glaciation in the area. Because the glaciogenic and alluvial fan deposits are locally interbedded, this wood date indicates that the last nonglacial period in the area extended back to more than 48 ka BP.

British Columbia

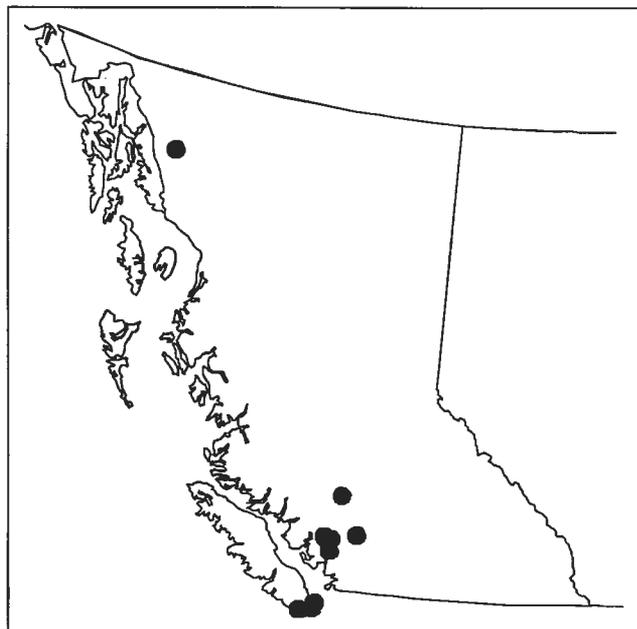


Figure 12. Radiocarbon dated sites in British Columbia.

GSC-4237. Mystery Creek rock avalanche 880 ± 100
 $\delta^{13}\text{C} = -26.2\text{‰}$

The wood (charcoal) was enclosed in sand. Sample EN-MYST-1 was collected by S.G. Evans and J.J. Clague on August 26, 1985, from 12.25 km north-northeast of Whistler, off highway 99 beneath debris of Mystery Creek rock avalanche, British Columbia ($50^{\circ}13'40''\text{N}$, $122^{\circ}15'00''\text{W}$), at an elevation of 518 m; submitted by S.G. Evans.

The sample (3.3 g dry weight) was treated with hot acid, and distilled water rinses; base treatment was omitted. The treated sample (2.7 g) yielded 2.79 L of CO_2 gas. The age estimate is based on two counts for 2360 minutes in the 2 L counter with a mixing ratio of 1.57.

The uncorrected age is 900 ± 100 .

Comment (S.G. Evans): This sample gives a minimum age for the Mystery Creek rock avalanche (estimated volume: $40 \times 10^6 \text{ m}^3$)

Paradise Creek Valley Series

A series of peat samples from head of Paradise Creek valley, 0.6 km north-northeast of Castle Peak, Chilcotin Ranges, British Columbia ($51^{\circ}5.3'\text{N}$, $122^{\circ}58.2'\text{W}$), at an elevation of 2090 m, was collected by J.J. Clague and R.W. Mathewes on August 27, 1987; submitted by J.J. Clague and R.W. Mathewes.

GSC-4600. Paradise Creek valley (I) $10\,100 \pm 140$
 $\delta^{13}\text{C} = -27.1\text{‰}$

The peat sample CIA-87-CP11 (59 g dry weight), enclosed in silt, sand, gravel, was treated with cold base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (49.0 g) yielded 2.61 L of CO_2 gas. The age estimate is based on three counts for 4250 minutes in the 2 L counter with a mixing ratio of 1.71. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.109 ± 0.076 , 0.994 ± 0.021 , and 18.078 ± 0.096 cpm, respectively.

The uncorrected age is $10\,200 \pm 140$.

GSC-4630. Paradise Creek valley (II) 9050 ± 100
 $\delta^{13}\text{C} = -25.1\text{‰}$

The peat, organic-rich silt sample CIA-87-CP12 (70 g wet weight), enclosed in silt, sand, and gravel, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (34.8 g) yielded 4.21 L of CO_2 gas. The age estimate is based on three counts for 4000 minutes in the 2 L counter with a mixing ratio of 1.06. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.859 ± 0.057 , 0.994 ± 0.021 , and 18.078 ± 0.096 cpm, respectively.

The uncorrected age is 9050 ± 100 .

Comment (J.J. Clague and R.W. Mathewes): The dated peat occurs within a sequence of colluvium and slope wash in the Castle Peak cirque. GSC-4600 is older than dates on peat (9050 ± 100 BP, GSC-4630) and a log (9120 ± 120 BP, RIDDL-975), which are stratigraphically lower in the sequence. GSC-4600 and -4630 are thought to be anomalously old, probably from incorporation of old carbon in aquatic mosses. Fossil logs above present treeline in the Castle Peak cirque have yielded radiocarbon ages ranging from 8230 ± 110 to 9120 ± 120 BP (GSC-4364; McNeely and McCuaig, 1991 and RIDDL-975, resp.). These dates indicate that a climate at this site during the early Holocene was warmer than today (Clague and Mathewes, 1989).

Island View Beach Series

A series of peat samples from Island View Beach, 8 km south-southeast of Sidney, Vancouver Island, British Columbia (48°34.7'N, 123°22.4'W), at an elevation of about 2 m, was collected by J.J. Clague and R.J. Hebda on August 19, 1987; submitted by J.J. Clague.

GSC-4795. Island View Beach (I) 2410 ± 50
 $\delta^{13}\text{C} = -26.6\text{‰}$

The peat, sample CIA-87-210-31 (16.0 g wet weight) with mud above and peat below, was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (9.8 g) yielded 6.50 L of CO₂ gas. The age estimate is based on one count for 2345 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 21.002 ± 0.102, 2.153 ± 0.022, and 28.455 ± 0.126 cpm, respectively.

The uncorrected age is 2440 ± 50.

GSC-4594. Island View Beach (II) 2440 ± 50
 $\delta^{13}\text{C} = -28.3\text{‰}$

The peat, sample CIA-87-208-9 (95.7 g wet weight) enclosed in peat below and organic mud above, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (20.6 g) yielded 7.81 L of CO₂ gas. The age estimate is based on two counts for 3940 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 20.701 ± 0.089, 2.145 ± 0.025, and 28.219 ± 0.124 cpm, respectively.

The uncorrected age is 2490 ± 50.

GSC-4572. Island View Beach (III) 2480 ± 90
 $\delta^{13}\text{C} = -25.2\text{‰}$

The wood, sample CIA-87-210-18 (6.0 g dry weight; *Salix*; identified by R.J. Mott (unpublished GSC Wood Report No. 88-2)) enclosed in peat, was treated with hot base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (3.6 g) yielded 3.71 L of CO₂ gas. The age estimate is based on two counts for 2160 minutes in the 2 L counter with a mixing ratio of 1.23. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.397 ± 0.098, 1.062 ± 0.028, and

18.241 ± 0.155 cpm, respectively.

The uncorrected age is 2480 ± 90.

GSC-4593. Island View Beach (IV)
uncorrected 2500 ± 70

The wood, sample CIA-87-210-12 (5.0 g wet weight; *Salix*; identified by R.J. Mott (unpublished GSC Wood Report No. 88-11)) enclosed in peat, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (3.7 g) yielded 3.87 L of CO₂ gas. The age estimate is based on two counts for 2450 minutes in the 2 L counter with a mixing ratio of 1.16. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.348 ± 0.085, 1.016 ± 0.018, and 18.217 ± 0.097 cpm, respectively.

GSC-4571. Island View Beach (V) 2630 ± 60
 $\delta^{13}\text{C} = -30.4\text{‰}$

The peat, sample CIA-87-210-7 (189.0 g wet weight) enclosed in peat, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (33.4 g) yielded 8.06 L of CO₂ gas. The age estimate is based on two counts for 2380 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 19.936 ± 0.100, 2.144 ± 0.024, and 27.947 ± 0.117 cpm, respectively.

The uncorrected age is 2710 ± 60.

Comment (J.J. Clague): GSC-4795 dates the top of a freshwater peat overlain by 35 cm of brackish, organic-rich mud. The mud, in turn, is overlain by 5 cm of peat, which is the surface unit at this site. The sample site lies at the upper limit of the tides. The stratigraphic and radiocarbon evidence indicates that there was a major transgression at Island View Beach about 2000 radiocarbon years ago. The radiocarbon dates from Island View Beach, which help date this transgression include: 2040 ± 130 BP (GSC-252, Lowdon and Blake, 1980); 2440 ± 50 BP (GSC-4594); 2480 ± 90 BP (GSC-4572); 2500 ± 70 BP (GSC-4593); and 2630 ± 60 BP (GSC-4571, Clague, 1989).

GSC-4731. Helmcken Park 8580 ± 130
δ¹³C = -28.0‰

The peat was enclosed in peat. Sample CIA-88-165-15 was collected by J.J. Clague and R.J. Hebda on June 28, 1988, from Helmcken Centennial Park on the west side of Portage Inlet, 0.35 km south of highway 1, Victoria, Vancouver Island, British Columbia (48°27.6'N, 123°25.7'W), at a depth of 2 m; submitted by J.J. Clague.

The sample (38.4 g wet weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (18.9 g) yielded 2.11 L of CO₂ gas. The age estimate is based on one count for 2725 minutes in the 2 L counter with a mixing ratio of 2.16. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.177 ± 0.091, 1.109 ± 0.018, and 18.080 ± 0.095 cpm, respectively.

The uncorrected age is 8630 ± 130.

Comment (J.J. Clague): GSC-4731 dates the base of a freshwater peat, which extends up to a few metres below present sea level in Portage Inlet and is overlain by marine mud. The peat was deposited during a time when sea level was lower relative to the land today. Elsewhere in Portage Inlet, the base and top of the peat have yielded radiocarbon ages of 9250 ± 140 and 5470 ± 115 BP (I-3676 and I-3673), respectively (Foster, 1972).

Muir Creek Series

A series of wood samples from the mouth of Muir Creek, 0.15 km south of highway 14, 10 km west of Sooke, Vancouver Island, British Columbia (48°22.9'N, 123°51.8'W), were collected by J.J. Clague on July 2, 1988; submitted by J.J. Clague.

GSC-4766. Muir Creek (I) 2920 ± 60
δ¹³C = -24.6‰

One piece wood, sample CIA-88-175-25 (43-46 cm; 28.3 g dry weight; *Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 89-14)) enclosed in organic-rich sand-silt, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.5 g) yielded 8.43 L of CO₂ gas. The age estimate is based on one count for 2520 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were

19.769 ± 0.097, 2.157 ± 0.026, and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 2920 ± 60.

Comment (J.J. Clague): This sample dates one of several organic-rich beds in a sequence of fluvial and estuarine sediments at the mouth of Muir Creek. This sediment sequence is located in the present-day intertidal zone and provides a record of relative sea level changes during the Holocene. The dated sample was collected 43-46 cm below the top of the original undisturbed land surface (1.25 m of fill overlies this surface at the sample site). Diatom, foraminifera, and pollen analyses have been performed on the sediments at this site.

GSC-4820. Muir Creek (II) 3120 ± 70
δ¹³C = -25.9‰

The charcoal, sample CIA-88-175-24 (55 cm; 14.5 g dry weight) enclosed in sand-silt, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (9.0 g) yielded 8.33 L of CO₂ gas. The age estimate is based on two counts for 2445 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.164 ± 0.077, 1.064 ± 0.019, 17.975 ± 0.0 cpm, and respectively.

The uncorrected age is 3140 ± 70.

Comment (J.J. Clague): Several organic-rich beds (peat, organic-rich silt and sand) are interstratified with thicker units of silty sand and sandy silt at the mouth of Muir Creek. Two of the organic beds contain in situ stumps and have yielded ages of 2920 ± 60 BP (GSC-4766) and 3530 ± 60 BP (GSC-4758). GSC-4820 is from a charcoal-rich sandy silt layer about 10 cm below GSC-4766. Two additional ages from this succession, below GSC-4758, are 3640 ± 60 BP (GSC-4787) and 5200 ± 70 BP (GSC-4765). The beds with the rooted stumps are below present sea level and may record subsidence during large earthquakes.

GSC-4758. Muir Creek (III) 3530 ± 60
δ¹³C = -25.6‰

The conifer wood pieces, sample CIA-88-175-14 (115-117 cm; 9.1 g dry weight; probably *Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 89-11)) with sandy mud above and peat below, were treated with

Mount Cayley Series

A series of wood samples from the Squamish Valley, west of Mount Cayley, about 40 km north of Squamish, British Columbia that were collected during 1985, 1986, and 1989 by S.G. Evans and submitted for dating by S.G. Evans.

GSC-4774. Mount Cayley (I) 350 ± 50
 $\delta^{13}\text{C} = -25.9\text{‰}$

The wood (*Tsuga*; identified by H. Jetté (unpublished GSC Wood Report No. 89-20)), sample EN-86-TCC3, was collected on July 8, 1986, from the south bank of Turbid Creek, about 600 m upstream of confluence with the Squamish River, British Columbia (50°04'30"N, 123°20'W), at an elevation of about 260 m.

The sample (11.7 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.4 g) yielded 8.08 L of CO₂ gas. The age estimate is based on two counts for 2085 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 27.152 ± 0.121 , 2.157 ± 0.026 , and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 370 ± 50 .

GSC-5104. Mount Cayley (II) 440 ± 80
 $\delta^{13}\text{C} = -21.3\text{‰}$

The wood (*Thuja plicata*; identified by R.J. Mott (unpublished GSC Wood Report No. 90-58)) was enclosed in debris avalanche diamicton. Sample EN-89-30J10 was collected on June 30, 1989, from Turbid Creek, west of Mount Cayley, British Columbia (50°4'N, 123°20'W), at an elevation of 245 m.

The sample (9.5 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.6 g) yielded 8.70 L of CO₂ gas. The age estimate is based on two counts for 2060 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.831 ± 0.099 , 1.101 ± 0.023 , and 18.696 ± 0.163 cpm, respectively.

The uncorrected age is 380 ± 80 .

GSC-4768. Mount Cayley (III) 500 ± 50
 $\delta^{13}\text{C} = -24.6\text{‰}$

The wood (*Pseudotsuga menziesii*; identified by H. Jetté (unpublished GSC Wood Report No. 89-15)) was enclosed in debris, an avalanche diamicton. Sample EN-86-SQ2 was collected on July 13, 1986, from the east bank of Squamish River, 600 m upstream of mouth of Turbid Creek, British Columbia (50°04'21"N, 123°20'35"W), at an elevation of about 120 m.

The sample (12.0 g dry weight) was treated with hot base, hot acid, and distilled water rinses. The treated sample (8.4 g) yielded 8.38 L of CO₂ gas. The age estimate is based on two counts for 2235 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 26.737 ± 0.117 , 2.157 ± 0.026 , and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 490 ± 50 .

GSC-5195. Mount Cayley (IV) 950 ± 80
 $\delta^{13}\text{C} = -23.0\text{‰}$

The wood (*Thuja plicata*; identified by H. Jetté (unpublished GSC Wood Report No. 91-26)) was enclosed in debris avalanche diamicton. Sample EN-89-30J4 was collected on June 30, 1989, 540 m upstream on Turbid Creek from the confluence with the Squamish River, west of Mount Cayley volcano, British Columbia (50°4'N, 123°20'W), at an elevation of 174 m.

The sample (7.4 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (6.8 g) yielded 5.77 L of CO₂ gas. The age estimate is based on two counts for 2060 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 16.256 ± 0.095 , 1.087 ± 0.025 , and 18.225 ± 0.161 cpm, respectively.

The uncorrected age is 920 ± 80 .

GSC-4904. Mount Cayley (V) 1010 ± 60
 $\delta^{13}\text{C} = -24.9\text{‰}$

The wood (*Thuja plicata*; identified by H. Jetté (unpublished GSC Wood Report No. 89-49)) was enclosed in debris, avalanche diamicton. Sample EN-86-TCC2 was collected on July 8, 1986, from the south bank of Turbid

Creek, about 600 m upstream of confluence with the Squamish River, British Columbia (50°04'30"N, 123°20'00"W), at an elevation of about 260 m.

The sample (9.9 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.2 g) yielded 8.65 L of CO₂ gas. The age estimate is based on two counts for 2070 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 24.828 ± 0.119, 2.161 ± 0.033, and 28.156 ± 0.180 cpm, respectively.

The uncorrected age is 1010 ± 60.

GSC-4298. Mount Cayley (VI) 1060 ± 60
δ¹³C= -24.2‰

The wood (*Thuja plicata*; identified by H. Jetté (unpublished GSC Wood Report No. 86-18)) was enclosed in a mudflow diamicton. Sample EN-CAY-TUR3 was collected by P. Jordan in September 1985, 650 m upstream from the mouth of Turbid Creek where Turbid Creek flows into the Squamish River, 43 km north of Squamish, British Columbia (50°04'30"N, 123°20'05"W), at an elevation of 240 m.

The sample (11.6 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.7 g) yielded 8.45 L of CO₂ gas. The age estimate is based on two counts for 2500 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 1050 ± 60.

GSC-4843. Mount Cayley (VII) 1250 ± 110
δ¹³C= -21.9‰

The wood (*Tsuga*; identified by R.J. Mott (unpublished GSC Wood Report No. 89-31)) was enclosed in debris, an avalanche diamicton. Sample EN-89-SQ-16 was collected on May 15, 1989, from the west bank of the Squamish River opposite mouth of Turbid Creek, British Columbia (50°04'30"N, 123°20'45"W), at an elevation of about 120 m.

The sample (1.9 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (1.6 g) yielded 1.58 L of CO₂ gas. The age estimate is based on two counts for 2175 minutes in the 2 L counter with a mixing ratio of 2.79. The count rates for the

sample (net) and for monthly backgrounds and standards (net) were 15.365 ± 0.159, 1.077 ± 0.015, and 17.836 ± 0.153 cpm, respectively.

The uncorrected age is 1200 ± 110.

GSC-4770. Mount Cayley (VIII) 1270 ± 50
δ¹³C= -22.3‰

The wood (*Pseudotsuga menziesii*; identified by H. Jetté (unpublished GSC Wood Report No. 89-16)) was enclosed in debris, an avalanche diamicton. Sample EN-86-SQ14 was collected on July 13, 1986, from the east bank of the Squamish River, 600 m upstream of mouth of Turbid Creek, British Columbia (50°04'21"N, 123°20'35"W), at an elevation of about 150 m.

The sample (12.3 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.4 g) yielded 8.33 L of CO₂ gas. The age estimate is based on two counts for 2395 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 24.384 ± 0.108, 2.157 ± 0.026, and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 1230 ± 50.

GSC-4867. Mount Cayley (IX) 4853 ± 70
δ¹³C= -25.5‰

The wood (*Pseudotsuga menziesii*; identified by R.J. Mott (unpublished GSC Wood Report No. 89-28)) was enclosed in debris, an avalanche diamicton. Sample EN-89-SQ-18 was collected on May 15, 1989, from the west bank of the Squamish River, 3750 m upstream from Turbid Creek, British Columbia (50°06'00"N, 123°22'00"W), at an elevation of about 120 m.

The sample (5.8 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (4.8 g) yielded 4.46 L of CO₂ gas. The age estimate is based on one count for 3860 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.641 ± 0.056, 1.067 ± 0.019, and 17.658 ± 0.099 cpm, respectively.

The uncorrected age is 4860 ± 70.

GSC-4884. Mount Cayley (X) 4920 ± 80
 $\delta^{13}\text{C} = -23.9\text{‰}$

The wood (conifer bark fragments identified by R.J. Mott (unpublished GSC Wood Report No. 89-43)) was enclosed in laminated silt. Sample EN-86-SQ-12 was collected on July 25, 1986, from the east bank of Squamish River, 500 m downstream from mouth of Turbid Creek, British Columbia (50°03'44"N, 123°20'09"W), at an elevation of about 120 m.

The sample (5.0 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (4.2 g) yielded 4.05 L of CO₂ gas. The age estimate is based on one count for 3570 minutes in the 2 L counter with a mixing ratio of 1.10. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.749 ± 0.062, 1.070 ± 0.019, and 17.936 ± 0.117 cpm, respectively.

The uncorrected age is 4900 ± 80.

GSC-4773. Mount Cayley (XI) 5030 ± 60
 $\delta^{13}\text{C} = -24.0\text{‰}$

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 89-19)) was enclosed in debris, an avalanche diamicton. Sample EN-86-TCG1 was collected on July 12, 1986, from the south side of Turbid Creek, about 1.6 km upstream from its confluence with the Squamish River, British Columbia (50°04'50"N, 123°19'30"W), at an elevation of 300 m.

The sample (14.0 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.4 g) yielded 8.38 L of CO₂ gas. The age estimate is based on one count for 4200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 15.221 ± 0.080, 2.157 ± 0.026, and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 5020 ± 60.

GSC-4772. Mount Cayley (XII) 5050 ± 70
 $\delta^{13}\text{C} = -24.5\text{‰}$

The wood (*Pseudotsuga menziesii*; identified by H. Jetté (unpublished GSC Wood Report No. 89-18)), sample EN-86-SQ9, was collected on July 26, 1986, from the east bank of the Squamish River, 700 m downstream from the mouth of Turbid Creek, British Columbia (50°03'39"N, 123°20'09"W), at an elevation of about 120 m.

The sample (10.5 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.5 g) yielded 8.47 L of CO₂ gas. The age estimate is based on two counts for 2055 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 15.165 ± 0.095, 2.157 ± 0.026, and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 5040 ± 70.

GSC-4771. Mount Cayley (XIII) 5080 ± 70
 $\delta^{13}\text{C} = -27.0\text{‰}$

The wood (*Tsuga*; identified by H. Jetté (unpublished GSC Wood Report No. 89-17)) was enclosed in debris, an avalanche diamicton. Sample EN-86-SQ10 was collected on July 25, 1986, from the east bank of the Squamish River, 500 m downstream from mouth of Turbid Creek, British Columbia (50°03'44"N, 123°20'09"W), at an elevation of about 120 m.

The sample (10.1 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.4 g) yielded 8.54 L of CO₂ gas. The age estimate is based on two counts for 2145 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 15.042 ± 0.093, 2.157 ± 0.026, and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 5110 ± 70.

GSC-4907. Mount Cayley (XIV) 5140 ± 70
 $\delta^{13}\text{C} = -22.8\text{‰}$

The wood (*Abies*; identified by H. Jetté (unpublished GSC Wood Report No. 89-48)) was enclosed in debris avalanche diamicton. Sample EN-86-SQ-4 was collected on July 24, 1986, from the east bank of the Squamish River, 700 m downstream from the mouth of Turbid Creek, British Columbia (50°03'39"N, 123°20'09"W), at an elevation of about 140 m.

The sample (10.7 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.3 g) yielded 7.83 L of CO₂ gas. The age estimate is based on two counts for 2010 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.978 ± 0.095, 2.189 ± 0.023, and 28.283 ± 0.127 cpm, respectively.

The uncorrected age is 5110 ± 70.

GSC-5287. Mount Cayley (XV) 5160 ± 60
 $\delta^{13}\text{C} = -25.4\text{‰}$

The wood (charred *Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 91-50)) was enclosed in debris avalanche. Sample EN-89-15J-1A was collected on September 6, 1991 from a fresh river cut on the Squamish River, 5.5 km upstream from the confluence with the Elaho River, British Columbia (50°06.5'N, 123°23.25'W), at an elevation of 180 m.

The sample (10.3 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.9 g) yielded 8.06 L of CO₂ gas. The age estimate is based on one count for 3600 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.902 ± 0.079 2.287 ± 0.039 28.354 ± 0.135 cpm, respectively.

The uncorrected age is 5170 ± 60.

GSC-4906. Mount Cayley (XVI) 5310 ± 70
 $\delta^{13}\text{C} = -25.1\text{‰}$

The wood (*Pseudotsuga menziesii*; identified by H. Jetté (unpublished GSC Wood Report No. 89-47)) was enclosed in debris avalanche diamicton. Sample EN-89-SQ-19 was collected on May 15, 1989, from the west bank of the Squamish River, 3750 m upstream from Turbid Creek, British Columbia (50°06'00"N, 123°22'00"W), at an elevation of about 120 m.

The sample (7.0 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (6.7 g) yielded 6.57 L of CO₂ gas. The age estimate is based on two counts for 2020 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.601 ± 0.094, 2.189 ± 0.023, and 28.283 ± 0.127 cpm, respectively.

The uncorrected age is 5310 ± 70.

GSC-5270. Mount Cayley (XVII) 5300 ± 140
 $\delta^{13}\text{C} = -27.9\text{‰}$

The wood (*Pseudotsuga menziesii*; identified by H. Jetté (unpublished GSC Wood Report No. 91-46)) was enclosed in lacustrine sediments. Sample EN-89-15J-2A was collected on June 15, 1989, from the south bank of the Elaho

River, just upstream from confluence with the Squamish River, British Columbia (50°6.5'N, 123°23.5'W), at an elevation of 180 m.

The sample (7.9 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (5.4 g) yielded 5.72 L of CO₂ gas. The age estimate is based on two counts for 1800 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.700 ± 0.082 1.224 ± 0.025 18.875 ± 0.273 cpm, respectively.

The uncorrected age is 5350 ± 140.

GSC-5271. Mount Cayley (XVIII) 5550 ± 70
 $\delta^{13}\text{C} = -25.6\text{‰}$

The wood (*Pseudotsuga menziesii*; identified by H. Jetté (unpublished GSC Wood Report No. 91-52)) was enclosed in landslide diamicton. Sample EN-89-2J-3B was collected on July 2, 1989 from a road cutbank, south of Shovelnose Creek, on the west slope of Mount Cayley Volcano, British Columbia (50°4.00'N, 123°8.00'W), at an elevation of 260 m.

The sample (10.6 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (7.0 g) yielded 7.44 L of CO₂ gas. The age estimate is based on two counts for 2180 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.155 ± 0.094 2.196 ± 0.038 28.279 ± 0.131 cpm, respectively.

The uncorrected age is 5560 ± 70.

Comment (S.G. Evans): An extensive investigation of the diamicton units, exposed in an extensive accumulation of volcanic debris in the Squamish valley west of Mount Cayley volcano, has yielded evidence for at least three major debris avalanches, initiated by the collapse of the western flank of Mount Cayley in the mid-Holocene. Radiocarbon ages obtained from tree fragments contained in the deposits indicate that the events took place at 4.8, 1.1, and 0.5 ka BP. All three debris avalanches dammed the Squamish River and formed temporary lakes upstream of the debris (Evans and Brooks, 1991, and 1992).

GSC Radiocarbon dates from the Turbid Creek debris fan.

Laboratory Number	Age years BP	
	normalized to $\delta^{13}\text{C} = -25\text{‰}$	uncorrected
GSC-4774	350 ± 50	370 ± 50
GSC-5104	440 ± 80	380 ± 80
GSC-4768	500 ± 50	490 ± 50
GSC-5195	950 ± 80	920 ± 80
GSC-4904	1010 ± 60	1010 ± 60
GSC-4298	1060 ± 60	1050 ± 60
GSC-4843	1250 ± 110	1200 ± 110
GSC-4770	1270 ± 50	1230 ± 50
GSC-4867	4853 ± 70	4860 ± 70
GSC-4884	4920 ± 80	4900 ± 80
GSC-4773	5030 ± 60	5020 ± 60
GSC-4772	5050 ± 70	5040 ± 70
GSC-4771	5080 ± 70	5110 ± 70
GSC-4907	5140 ± 70	5110 ± 70
GSC-5287	5160 ± 60	5170 ± 60
GSC-4906	5310 ± 70	5310 ± 70
GSC-5270	5300 ± 140	5350 ± 140
GSC-5271	5550 ± 70	5560 ± 70

GSC-4590. Muddy Lake 2280 ± 90
 $\delta^{13}\text{C} = -24.8\text{‰}$

The wood (*Abies*; identified by R.J. Mott (unpublished GSC Wood Report No. 88-9)) was enclosed in lacustrine silts. Sample EN-88-1 was collected by D. Martin on January 6, 1987, from Muddy Lake, British Columbia; 125 km east of Juneau, Alaska (58°11'N, 132°16'W), at an elevation of 956 m.

The sample (2 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (2.0 g) yielded 1.99 L of CO₂ gas. The age estimate is based on two counts for 2090 minutes in the 2 L counter with a mixing ratio of 2.26.

The uncorrected age is 2270 ± 90.

Comment (S.G. Evans): The sample was collected 1.8 m (6 ft) above the base of a drill hole in Muddy Lake, 9.1 m (30 ft) below the bottom of the lake at an unknown depth above the Muddy Lake rock avalanche debris. It gives a minimum age for the rock avalanche.

NORTHERN CANADA (MAINLAND)

Yukon Territory

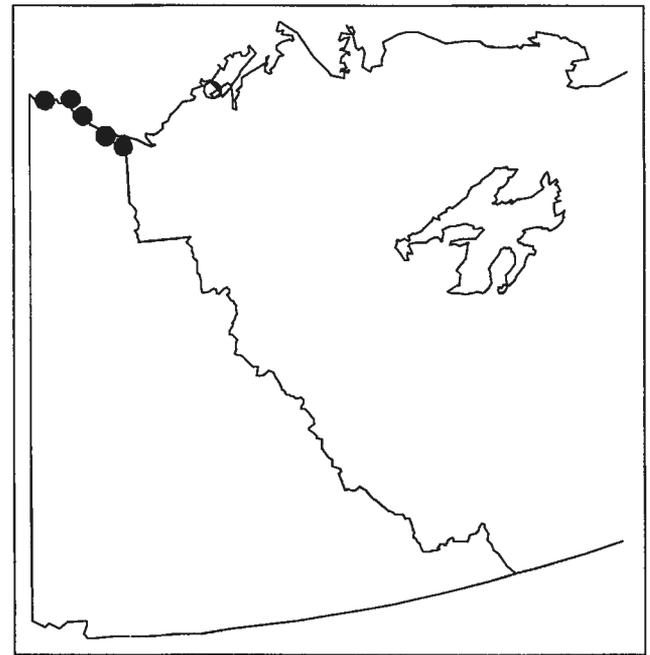


Figure 13. Radiocarbon dated sites in the Yukon.

Running River Series

Four age determinations were obtained on material collected in the downstream portion of the Running River on the Yukon Territory Coastal Plain. Two are associated with the paleo-Blow River drainage system while the other two are assigned to an interglacial interval predating the Buckland Glaciation.

GSC-4353. Running River (I)
 uncorrected 8660 ± 80

The wood (*Picea* sp.; identified by R.J. Mott (unpublished GSC Wood Report No. 86-74)) was enclosed in fluvial sand and gravel. Sample RCM-5 was collected, on the left bank of a small tributary stream, by V.N. Rampton on July 3, 1986, from 3.5 km south of Shingle Point airstrip and 1.7 km east of Running River, coastal plain, Yukon Territory (68°54.5'N, 137°17'W) at an elevation of about 50 m, and submitted by J-S. Vincent.

GSC-4418. Running River (IV) >35 000

The peat with small twigs was enclosed in organic silt. Sample VH-83-038 (2 bags) was collected by J-S. Vincent and V.N. Rampton on July 24, 1983, from a river bluff on the right bank of the Running River, 7 km from its mouth, 3.5 km southwest of Shingle Point Dew Line Site, coastal plain, Yukon Territory, (68°54.3'N, 137°20.5'W) at an elevation of about 50 m, and submitted by J-S. Vincent.

The sample (12.2 g dry weight) was treated with hot base, hot acid, and distilled water rinses; slightly calcareous. The age estimate is based on two counts for 2330 minutes (two 1-day) in the 2 L counter with a mixing ratio of 1.18.

Comment (J-S. Vincent): The section where the dated peat was collected consists, from river level up, of 1.2 m covered sediments; 4.3 m oxidized fluvial gravels with ice-wedge casts; 6.1 m unoxidized gravels; a thin bed of organic-rich silts from which the dated peat with twigs was collected; 0.6 m of Buckland Till; 4.3 m of Holocene fluvial gravels of the paleo system described above and from which GSC-3753 came from, and finally 0.8 m of peat and silts deposited in tundra ponds and sand deposited by wind action.

General comment on preceding age determinations:

The two dated samples come from the same stratigraphic unit since both are associated with the development of soils or ice-wedge casts on a gravel surface immediately underlying Buckland Till. The nonfinite ages, the presence of fluvial gravels with soils and substantial ice-wedge development, and the presence of the overlying till all lead towards assigning the deposits to an interglaciation preceding the Buckland Glaciation. It should also be noted that on the basis of some fossil insects recovered with sample VH-83-038, J.V. Matthews, Jr. concluded that the climate at the time of deposition may have been slightly warmer than at present (unpublished Fossil Arthropod Report No. 87-03). Major sequences of gravels, in the same stratigraphic position, along the Running River, the coast between the mouths of Running and Blow Rivers, and along the Blow River, may all represent deposition, on the coastal plain, of alluvial fans by rivers originating in the Barn or Richardson Mountains to the south.

GSC-4005. Herschel Island
uncorrected 8250 ± 80

The wood (*Salix* sp.; identified by R.J. Mott (unpublished GSC Wood Report No. 85-15)) was enclosed in autochthonous peat with wood and freshwater shells. Sample VH-83-090c was collected by J-S. Vincent, and V.N. Rampton on July 31, 1983, from 4 km north northwest of abandoned RCMP Post on Herschel Island, coastal plain, Yukon Territory, (69°36.2'N, 138°56.0'W) at an elevation of 150 m, and submitted by J-S. Vincent.

The sample (11.5 g dry weight) was treated with hot base, hot acid, and distilled water rinses, noncalcareous. The age estimate is based on one count for 4200 minutes (one 3-day) in the 5 L counter with a mixing ratio of 1.00.

Comment (J-S. Vincent): The dated *Salix* sp. wood is from the 30 cm thick peat in the section (381 ROX) described in Rampton (1982, p. 17-18). The section consists, from base of gully up, of 15 m covered sediments; 2.5 m clayey silts, possibly ice-thrusted; 1.5 m sand and silt with peaty beds; 0.3 m peat from which dated wood was collected; and 12 m of poorly exposed clayey silts with peaty and sandy interbeds. The clayey silt beneath the peat may be of marine origin because marine ostracods and foraminifera have been identified in these (see Rampton, 1982, Table 14). The thick overlying clayey silts were undoubtedly deposited in a large tundra lake which covered, before it drained, extensive areas of Herschel Island. The presence of an autochthonous peat overlain by a thick sequence of waterlain deposits can probably be understood by invoking relief inversions and ponding related to thermokarst activity in the ice-rich sediments of Herschel Island. Because of the stratigraphic setting and the compressed nature of the peat, much of the above described sequence was thought, by Rampton (1982) and earlier workers, to predate the Buckland Glaciation. This radiocarbon age determination has thus confirmed the Holocene age of this suite of sediments.

Komakuk Series

Two age determinations (one conventional, the other accelerator mass spectrometry) were obtained for organic matter in tundra pond deposits, from a low coastal bluff on Beaufort Sea, 2 km west of Komakuk DEW Line station and 12 km east of the mouth of the Backhouse River, coastal plain, Yukon Territory, (69°35.5'N, 140°14'W) at an elevation of less than 5 m, and submitted by J-S. Vincent.

GSC-4342. Komakuk (I) 9900 ± 200
δ¹³C = -28.6‰.

The wood (*Salix* sp.; identified by R.J. Mott (unpublished GSC Wood Report No. 86-76)) was enclosed in peat within fine-grained tundra pond deposits. Sample VH-85-057 was collected by J-S. Vincent on July 29, 1985.

The sample (5.6 g dry weight) was treated with hot base, hot acid, noncalcareous, and distilled water rinses. The age estimate is based on two counts for 2170 minutes (two 1-day) in the 2 L counter with a mixing ratio of 2.05.

The uncorrected age is 9950 ± 200.

TO-651. Komakuk (II) 10 580 ± 370

The mammal fecal pellets (identified by J.V. Matthews, Jr. in the unpublished GSC Plant Macrofossil Report No. 86-25) were enclosed in peat within fine-grained tundra pond deposits. Sample VH-85-055 was collected by J-S. Vincent on July 29, 1985.

The dry sample weighed 6 mg. The date is the average of two machine-ready targets, measured on different occasions, and has been corrected for natural, preparation and sputtering fractionation to a base of δ¹³C = -25‰.

General comment (J-S. Vincent): At the collection site, two distinct sequences of organic-rich silty tundra pond deposits rested on glaciomarine sediments of the Flaxman Member of the Gubik Formation (Carter et al., 1986). The fecal pellets date the lowermost sequence, whereas the *Salix* sp. wood dates the uppermost one. These age determinations, as several others on the Yukon Coastal Plain,

indicate that vegetation was well established and that tundra ponds were evolving through thermokarst activity at the end of the Late Wisconsinan and during the earliest Holocene. Plants (unpublished GSC Plant Macrofossil Report No. 86-25 by J.V. Matthews, Jr.) and insects (unpublished GSC Fossil Arthropod Report No. 86-24 by J.V. Matthews, Jr.) recovered from the fecal pellet bearing peat also live along the Yukon coast today. Conditions at the time of deposition of the tundra pond deposits were probably therefore similar to those of the present.

GSC-3737. Kay Point
uncorrected 9030 ± 80

The peat, associated with ice-wedge casts, was enclosed in sand. Sample VH-83-120 was collected by J-S. Vincent, and V.N. Rampton on August 1, 1983, from the low coastal bluff 1 km southeast of Kay Point, coastal plain, Yukon Territory (69°17.5'N, 138°22.0'W), at an elevation of about 3 m; submitted by J-S. Vincent.

The sample (70.0 g dry weight) was treated with hot base, hot acid, and distilled water rinses, noncalcareous. The age estimate is based on one 5-day counts in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 9030 ± 80.

Comment (J-S. Vincent): A composite reconstruction of the deposits present at Kay Point and to the southeast shows that: 0.5 m of clay at sea level is overlain by 4.6 m of gravel and 3.7 m of sand penetrated by numerous ice-wedge casts with abundant associated organic matter; 1.8 m of organic rich silt; 2.2 m of peat; and 0.6 m of sand with peat. The gravel at the base of the sequence is probably glaciofluvial and associated with retreat of Buckland Glaciation ice (Rampton, 1982) from the coastal plain. The overlying sands, peats and silts are related to the Holocene development of tundra ponds, through thermokarst activity, and to minor eolian input. This age determination, as well as GSC-480 (9710 ± 140 BP; Lowdon and Blake, 1976) and GSC-1872 (7170 ± 70 BP; Lowdon and Blake, 1976), are all from peats in ice-wedge casts which developed from the top of the sand unit into the underlying gravels. These ages testify to important ice wedging activity in the early part of the Holocene.

Northwest Territories (mainland)

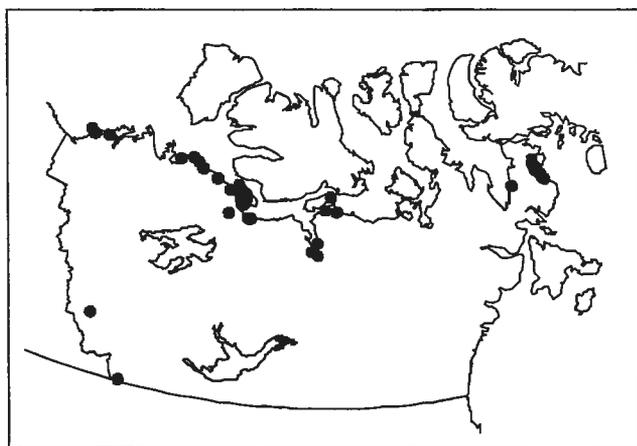


Figure 14. Radiocarbon dated sites on the mainland Northwest Territories.

Melville Peninsula

GSC-4750. Cape Jermain 6420 ± 90
 $\delta^{13}\text{C} = +1.4\text{‰}$

The marine shells (mixed shell collection) were enclosed in sand. Sample 88-DU-1433 (Sta. 1810) was collected by L.A. Dredge and M. Nixon on July 31, 1988, from stream emptying into large unnamed lake west of Cape Jermain, eastern Melville Peninsula, District of Franklin, Northwest Territories (67°51'18"N, 82°09'53"W), at an elevation of 141 m; submitted by L.A. Dredge.

The sample (42.0 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (33.5 g) yielded 5.82 L of CO₂ gas. The age estimate is based on two counts for 2060 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.149 ± 0.069, 1.092 ± 0.018, and 18.072 ± 0.097 cpm, respectively.

The uncorrected age is 6400 ± 90.

Comment (L.A. Dredge): Whole valves of *Mya truncata*, some with syphons and periostracum, were collected in a fine deltaic sand about 2 m below the flat surface of a delta. The shells give an age estimate for the 143 m waterplane and an approximate date for deglaciation. Marine limit is at about 148 m at this site (cf. GSC-291, 6880 ± 180 BP; Dyck et al., 1966).

GSC-4812. Parry Bay 6170 ± 80
 $\delta^{13}\text{C} = +1.5\text{‰}$

The marine shells (*Mya truncata* and *Hiatella arctica*; identified by L.A. Dredge) were enclosed in sand. Sample 88-DU-1430 (Sta. 1808) was collected by L.A. Dredge and M. Nixon on June 31, 1988, from north bank of an unnamed river draining into Parry Bay, 18.5 km inland from the coast, Melville Peninsula, District of Franklin, Northwest Territories (67°55'10"N, 82°18'41"W), at an elevation of 104 m; submitted by L.A. Dredge.

The sample (53.6 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (35.0 g) yielded 7.46 L of CO₂ gas. The age estimate is based on two counts for 2020 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.201 ± 0.097, 2.127 ± 0.043, and 28.373 ± 0.167 cpm, respectively.

The uncorrected age is 6150 ± 80.

Comment (L.A. Dredge): The shells were collected from a fresh exposure in a small delta, about 2 m below the top. They give an age estimate of the 104 m waterplane and a minimum date for deglaciation. Marine limit is at about 148 m in this area.

GSC-4809. Hall Lake 6240 ± 90
 $\delta^{13}\text{C} = +1.6\text{‰}$

The marine shells (*Hiatella arctica*; identified by L.A. Dredge) were enclosed in silty till. Sample 88-DU-1091 (Sta. 1057) was collected by L.A. Dredge and M. Nixon on June 30, 1988, from 18 km west of the north arm of Hall Lake, near Kingnartuak Mountains, Melville Peninsula, District of Franklin, Northwest Territories (68°47'32"N, 82°41'22"W), at an elevation of about 95 m; submitted by L.A. Dredge.

The sample (35.7 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (28.5 g) yielded 6.27 L of CO₂ gas. The age estimate is based on two counts for 2060 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.296 ± 0.071, 1.090 ± 0.023, and 17.970 ± 0.101 cpm, respectively.

The uncorrected age is 6210 ± 90.

Comment (L.A. Dredge): The whole valves and fragments were collected from a washed till surface. The date gives an estimated age for the 95 m water plane and a minimum age for deglaciation. Marine limit is at 110 m in this area.

Melville Peninsula Series

A series of marine shells from Melville Peninsula were collected by L.A. Dredge and M. Nixon in 1986 and 1988. The dates and interpretations are published in Dredge, 1991.

GSC-4759. Ajaqutalik River (I) 1590 ± 60
 $\delta^{13}\text{C} = -21.8\text{‰}$

The organic detritus was enclosed in sand. Sample 88-DU-1129 was collected by L.A. Dredge and M. Nixon on June 30, 1988, from mouth of Ajaqutalik River, where it enters Roche Bay, eastern Melville Peninsula, District of Franklin, Northwest Territories (68°24'17"N, 82°33'04"W), at an elevation of 5 m; submitted by L.A. Dredge.

The sample (97.7 g dry weight) was treated with hot base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (22.1 g) yielded 8.59 L of CO₂ gas. The age estimate is based on two counts for 2210 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 23.300 ± 0.111, 2.152 ± 0.026, and 28.221 ± 0.153 cpm, respectively.

The uncorrected age is 1540 ± 60.

Comment (L.A. Dredge): The detritus gives an age for the 5 m delta level and represents a period with more vegetation than present.

GSC-4814. Ajaqutalik River (II) 4610 ± 80
 $\delta^{13}\text{C} = +1.8\text{‰}$

The marine shells (*Hiatella arctica* and *Mya*; identified by L.A. Dredge) were enclosed in sand. Sample 88-DU-1032 (Sta. 1026) was collected by L.A. Dredge and M. Nixon on June 27, 1988, from the east bank of the Ajaqutalik River, 2.7 km upstream from the mouth, north Melville Peninsula, District of Franklin, Northwest Territories (68°23'04"N, 82°33'28"W), at an elevation of 35 m; submitted by L.A. Dredge.

The sample (43.3 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (34.7 g) yielded 7.60 L of CO₂ gas. The age estimate is based on two counts for 2155 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 16.042 ± 0.115, 2.127 ± 0.043, and 28.373 ± 0.167 cpm, respectively.

The uncorrected age is 4580 ± 80.

Comment (L.A. Dredge): The shells were collected from the surface of a beach berm and provide an estimate age for the 35 m sea level.

GSC-4803. Ajaqutalik River (III) 4980 ± 80
 $\delta^{13}\text{C} = +1.5\text{‰}$

The marine shells (*Mya truncata* and *Macoma calcarea*; identified by L.A. Dredge) were enclosed in sand. Sample 88-DU-1257 (Sta. 1271) was collected by L.A. Dredge and M. Nixon on July 11, 1988, near the mouth of a tributary to the Ajaqutalik River, 13.5 km west-southwest from the river mouth, eastern Melville Peninsula, District of Franklin, Northwest Territories (68°21'17"N, 82°50'46"W), at an elevation of 60 m; submitted by L.A. Dredge.

The sample (48.2 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (38.6 g) yielded 7.44 L of CO₂ gas. The age estimate is based on two counts for 2060 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 15.317 ± 0.102, 2.127 ± 0.043, and 28.373 ± 0.167 cpm, respectively.

The uncorrected age is 4950 ± 80.

Comment (L.A. Dredge): The shells were collected from delta topset sands and give an approximate date for the 60 m sea level. The date does not fit onto a simple exponential emergence curve for the area (Dredge, 1991) and suggests the growth of an ice cap on central Melville Peninsula.

GSC-4798. Ajaqutalik River (IV) 6260 ± 90
 $\delta^{13}\text{C} = +1.4\text{‰}$

The marine shells (*Hiatella arctica*, *Mya truncata* and *M. arenaria*; identified by L.A. Dredge) were enclosed in sand. Sample 88-DU-1104 (Sta. 1173) was collected by

Coronation Gulf - Dolphin and Union Strait Series

A series of lake sediment samples from north of Coppermine, District of Mackenzie, Northwest Territories were collected by I. McMartin and D.A. St-Onge on July 10, 1988; submitted by D.A. St-Onge.

GSC-4842. Coronation Gulf (I) 7010 ± 110
 $\delta^{13}\text{C} = -26.3\text{‰}$

The lake sediment, basal gyttja, was collected from 77 km north of Coppermine, District of Mackenzie, Northwest Territories (68°32'32"N, 115°12'48"W), at an elevation of 105 m. Sample SV(M)-88-69 (72.8 g wet weight), was treated with hot acid, and distilled water rinses; base treatment was omitted (moderately calcareous). The treated sample (22.9 g) yielded 3.57 L of CO₂ gas. The age estimate is based on two counts for 2085 minutes in the 2 L counter with a mixing ratio of 1.25. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.431 ± 0.075, 1.077 ± 0.015, and 17.836 ± 0.153 cpm, respectively.

The uncorrected age is 7030 ± 110.

GSC-4823. Coronation Gulf (II) 7040 ± 90
 $\delta^{13}\text{C} = -21.2\text{‰}$

The lake sediment, basal gyttja, was collected from (68°33'25"N, 115°13'32"W), at an elevation of 148 m. Sample SV(M)-88-68 (54.1 g wet weight), enclosed in gyttja, was treated with hot acid, and distilled water rinses; base treatment was omitted (very calcareous). The treated sample (16.0 g) yielded 3.21 L of CO₂ gas. The age estimate is based on one count for 3940 minutes in the 2 L counter with a mixing ratio of 1.38. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.540 ± 0.064, 1.090 ± 0.023, and 17.970 ± 0.101 cpm, respectively.

The uncorrected age is 6980 ± 90.

Comment (D.A. St-Onge): See McMartin, 1990 for comments.

A number of shell samples from an area north of Coppermine, west of Coronation Gulf and south of Dolphin and Union Strait were collected by D.A. St-Onge, I. McMartin, R. Avery, and M. Potschin during 1988/89 and submitted for dating by I. McMartin and D.A. St-Onge.

GSC-4845. 2.5 km north of 9120 ± 120
Basil Bay $\delta^{13}\text{C} = +0.4\text{‰}$

The marine shells (unidentifiable fragments) were enclosed in silty sand. Sample SV(A)-88-13 was collected by R. Avery on July 30, 1988, from 2.5 km north of Basil Bay, Coronation Gulf, 53 km north of Coppermine, District of Mackenzie, Northwest Territories (68°18'29"N, 114°59'49"W), at an elevation of 100 m; submitted by I. McMartin and D.A. St-Onge.

The sample (31.3 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (25.0 g) yielded 5.51 L of CO₂ gas. The age estimate is based on two counts for 2120 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.735 ± 0.059, 1.077 ± 0.015, and 17.836 ± 0.153 cpm, respectively.

The uncorrected age is 9110 ± 120.

GSC-4847. 33.5 km south-southwest 9530 ± 80
of Bernard Harbour $\delta^{13}\text{C} = +1.6\text{‰}$

The marine shells (*Hiatella arctica*; identified by I. McMartin) were enclosed in silty clay. Sample SV(M)-88-58 was collected by I. McMartin on July 24, 1988, from 73 km north of Coppermine and 33.5 km south-southwest of Bernard Harbour, District of Mackenzie, Northwest Territories (68°29'12"N, 114°59'32"W), at an elevation of 97 m; submitted by I. McMartin and D.A. St-Onge.

The sample (43.4 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (33.7 g) yielded 7.49 L of CO₂ gas. The age estimate is based on one count for 3810 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.762 ± 0.059, 2.186 ± 0.024, and 28.589 ± 0.128 cpm, respectively.

The uncorrected age is 9500 ± 80.

GSC-4709. 55 km north-northwest 9190 ± 160
of Coppermine $\delta^{13}\text{C} = +1.4\text{‰}$

The marine shells, sample SV-88-15, were collected by D.A. St-Onge on July 14, 1988, from 55 km north-northwest of Coppermine, District of Mackenzie, Northwest Territories (68°19'03"N, 115°22'28"W), at an elevation of 100 m; submitted by D.A. St-Onge.

The sample (8.2 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (7.73 g) yielded 1.60 L of CO₂ gas. The age estimate is based on one count for 2775 minutes in the 2 L counter with a mixing ratio of 2.79. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.777 ± 0.107 , 1.109 ± 0.018 , and 18.080 ± 0.095 cpm, respectively.

The uncorrected age is 9160 ± 160 .

GSC-4930. 17 km northwest of Basil Bay 9480 ± 120
 $\delta^{13}\text{C} = +1.7\text{‰}$

The marine shells, sample SV(M)-89-45, were collected by I. McMartin on July 20, 1989, from 17 km northwest of Basil Bay, 65 km north-northwest of Coppermine, District of Mackenzie, Northwest Territories (68°24'42"N, 115°15'52"W), at an elevation of 105 m; submitted by I. McMartin and D.A. St-Onge.

The sample (19.5 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (15.6 g) yielded 3.41 L of CO₂ gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 1.31. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.509 ± 0.072 , 1.083 ± 0.019 , and 17.862 ± 0.102 cpm, respectively.

The uncorrected age is 9450 ± 120 .

GSC-4915. Klengen Bay 9520 ± 80
 $\delta^{13}\text{C} = +0.7\text{‰}$

The marine shells, (*Hiatella arctica*; identified by I. McMartin), sample SV(M)-89-6, were collected by I. McMartin on July 8, 1989, from 7 km northwest of Klengen Bay, 47 km north of Coppermine, District of Mackenzie, Northwest Territories (68°14'42"N, 115°20'06"W), at an elevation of 115 m; submitted by I. McMartin and D.A. St-Onge.

The sample (38.8 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (30.5 g) yielded 6.94 L of CO₂ gas. The age estimate is based on one count for 3930 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.654 ± 0.057 , 2.189 ± 0.023 , and 28.283 ± 0.127 cpm, respectively.

The uncorrected age is 9510 ± 80 .

GSC-4696. 70 km north of Coppermine 9540 ± 80
 $\delta^{13}\text{C} = +0.7\text{‰}$

The marine shells (*Hiatella arctica*; identified by I. McMartin), sample SV(M)-88-61, were collected by I. McMartin on July 24, 1988, from 70 km north of Coppermine, District of Mackenzie, Northwest Territories (68°27'33"N, 115°05'54"W), at an elevation of 111 m; submitted by D.A. St-Onge.

The sample (43.6 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (33.7 g) yielded 7.42 L of CO₂ gas. The age estimate is based on one count for 4200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.592 ± 0.059 , 2.221 ± 0.031 , and 28.121 ± 0.123 cpm, respectively.

The uncorrected age is 9520 ± 80 .

GSC-4749. 76 km north of Coppermine 9620 ± 90
 $\delta^{13}\text{C} = +0.7\text{‰}$

The marine shells (*Hiatella arctica*; identified by D.A. St-Onge) were enclosed in nearshore sand. Sample SV-88-25 was collected by D.A. St-Onge on July 15, 1988 from 76 km north of Coppermine, District of Mackenzie, Northwest Territories (68°32'32"N, 115°05'40"W), at an elevation of 105 m; submitted by D.A. St-Onge.

The sample (44.7 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (31.3 g) yielded 6.87 L of CO₂ gas. The age estimate is based on one count for 4200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.527 ± 0.057 , 2.152 ± 0.026 , and 28.221 ± 0.153 cpm, respectively.

The uncorrected age is 9610 ± 90 .

GSC-4846. 34 km southwest of Bernard Harbour 9610 ± 80
 $\delta^{13}\text{C} = -0.1\text{‰}$

The marine shells (*Hiatella arctica*; identified by I. McMartin) were enclosed in sandy gravels. Sample SV(P)-88-12 was collected by M. Potschin on July 18, 1988, from 75 km north of Coppermine, 34 km southwest of Bernard Harbour, District of Mackenzie, Northwest Territories (68°30'33"N, 115°10'53"W), at an elevation of 100 m; submitted by I. McMartin and D.A. St-Onge.

The sample (44.5 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (35.1 g) yielded 7.85 L of CO₂ gas. The age estimate is based on one count for 3665 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.642 ± 0.059, 2.186 ± 0.024, and 28.589 ± 0.128 cpm, respectively.

The uncorrected age is 9610 ± 80.

GSC-4747. 44 km north-northwest of Coppermine 9640 ± 170
δ¹³C= +0.8‰

The marine shells (*Hiatella arctica* and *Mya arenaria*; identified by I. McMartin), sample SV(M)-88-67, were collected by I. McMartin on July 30, 1988, from 44 km north-northwest of Coppermine, District of Mackenzie, Northwest Territories (68°11'30"N, 115°18'47"W), at an elevation of 105 m; submitted by D.A. St-Onge.

The sample (22 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (8.9 g) yielded 1.85 L of CO₂ gas. The age estimate is based on two counts for 2120 minutes in the 2 L counter with a mixing ratio of 2.44. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.409 ± 0.107, 1.114 ± 0.019, and 17.921 ± 0.095 cpm, respectively.

The uncorrected age is 9620 ± 170.

GSC-4849. 25 km southeast of Stapylton Bay 9690 ± 150
δ¹³C= +1.2‰

The marine shells (*Hiatella arctica*; identified by I. McMartin) were enclosed in sand and gravels. Sample SV-88-29 was collected by D.A. St-Onge on July 18, 1988, from 25 km southeast of Stapylton Bay and 93 km north-northwest of Coppermine, District of Mackenzie, Northwest Territories (68°39'31"N, 115°26'46"W), at an elevation of 80 m; submitted by I. McMartin and D.A. St-Onge.

The sample (10.1 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (9.2 g) yielded 1.79 L of CO₂ gas. The age estimate is based on one count for 3665 minutes in the 2 L counter with a mixing ratio of 2.43. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.353 ± 0.081, 1.077 ± 0.015, and 17.836 ± 0.153 cpm, respectively.

The uncorrected age is 9670 ± 150.

GSC-4848. 41 km southwest of Bernard Harbour 9700 ± 80
δ¹³C= +1.0‰

The marine shells (*Hiatella arctica*; identified by I. McMartin) were enclosed in silty clay. Sample SV-88-35 was collected by D.A. St-Onge on July 21, 1988, from 70.5 km north of Coppermine and 41 km southwest of Bernard Harbour, District of Mackenzie, Northwest Territories (68°27'26"N, 115°21'23"W), at an elevation of 95 m; submitted by I. McMartin and D.A. St-Onge.

The sample (44.7 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (35.5 g) yielded 7.88 L of CO₂ gas. The age estimate is based on one count for 3650 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.563 ± 0.059, 2.186 ± 0.024, and 28.589 ± 0.128 cpm, respectively.

The uncorrected age is 9680 ± 80.

GSC-4917. 19 km south of Stapylton Bay 9850 ± 80
δ¹³C= +1.9‰

The marine shells (*Hiatella arctica*; identified by I. McMartin), sample SV(M)-89-4, were collected by I. McMartin on July 7, 1989, from 19 km south of Stapylton Bay, 95 km north-northwest of Coppermine, District of Mackenzie, Northwest Territories (68°39'21"N, 115°46'40"W), at an elevation of 99 m; submitted by I. McMartin and D.A. St-Onge.

The sample (37.1 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (29.6 g) yielded 6.66 L of CO₂ gas. The age estimate is based on one count for 3950 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.333 ± 0.057, 2.189 ± 0.023, and 28.283 ± 0.127 cpm, respectively.

The uncorrected age is 9820 ± 80.

GSC-4727. 74 km north-northwest of Coppermine 9920 ± 100
δ¹³C= +0.5‰

The marine shells (*Hiatella arctica*; identified by I. McMartin), sample SV-88-7, were collected by D.A. St-Onge on July 9, 1988, from 74 km north-northwest of Coppermine, District of Mackenzie, Northwest Territories (68°27'58"N, 115°34'34"W), at an elevation of 100 m; submitted by D.A. St-Onge.

The sample (51.8 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (36.3 g) yielded 7.99 L of CO₂ gas. The age estimate is based on one count for 2790 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.174 ± 0.070, 2.166 ± 0.034, and 28.137 ± 0.173 cpm, respectively.

The uncorrected age is 9930 ± 100.

GSC-4926. 12 km south of Stapyhton Bay 10 100 ± 90
δ¹³C= +1.3‰

The marine shells (*Hiatella arctica*; identified by I. McMartin), sample SV(M)-89-26, were collected by I. McMartin on July 12, 1989, from 12 km south of Stapyhton Bay, 110 km north-northwest of Coppermine, District of Mackenzie, Northwest Territories (68°48'15"N, 115°39'12"W), at an elevation of 85 m; submitted by I. McMartin and D.A. St-Onge.

The sample (36.8 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (31.0 g) yielded 6.94 L of CO₂ gas. The age estimate is based on one count for 3930 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.998 ± 0.057, 2.105 ± 0.027, and 28.136 ± 0.132 cpm, respectively.

The uncorrected age is 10 100 ± 90.

GSC-4916. 64 km north-northwest of Coppermine 10 700 ± 100
δ¹³C= -0.1‰

The marine shells were enclosed in silty rhythmites. Sample SV(M)-89-10 was collected by I. McMartin on July 11, 1989, from 64 km north-northwest of Coppermine, District of Mackenzie, Northwest Territories (68°22'41"N, 115°35'17"W), at an elevation of 100 m; submitted by I. McMartin and D.A. St-Onge.

The sample (26.9 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (21.7 g) yielded 4.67 L of CO₂ gas. The age estimate is based on two counts for 5080 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.747 ± 0.044, 1.073 ± 0.016, and 18.101 ± 0.100 cpm, respectively.

The uncorrected age is 10 800 ± 100.

TO-1231. 46 km north-northwest of Coppermine 11 170 ± 80

The marine shells fragments (*Portlandia arctica*; identified by I. McMartin) was found on the surface of fine-grained marine sediments (clay and fine sand). Sample SV(M)-88-11 was collected by I. McMartin on July 13, 1988, from 46 km north-northwest of Coppermine, District of Mackenzie, Northwest Territories (68°14'17"N, 115°28'59"W), at an elevation of 125 m; submitted by D.A. St-Onge.

The sample was treated with an acid leach to remove 50% of the outer material.

Comment (D.A. St-Onge): A suite of dates (listed below) from west of Coronation Gulf and south of Dolphin and Union Strait indicates that from 11.2 ka BP (TO-1231) an arm of the sea existed between glacier ice to the east and northeast, and deglaciated uplands existed to the west and southwest. For a detailed discussion, see McMartin, 1990.

Material	Elevation (m)	Age a BP	Lab No.
Lacustrine sediments	105	7010 ± 100	GSC-4842
Lacustrine sediments	148	7040 ± 90	GSC-4823
Shell fragments	100	9120 ± 120	GSC-4845
Shell fragments	100	9190 ± 160	GSC-4709
Shell fragments	105	9480 ± 140	GSC-4930
<i>Hiatella arctica</i>	115	9520 ± 80	GSC-4915
<i>Hiatella arctica</i>	097	9530 ± 80	GSC-4847
<i>Hiatella arctica</i>	111	9540 ± 80	GSC-4696
<i>Hiatella arctica</i>	100	9610 ± 80	GSC-4846
<i>Hiatella arctica</i>	105	9620 ± 90	GSC-4749
<i>Hiatella arctica</i>	105	9640 ± 170	GSC-4747
<i>Hiatella arctica</i>	080	9690 ± 150	GSC-4849
<i>Hiatella arctica</i>	095	9700 ± 80	GSC-4848
<i>Hiatella arctica</i>	099	9850 ± 80	GSC-4917
<i>Hiatella arctica</i>	100	9920 ± 100	GSC-4727
<i>Hiatella arctica</i>	085	10 100 ± 90	GSC-4926
Shell fragments	100	10 700 ± 100	GSC-4916
<i>Portlandia arctica</i>	125	11 170 ± 80	TO-1231

A series of marine shell samples and two samples of driftwood were collected by D.E. Kerr from the Arctic mainland coast between western Queen Maud Gulf and Darnley Bay, District of Mackenzie, Northwest Territories, during the summers of 1984 to 1989. This suite of samples were submitted by D.E. Kerr to be dated at the Alberta Environmental Centre's laboratory in Vegreville (AECV), under the direction of Dr. L.D. Arnold.

AECV-947Cc. Queen Maud Gulf 5170 ± 100
 $\delta^{13}\text{C} = +1.5\text{‰}$

The marine shells (*Mya truncata* and *Macoma*; identified by D.E. Kerr) were enclosed in silty clay. Sample 89 K-7 was collected by D.E. Kerr on July 20, 1989 from the top of a river-bank section along an unnamed river flowing into the west end of Queen Maud Gulf, District of Mackenzie, Northwest Territories (68°08'N, 105°03'W), at an elevation of 27.4 m.

AECV-948Cc. Kent Peninsula 7800 ± 150
 $\delta^{13}\text{C} = +1.8\text{‰}$

The marine shells (*Mya truncata* and *M. arenaria*; identified by D.E. Kerr) were enclosed in silty clay. Sample 89 K-13 was collected by D.E. Kerr on July 20, 1989 from along Beaufort River, Kent Peninsula, east of Bathurst Inlet, District of Mackenzie, Northwest Territories (68°45'N, 105°42'W), at an elevation of 58 m.

AECV-946Cc. Melville Sound 2330 ± 90
 $\delta^{13}\text{C} = -0.8\text{‰}$

The marine shells (*Mytilus edulis*; identified by D.E. Kerr) were enclosed in silty sand. Sample 89 K-3 was collected by D.E. Kerr on July 19, 1989 from a river-bank section at the mouth of an unnamed river on south side of Melville Sound, east of Bathurst Inlet, District of Mackenzie, Northwest Territories (68°12'N, 106°18'W), at an elevation of 5 m.

AECV-447Cc. Bathurst Inlet (I)
uncorrected 2620 ± 110

The marine shells (*Astarte montagui*; identified by D.E. Kerr) were enclosed in sandy silt. Sample 87K-3 was collected by D.E. Kerr on August 12, 1987 from Gordon Bay, Bathurst Inlet, District of Mackenzie, Northwest Territories (66°49'N, 107°07'W), at an elevation of 1.5 m.

AECV-448C. Bathurst Inlet (II)
uncorrected 3080 ± 110

The wood (driftwood?) was enclosed in sandy peat. Sample 87K-8a was collected by D.E. Kerr on August 17, 1987 from southern Bathurst Inlet, District of Mackenzie, Northwest Territories (66°19'N, 107°05'W), at an elevation of 24 m.

AECV-446Cc. Bathurst Inlet (III)
uncorrected 7720 ± 140

The marine shells (*Hiatella arctica* and *Mya truncata*; identified by D.E. Kerr) were enclosed in sandy clay. Sample 87K-S-2 was collected by D.E. Kerr on July 27, 1987 from southern Bathurst Inlet, District of Mackenzie, Northwest Territories (66°28'N, 107°40'W), at an elevation of 177 m.

AECV-445C. northern Coronation Gulf
uncorrected 3850 ± 210

The wood (driftwood?) was enclosed in sandy peat. Sample SVK-86-77 was collected by D.E. Kerr on July 30, 1986 from southern Victoria Island, District of Mackenzie, Northwest Territories (68°52'N, 110°35'W), at an elevation of 24 m.

AECV-404Cc. Coronation Gulf (I)
uncorrected 9080 ± 150

The marine shells (*Hiatella arctica* and *Mya truncata*; identified by D.E. Kerr) were enclosed in sand. Sample K-86-62 was collected by D.E. Kerr on July 28, 1986 from southern Coronation Gulf, District of Mackenzie, Northwest Territories (67°40'30"N, 114°16'30"W), at an elevation of 120 m.

AECV-472Cc. Coronation Gulf (II)
uncorrected 9560 ± 130

The marine shells (*Mya truncata*; identified by D.E. Kerr) were enclosed in silty clay. Sample SVK-84-11 was collected by D.E. Kerr on August 5, 1984 from Coppermine area, southern Coronation Gulf, District of Mackenzie, Northwest Territories (67°40'N, 114°33'W), at an elevation of 120 m.

AECV-646Cc. Dolphin and Union Strait (I)
uncorrected 5660 ± 110

The marine shells (*Mytilus edulis*; identified by D.E. Kerr) were enclosed in sandy clay. Sample 88K-28 was collected by D.E. Kerr on July 15, 1988 from south of Dolphin and Union Strait, and west of Coronation Gulf, District of Mackenzie, Northwest Territories (68°44'N, 115°37'W), at an elevation of 18 m.

AECV-717Cc. Dolphin and Union Strait (II)
uncorrected 7250 ± 180

The marine shells (*Clinocardium ciliatum*; identified by D.E. Kerr) were enclosed in sandy clay. Sample 88K-28a was collected by D.E. Kerr on July 13, 1988 from south Dolphin and Union Strait coast, District of Mackenzie, Northwest Territories (68°45'N, 115°38'W), at an elevation of 15 m.

AECV-474Cc. Dolphin and Union Strait (III)
uncorrected 10 040 ± 240

The marine shells (*Macoma*; identified by D.E. Kerr) were enclosed in sand. Sample SVK-86-20 was collected by D.E. Kerr on July 15, 1986 from south of Dolphin and Union Strait, District of Mackenzie, Northwest Territories (68°44'N, 116°56'W), at an elevation of 80 m.

AECV-713Cc. Dolphin and Union Strait (IV)
uncorrected 10 420 ± 540

The marine shells (*Mya* and *Hiatella arctica*; identified by D.E. Kerr) were enclosed in sandy clay. Sample SVK-86-22 was collected by D.E. Kerr on July 21, 1986 from south of Dolphin and Union Strait, District of Mackenzie, Northwest Territories (68°44'N, 116°56'17"W), at an elevation of 70 m.

AECV-403Cc. Coppermine area
uncorrected 9800 ± 140

The marine shells (*Hiatella arctica* and *Mya truncata*; identified by D.E. Kerr) were enclosed in sandy silt. Sample SV-84K-42A was collected by D.E. Kerr on August 10, 1984 from west of Coppermine, District of Mackenzie, Northwest Territories (67°48'N, 116°40'W), at an elevation of 73 m.

AECV-712Cc. Clifton Point (I)
uncorrected 9300 ± 540

The marine shells (*Hiatella arctica* and *Macoma balthica*; identified by D.E. Kerr) were enclosed in sandy clay. Sample SVK-86-3 was collected by D.E. Kerr on July 18, 1986 from Clifton Point area, District of Mackenzie, Northwest Territories (69°07'31"N, 118°30'55"W), at an elevation of 30 m.

AECV-473Cc. Clifton Point (II)
uncorrected 9600 ± 140

The marine shells (*Hiatella arctica*; identified by D.E. Kerr) were enclosed in sandy silt. Sample SVK-86-4 was collected by D.E. Kerr on July 3, 1986 from Clifton Point area, District of Mackenzie, Northwest Territories (69°07'N, 118°31'W), at an elevation of 45 m.

AECV-462Cc. Tinney Point (I)
uncorrected 10 000 ± 170

The marine shells (*Hiatella arctica*; identified by D.E. Kerr) were enclosed in sandy silt. Sample SVK-86-48 was collected by D.E. Kerr on July 23, 1986 from west of Tinney Point, District of Mackenzie, Northwest Territories (69°24'N, 120°20'W), at an elevation of 25 m.

AECV-444C. Tinney Point (II)
uncorrected 10 620 ± 160

The marine shells were enclosed in sandy clay. Sample SVK-86-42 was collected by D.E. Kerr on July 23, 1986 from west of Tinney Point, District of Mackenzie, Northwest Territories (69°24'N, 120°16'W), at an elevation of 30 m.

AECV-642Cc. Clinton Point (I)
uncorrected 10 340 ± 140

The marine shells (*Hiatella arctica*; identified by D.E. Kerr) were enclosed in sandy clay. Sample 88K-19 was collected by D.E. Kerr on June 19, 1988 from west of Clinton Point, District of Mackenzie, Northwest Territories (69°38'N, 121°03'W), at an elevation of 24 m.

AECV-645Cc. Clinton Point (II)
uncorrected 10 410 ± 150

The marine shells were enclosed in sandy silt. Sample 88K-24 was collected by D.E. Kerr on June 18, 1988 from west of Clinton Point, District of Mackenzie, Northwest Territories (69°38'N, 121°02'W), at an elevation of 22 m.

AECV-644Cc. Keats Point

uncorrected 10 840 ± 180

The marine shells (*Hiatella arctica*; identified by D.E. Kerr) were enclosed in sandy silt. Sample 88K-22 was collected by D.E. Kerr on June 17, 1988 from Keats Point area, District of Mackenzie, Northwest Territories (69°46'N, 121°40'W), at an elevation of 16.5 m.

AECV-643Cc. Pearce Point

uncorrected 11 790 ± 160

The marine shells (*Hiatella arctica*; identified by D.E. Kerr) were enclosed in sandy clay. Sample 88K-20 was collected by D.E. Kerr on June 19, 1988 from south of Pearce Point, District of Mackenzie, Northwest Territories (69°35'N, 123°08'W), at an elevation of 5 m.

Comment (D.E. Kerr): These dates range from Late Pleistocene to Late Holocene and record a relatively rapid period of ice retreat from west to east. They form the basis of seven relative sea level emergence curves which reflect differential uplift, from less than 5 m in the west to over 220 m in the east. The details of these dates will be presented in a manuscript entitled "Late Quaternary sea level history in the Paulatuk to Bathurst Inlet region, NWT" which is in preparation (cf. Kerr, 1992). Preliminary discussions can be found in Kerr, 1987a, 1987b, and 1989.

Avalanche Lake Series

A series of wood samples from 26 km north-northeast of junction between Broken Skull River and South Nahanni River, above Avalanche Lake, District of Mackenzie, Northwest Territories (62°25'N, 127°15'W), at an elevation of about 1800 m, were collected by S.G. Evans on July 11, 1987 and August 10, 1990, and by P. Kaiser and J. Simmons on June 10, 1980; submitted by S.G. Evans.

GSC-4603. Avalanche Lake (I) 320 ± 50
 $\delta^{13}\text{C} = -21.7\text{‰}$

The wood, sample EN-AVL-87-2 (10.9 g dry weight; *Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 88-13)) enclosed in rock avalanche debris, was treated with hot base, hot acid, and distilled water rinses, noncalcareous. The treated sample (8.5 g) yielded 8.10 L of CO₂ gas. The age estimate is based on two counts for 2440

minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 27.285 ± 0.113, 2.094 ± 0.026, and 28.208 ± 0.143 cpm, respectively.

The uncorrected age is 270 ± 50.

GSC-5102. Avalanche Lake (II) 310 ± 80
 $\delta^{13}\text{C} = -23.4\text{‰}$

The wood, sample EN-90-10-A1 (7.7 g dry weight; *Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 90-60)) enclosed in rock avalanche debris, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (6.7 g) yielded 6.52 L of CO₂ gas. The age estimate is based on two counts for 1970 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 27.357 ± 0.127, 2.172 ± 0.034, and 28.328 ± 0.234 cpm, respectively.

The uncorrected age is 280 ± 80.

GSC-4637. Avalanche Lake (III) 460 ± 80
 $\delta^{13}\text{C} = -22.1\text{‰}$

The wood, sample EN-AVL-87-3 (2 g dry weight) enclosed in rock avalanche material, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (2.3 g) yielded 2.22 L of CO₂ gas. The age estimate is based on two counts for 2240 minutes in the 2 L counter with a mixing ratio of 2.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.169 ± 0.142, 1.038 ± 0.027, and 18.075 ± 0.093 cpm, respectively.

The uncorrected age is 410 ± 80.

GSC-4209. Avalanche Lake (IV) 480 ± 50
 $\delta^{13}\text{C} = -26.1\text{‰}$

The wood, sample EN-AVL-TR3 (11.5 g dry weight; *Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 86-8)) beneath rock in rockslide debris, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (10.4 g) yielded 9.9 L of CO₂ gas. The age estimate is based on two counts for 2430 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 500 ± 50.

GSC-5103. Avalanche Lake (V) 600 ± 80
 $\delta^{13}\text{C} = -24.3\text{‰}$

The wood, sample EN-90-10-A2 (5.7 g dry weight; *Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 90-62)) enclosed in rock avalanche debris, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (5.2 g) yielded 5.04 L of CO₂ gas. The age estimate is based on two counts for 2040 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.374 ± 0.098, 1.101 ± 0.023, and 18.696 ± 0.163 cpm, respectively.

The uncorrected age is 590 ± 80.

GSC-4595. Avalanche Lake (VI) 610 ± 50
 $\delta^{13}\text{C} = -25.3\text{‰}$

The wood, sample EN-AVL-87-1 (12.3 g wet weight; *Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 88-12)) enclosed in rock avalanche debris, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.2 g) yielded 7.8 L of CO₂ gas. The age estimate is based on two counts for 2050 minutes in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 620 ± 50.

Comment (S.G. Evans): Avalanche Lake series: samples were collected from within rock avalanche debris on the shelf, 640 m above the Avalanche Lake valley and well above the present treeline. Debris was derived from a massive dip slope detachment on the north side of Avalanche Lake. Wood fragments were picked up as the debris smashed through the forest on the valley floor. The dates are conclusive evidence that the Avalanche Lake rock avalanche occurred in the 16th or 17th century A.D. and not in the late Pleistocene (Evans, 1989).

GSC-4711. Eskimo Lakes >42 000
 $\delta^{13}\text{C} = -29.7\text{‰}$

The peat was enclosed in gravel. Sample DHA 88-55 was collected by S.R. Dallimore on August 18, 1988, from the south shore of Tuktoyaktuk Peninsula, central Eskimo Lakes, District of Mackenzie, Northwest Territories (69°32.5'N, 131°51'W), at an elevation of 12 m; submitted by S.R. Dallimore.

The sample (242.5 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (13.3 g) yielded 11.77 L of CO₂ gas. The age estimate is based on one count for 7200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were -0.029 ± 0.035, 2.221 ± 0.031, and 28.121 ± 0.123 cpm, respectively.

Comment (S.R. Dallimore): The coarse gravel in which the peat pod was enclosed is interpreted as a glaciofluvial outwash from the last glaciation that covered this part of the Tuktoyaktuk Peninsula. A nonfinite date may confirm the chronology presented by Rampton (1988), which suggests that the last glacial advance in the area was the early Wisconsinan Toker Point strata. Alternately, the peat pod was clearly re-worked and may, therefore, be from an older formation.

GSC-4699. Kugmallit Bay 6490 ± 80
 $\delta^{13}\text{C} = -25.9\text{‰}$

The wood, a stump, (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 88-35)) was enclosed in peat. Sample OG-88-1 was collected by J.R. MacKay and L. Ovenden on July 22, 1988, from 18 km west-southwest of Tuktoyaktuk on shore of Kugmallit Bay, District of Mackenzie, Northwest Territories (69°24'N, 133°27'W), at an elevation of 2 m; submitted by L. Ovenden.

The sample (10.5 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.7 g) yielded 7.93 L of CO₂ gas. The age estimate is based on two counts for 2140 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.517 ± 0.088, 2.221 ± 0.031, and 28.121 ± 0.123 cpm, respectively.

The uncorrected age is 6500 ± 80.

Comment (L. Ovenden): The receding shoreline exposed a 1 m thick peat deposit in a depression next to a hill. The stump was in growth position at base of the peat, close to foot of hill. Estimated diameter of stump 10 cm above root is 13 cm. The stump is of similar age to others which have been found on Tuktoyaktuk Peninsula (Spear 1983).

GSC-4715. Kidluit Bay (I) >35 000
 $\delta^{13}\text{C} = -26.5\text{‰}$

The sample consisted of detrital organics (Fossil Arthropod Report No. 88-14 and Plant Macrofossil Report No. 88-29) from a 2 cm thick band enclosed in massive brown sand. Sample DHA 88-207A was collected by S.R. Dallimore on August 13, 1988, from northern Richards Island, District of Mackenzie, Northwest Territories (69°32'N, 134°00'W), at an elevation of 8 m; submitted by S.R. Dallimore.

The sample was treated with hot base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (8.8 g) yielded 6.30 L of CO₂ gas. The age estimate is based on one count for 2510 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.177 ± 0.046 , 2.166 ± 0.034 , and 28.137 ± 0.173 cpm, respectively.

Comment (S.R. Dallimore): The brown sand from which this sample was collected is thought to be the Kittigazuit Formation, which is widespread throughout northern Richard Island. The sample contained a rich and diverse array of plant and arthropod macrofossils which were generally well-preserved.

AA-7676. Kidluit Bay (II) modern

The detrital leaves of *Salix* (identified by A. Telka) were enclosed in brown sand. Sample DHA 88-207B was collected by S.R. Dallimore on August 13, 1988, from the west shore of Kidluit Bay on Richards Island, District of Mackenzie, Northwest Territories (69°32'N, 134°00'W), at an elevation of 8 m; submitted by S.R. Dallimore.

Comment (S.R. Dallimore): The sample DHA 88-207B was collected only a few meters from sample DHA-207A (GSC-4714, >35 ka). However unlike DHA-207A which was from a continuous organic band in the sand, this sample was from a isolated small block of sand. The modern age suggests that the block was most likely material slumped from above.

GSC-3729. Coal Mine Lake 10 300 ± 110
 $\delta^{13}\text{C} = -27.7\text{‰}$

The wood (*Salix* sp. and *Betula* cf. *glandulosa*; identified by R.J. Mott (unpublished GSC Wood Report No. 83-42)) was enclosed in peat. Samples VH-83-137 and MRA-8-2-83-29 were collected by J-S. Vincent, J.V. Matthews, Jr., and V.N. Rampton on August 2, 1983, from an ice slump 6 km west of small bay on west side of Coal Mine Lake, District of Mackenzie Northwest Territories, (68°42.4'N, 136°29.0'W) at an elevation of less than 150 m, and submitted by J-S. Vincent.

The sample (9.0 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The age estimate is based on one count for 7020 minutes (one 5-day) in the 2 L counter with a mixing ratio of 1.06.

The uncorrected age is $10\,400 \pm 110$.

Comment (J-S. Vincent): Pockets of wood-bearing peats were collected, at the head of an ice slump, in a 1 m thick pebbly silt bed overlying icy sediments and underlying 1.5 m of till reworked on a slope and 0.5 m of silts. The stratigraphic position of the disturbed sediments and age of the dated material indicates that thermokarst slope processes were affecting shallow ground ice in the area at the very end of the Late Wisconsinan.

**NORTHERN CANADA,
ARCTIC ARCHIPELAGO**

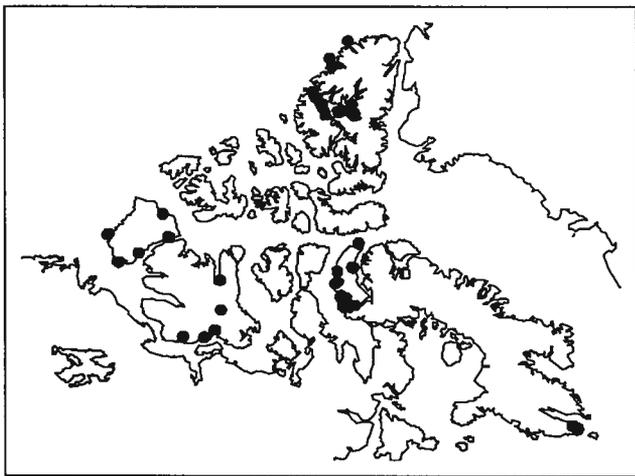


Figure 15. Radiocarbon dated sites in the Arctic Archipelago.

Axel Heiberg Island

GSC-4686. 'Fossil Forest' >39 000
 $\delta^{13}\text{C} = -23.4\text{‰}$

The wood was obtained from a surface collection. Sample 88-MIB-1 was collected by in 1988 from the 'Fossil Forest', eastern Axel Heiberg Island, District of Franklin, Northwest Territories (79°54'N, 88°50'W), submitted by R. McNeely.

The sample (23.5 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.4 g) yielded 8.06 L of CO₂ gas. The age estimate is based on one count for 3790 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were -0.069 ± 0.049 , 2.122 ± 0.043 , and 28.206 ± 0.127 cpm, respectively.

Laboratory comment: This sample was made available to the laboratory at a point in time when the GSC and IsoTrace laboratories were discussing the validity of dating 'old' samples. The sample from the Eureka Sound Formation (Eocene) was expected to date beyond the limit of our standard conventional dating at GSC (i.e., nonfinite) which it did.

GSC-4788. Flat Sound 7920 ± 100
 $\delta^{13}\text{C} = +2.4\text{‰}$

The marine bivalve shells (*Mya truncata*; identified by J. Bednarski) were enclosed in silt. Sample NS-88-14-S was collected by J. Bednarski on July 4, 1988, from the west side of Flat Sound, Axel Heiberg Island, District of Franklin, Northwest Territories (80°16'N, 89°15'W), at an elevation of 73 m; submitted by J. Bednarski.

The sample (40.1 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (32.1 g) yielded 6.89 L of CO₂ gas. The age estimate is based on two counts for 2170 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.735 ± 0.063 , 1.064 ± 0.019 , and 17.975 ± 0.097 cpm, respectively.

The uncorrected age is 7890 ± 100.

Comments (J. Bednarski): The sample provides a minimum age for a higher relative sea level in the area. At the time these bivalves were growing the sea was higher than 73 m above present sea level and probably as high as 101 m, which is marked by a prominent strandline.

GSC-4719. Stang Bay (I) 8150 ± 90
 $\delta^{13}\text{C} = +1.6\text{‰}$

The marine shells (*Mya truncata*; identified by J. Bednarski) were enclosed in silt. Sample NS-88-3-S was collected by J. Bednarski on June 26, 1988, from 3 km south of the largest lake at the head of Stang Bay, Axel Heiberg Island, District of Franklin, Northwest Territories (80°25'N, 89°29'W), at an elevation of 58 m; submitted by J. Bednarski.

The sample (47.1 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (39.5 g) yielded 7.86 L of CO₂ gas. The age estimate is based on two counts for 2160 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.231 ± 0.083 , 2.166 ± 0.034 , and 28.137 ± 0.173 cpm, respectively.

The uncorrected age is 8130 ± 90.

Comment (J. Bednarski): The sample consisted of paired valves in growth position and dates a higher relative sea level of at least 84 m above the present one. It also provides a minimum age for the local marine limit which is at about 143 m.

GSC-4797. Stang Bay (II) 8350 ± 100
 $\delta^{13}\text{C} = +2.1\text{‰}$

The marine shells (*Mya truncata*; identified by J. Bednarski) were enclosed in fine sand. Sample NS-88-5-S was collected by J. Bednarski on June 27, 1988, from about 2.5 km south-southwest of the head of Stang Bay, Axel Heiberg Island, District of Franklin, Northwest Territories (80°26'N, 89°44'W), at an elevation of 70 m; submitted by J. Bednarski.

The sample (46.4 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample's (37.1 g) age estimate is based on two counts for 2035 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.386 ± 0.063, 1.064 ± 0.019, and 17.975 ± 0.097 cpm, respectively.

The uncorrected age is 8310 ± 100.

Comment (J. Bednarski): This sample of paired valves, in growth position, provides a minimum age for the marine limit in the area.

GSC-4793. Nansen Sound (I) 38 500 ± 1320
 $\delta^{13}\text{C} = +1.4\text{‰}$

The marine bivalve shells (*Hiatella arctica*; identified by J. Bednarski) were enclosed in silt and fine sand. Sample NS-88-24-S was collected by J. Bednarski on July 24, 1988, from on the west side of Nansen Sound, Axel Heiberg Island, District of Franklin, Northwest Territories (80°42'N, 90°45'W), at an elevation of 80-81 m; submitted by J. Bednarski.

The sample (30.7 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (24.4 g) yielded 5.38 L of CO₂ gas. The age estimate is based on one count for 3710 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.150 ± 0.024, 1.072 ± 0.016, and 18.025 ± 0.147 cpm, respectively.

The uncorrected age is 38 500 ± 1320.

Comment (J. Bednarski): The sample was collected from the surface of an outlying ridge which is mantled with 1 to 3 m of glaciomarine silt.

GSC-4753. Nansen Sound (II) 8320 ± 130
 $\delta^{13}\text{C} = +1.5\text{‰}$

The marine bivalve shells (*Mya truncata*; identified by J. Bednarski) were enclosed in silty gravel. Sample NS-88-16-S was collected by J. Bednarski on July 9, 1988, from the west side of Nansen Sound, northern Axel Heiberg Island, District of Franklin, Northwest Territories (80°43'N, 91°00'W), at an elevation of 56 m; submitted by J. Bednarski.

The sample (34.9 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (27.7 g) yielded 27.1 L of CO₂ gas. The age estimate is based on one count for 1000 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.430 ± 0.089, 1.092 ± 0.018, and 18.072 ± 0.097 cpm, respectively.

The uncorrected age is 8300 ± 130.

Comment (J. Bednarski): This date provides a minimum age for a higher relative sea level of at least 88 m above present sea level.

GSC-4740. Nansen Sound (III) 10 300 ± 100
 $\delta^{13}\text{C} = -0.8\text{‰}$

The marine bivalve shells (*Yoldia* ?) were enclosed in mud. Sample NS-88-41-S was collected by J. Bednarski on July 29, 1988, from the west coast of Nansen Sound, northern Axel Heiberg Island, District of Franklin, Northwest Territories (80°58'N, 91°40'W), at an elevation of 68 m; submitted by J. Bednarski.

The sample (21.0 g dry weight) was treated with an acid leach to remove the outer 5% of the sample. The treated sample (19.7 g) yielded 4.08 L of CO₂ gas. The age estimate is based on one count for 4200 minutes in the 2 L counter with a mixing ratio of 1.12. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.979 ± 0.046, 1.114 ± 0.019, and 17.921 ± 0.095 cpm, respectively.

The uncorrected age is 10 300 ± 100.

Comment (J. Bednarski): This sample provides a minimum age for the local marine limit at about 87 m above present sea level.

Baffin Island

GSC-4602. Meta Incognita Peninsula (I) 8680 ± 110
 $\delta^{13}\text{C} = +2.7\text{‰}$

The marine shells (*Mya truncata*; identified by G.H. Miller) were enclosed in silty sand. Sample M86-BS86 was collected by G.H. Miller on August 24, 1986, from westernmost arm of Jackman Sound, southeast Meta Incognita Peninsula, Baffin Island, District of Franklin, Northwest Territories (62°20.5'N, 66°30.5'W), at an elevation of 15 m; submitted by G.H. Miller.

The sample (17.7 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (14.7 g) yielded 3.11 L of CO₂ gas. The age estimate is based on two counts for 2560 minutes in the 2 L counter with a mixing ratio of 1.43. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.220 ± 0.070, 1.016 ± 0.018, and 18.217 ± 0.097 cpm, respectively.

The uncorrected age is 8630 ± 110.

Comment (G.H. Miller): The shells were collected from an ice-contact raised marine delta complex, grading from extremely coarse-grained sediment at the ice-proximal margin, to sandy silts at the distal limit a kilometre or so down valley. The shells date an interval when ice stood at a position only a few hundred metres beyond the Little Ice Age maximum moraine of a major outlet glacier of Terra Nivea Ice Cap. Rare limestone erratics, present in the enclosing sediments, may be reworked from an earlier, more extensive advance of Labradorean ice. Thus, it is not certain whether the glacial advance that deposited the sediments enclosing the shells was an expansion of a proto-Terra Nivea Ice Cap, or whether it represents the incursion of Labradorean ice across Meta Incognita Peninsula. The reservoir-corrected date (8620 ± 110 BP) confirms a Cockburn substage age of the shells, in keeping with a large number of other dates across southeast Baffin Island that document a readvance of local glaciers of the Labradorean and Foxe sectors of the Laurentide Ice Sheet at that time.

GSC-4607. Meta Incognita Peninsula (II) 8810 ± 90
 $\delta^{13}\text{C} = +1.3\text{‰}$

The marine shells (*Hiattella arctica* and some *Mya truncata*; identified by G.H. Miller) were enclosed in stony muds. Sample M86-BS73 was collected by G.H. Miller on August 22, 1986, from inner Noble Inlet, on the southeastern tip of Meta Incognita Peninsula, Baffin Island, District of Franklin, Northwest Territories (62°5.5'N, 66°08'W), at an elevation of 6-20 m; submitted by G.H. Miller.

The sample (52.6 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (36.7 g) yielded 7.83 L of CO₂ gas. The age estimate is based on two counts for 3460 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.447 ± 0.072, 2.094 ± 0.026, and 28.208 ± 0.143 cpm, respectively.

The uncorrected age is 8790 ± 90.

Comment (G.H. Miller): The shells were collected from a distal facies of an ice-contact deltaic complex in inner Noble Inlet. They lived in a time when ice from a Labradorean dispersal centre advanced across Hudson Strait and overran southeasternmost Meta Incognita Peninsula. The reservoir-corrected date (assuming 450 year reservoir age of seawater) is 8770 ± 90 BP. This date is in keeping with numerous other dates in the region that indicate the last advance of Labradorean ice was during the Cockburn substage, specifically between about 8900 and 8500 radiocarbon years ago. Shells from a similar stratigraphic position in the same deltaic complex previously dated 8540 ± 150 BP (reservoir corrected; Miller et al., 1988)

Paquet Bay Series

A series of marine mollusc shells samples from west shore of the west arm of inner Paquet Bay, 3.5 km northwest from the head of the bay, Baffin Island, District of Franklin, Northwest Territories (71°47.3'N, 77°58.3'W), were collected by J.A. Stravers on July 27, 1986; submitted by J.A. Stravers.

GSC-4613. Paquet Bay (I) 2850 ± 70
 $\delta^{13}\text{C} = +6.3\text{‰}$

The marine mollusc shells were enclosed in stratified marine sands. Sample P.B. 23-1-1986 (23.5 g dry weight of *Hiatella arctica*; identified by J.A. Stravers) were collected at an elevation of 7 m. The sample was treated with an acid leach to remove the outer 20% of the sample. The treated sample (18.9 g) yielded 4.01 L of CO₂ gas. The age estimate is based on two counts for 2430 minutes in the 2 L counter with a mixing ratio of 1.09. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.834 ± 0.083, 0.994 ± 0.021, and 18.078 ± 0.096 cpm, respectively.

The uncorrected age is 2750 ± 70.

GSC-4619. Paquet Bay (II)
uncorrected 3140 ± 70
 $\delta^{13}\text{C} = \text{lost}$

The marine mollusc shells were enclosed in marine stony mud. Sample P.B. 23-2-1986 (33.3 g dry weight of *Hiatella arctica*; identified by J.A. Stravers) was collected at an elevation of 4 m. The sample was treated with an acid leach to remove the outer 20% of the sample. The treated sample (25.9 g) yielded 5.59 L of CO₂ gas. The age estimate is based on two counts for 2280 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.223 ± 0.079, 0.994 ± 0.021, and 18.078 ± 0.096 cpm, respectively.

Tay Sound Series

A series of marine mollusc shell samples from Tay Sound, Baffin Island, District of Franklin, Northwest Territories were collected by J.A. Stravers on July 18, 1986; submitted by J.A. Stravers.

GSC-4610. Tay Sound (I) 3430 ± 60
 $\delta^{13}\text{C} = +2.6\text{‰}$

The marine mollusc shells were collected from 750 m upstream, on the north bank of the centralmost of five streams draining into the head of Tay Sound (71°52'N, 78°31'W), at an elevation of 5 m. Sample T.S. 6 lower unit 1986 (22.1 g dry weight; *Mya*; identified by J.A. Stravers), enclosed in stony marine mud, was treated with an acid

leach to remove the outer 20% of the sample. The treated sample (17.8 g) yielded 3.80 L of CO₂ gas. The age estimate is based on one count for 4200 minutes in the 2 L counter with a mixing ratio of 1.16. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.851 ± 0.065, 0.994 ± 0.021, and 18.078 ± 0.096 cpm, respectively.

The uncorrected age is 3390 ± 60.

GSC-4624. Tay Sound (II) 5010 ± 80
 $\delta^{13}\text{C} = +0.4\text{‰}$

The marine mollusc shells were collected from southwest bank of tributary, 1.5 km northwest of river junction near the outer elbow of Tay Sound (71°58.8'N, 79°14'W), at an elevation of 37 m. Sample T.S. 4-1986 (20 g wet weight; *Mya truncata* juveniles; identified by J.A. Stravers), enclosed in stratified muddy sands, was treated with an acid leach to remove the outer 10% of the sample. The treated sample (20.3 g) yielded 3.48 L of CO₂ gas. The age estimate is based on two counts for 2480 minutes in the 2 L counter with a mixing ratio of 1.26. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.694 ± 0.082, 1.038 ± 0.027, and 18.075 ± 0.093 cpm, respectively.

The uncorrected age is 5000 ± 80.

Comment (J.A. Stravers): These dates may be used to approximate sea levels at their respective times.

GSC-4694. Stanley Point 9780 ± 90
 $\delta^{13}\text{C} = +0.5\text{‰}$

The marine shells (*Hiatella arctica*; identified by A.S. Dyke) were enclosed in stony clay. Sample 88-DCA-147 was collected by A.S. Dyke on August 9, 1988, from 11.3 km west of Stanley Point on the north coast of Brodeur Peninsula, northwest Baffin Island, District of Franklin, Northwest Territories (73°49'N, 85°27'W), at an elevation of 41 m; submitted by A.S. Dyke.

The sample (52.6 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (37.1 g) yielded 8.18 L of CO₂ gas. The age estimate is based on one count for 3900 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.327 ± 0.060, 2.221 ± 0.031, and 28.121 ± 0.123 cpm, respectively.

The uncorrected age is 9780 ± 90.

Comment (A.S. Dyke): The sample consisted of thick, clean, whole valves of *Hiatella arctica* collected from the surface of a recent flow slide in stony clay on the side of an old, vegetated stream cut. The stony clay is overlain by a 1 m thick beach gravel. This deposit of stony clay, overlain in many places by beach gravel form a low coastal foreland extending about 20 km along the Lancaster Sound coast. In places the clay exceeds 10 m in thickness. Marine limit, recorded by the highest beaches, is at 60 m a.s.l. The large volume and high stone content of the clay indicate that it is a proximal glaciomarine sediment. The date is a minimum for deglaciation of western Lancaster Sound.

GSC-4751. Vista River valley (I) 8210 ± 80
 $\delta^{13}\text{C} = +1.5\text{‰}$

The marine shells (*Hiatella arctica*; identified by A.S. Dyke) were enclosed in sand. Sample 88-DCA-87 was collected by A.S. Dyke on July 26, 1988, from Vista River valley, 7.6 km northwest of Kakiak Point, east coast of Brodeur Peninsula, northwest Baffin Island, District of Franklin, Northwest Territories (72°43'N, 86°51'W), at an elevation of 49 m; submitted by A.S. Dyke.

The sample (50.6 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (35.4 g) yielded 7.69 L of CO₂ gas. The age estimate is based on two counts for 2105 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.255 ± 0.081, 2.157 ± 0.026, and 28.419 ± 0.123 cpm, respectively.

The uncorrected age is 8190 ± 80.

Comment (A.S. Dyke): The sample consisted mostly of whole valves of juvenile *Hiatella arctica*, many paired at time of collection. Shells were collected from a fresh gully in sand, which exhibited patches of salt (NaCl) efflorescence on the surface, indicating recent exposure and melting of saline permafrost. The shells came from the basal foreset sands in the distal part of a large delta, whose surface forms a large terrace at 57 m a.s.l. The sample dates a 57 m relative sea level and the end of delta progradation. The start of construction of this delta is dated by GSC-4791.

GSC-4791. Vista River valley (II) 8890 ± 100
 $\delta^{13}\text{C} = +0.8\text{‰}$

The marine shells (*Hiatella arctica*; identified by A.S. Dyke) were enclosed in sand and silt. Sample 88-DCA-123 was collected by A.S. Dyke on August 1, 1988, from the Vista River valley, 11.8 km northwest of Kakiak Point on the east coast of Brodeur Peninsula, northwest Baffin Island, District of Franklin, Northwest Territories (72°44.5'N, 86°57'W), at an elevation of 43-53 m; submitted by A.S. Dyke.

The sample (51.3 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (35.7 g) yielded 6.46 L of CO₂ gas. The age estimate is based on two counts for 2050 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.951 ± 0.062, 1.064 ± 0.019, and 17.975 ± 0.097 cpm, respectively.

The uncorrected age is 8880 ± 100.

Comment (A.S. Dyke): The sample consisted almost entirely of whole, clean valves of juvenile *Hiatella arctica*, many paired at time of collection. The shells came from the upper bottomset beds beneath the proximal end of a large delta terrace, here at 58.5 m altitude. The bottomset beds consist of horizontally bedded fine sand and silt with dropstones. The sample dates beginning of progradation of a large delta and provides a maximum age in the overlying terrace.

GSC-4722. Vista River valley (III) 9150 ± 80
 $\delta^{13}\text{C} = +1.5\text{‰}$

The marine shells (*Hiatella arctica*; identified by A.S. Dyke) were enclosed in stony mud. Sample 88-DCA-122 was collected by A.S. Dyke on July 31, 1988, from Vista River valley, 13.7 km northwest of Kakiak Point, east coast of Brodeur Peninsula, northwest Baffin Island, District of Franklin, Northwest Territories (72°45'N, 87°00'W), at an elevation of 79.5 m; submitted by A.S. Dyke.

The sample (36 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (28.7 g) yielded 6.33 L of CO₂ gas. The age estimate is based on one count for 3690 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards

(net) were 9.093 ± 0.061 , 2.135 ± 0.026 , and 28.327 ± 0.120 cpm, respectively.

The uncorrected age is 9130 ± 80 .

Comment (A.S. Dyke): The sample consisted of fragments and a few whole valves of *Hiatella arctica* from the surface of stony mud. Many shells had secondary carbonate encrustations and chalky surfaces that were removed prior to submission for dating. The collection site is on the north side of Vista River, directly across the river from a large, kettled, ice contact, marine-limit delta terrace at or only slightly above the level of the collection site. Although not in situ, the shells provide a reasonable age for local marine limit.

GSC-4775. Bernier Bay 7140 ± 90
 $\delta^{13}\text{C} = +0.9\text{‰}$

The marine shells (*Hiatella arctica*; identified by A.S. Dyke) were enclosed in marine silty clay. Sample 88-DCA-531 was collected by J. Hooper on August 3, 1988, from 17 km southwest of the head of Bernier Bay, northwest Baffin Island, District of Franklin, Northwest Territories ($70^{\circ}55'\text{N}$, $87^{\circ}23'\text{W}$), at an elevation of 63 m; submitted by A.S. Dyke.

The sample (30.2 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (24.7 g) yielded 5.31 L of CO_2 gas. The age estimate is based on two counts for 2215 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.443 ± 0.065 , 1.092 ± 0.018 , and 18.072 ± 0.097 cpm, respectively.

The uncorrected age is 7130 ± 90 .

Comment (J. Hooper): The sample is a collection of in situ whole valves. The shells were excavated from laminar marine silts. Although not related to a specific shoreline feature, the date provides a minimum estimate of the amount of emergence of the inner Bernier Bay coast since 7.1 ka BP.

GSC-4703. Easter Cape area 8310 ± 100
 $\delta^{13}\text{C} = +0.9\text{‰}$

The marine shells (*Mya truncata*; identified by J. Hooper) were enclosed in glaciomarine diamicton. Sample 88-DCA-458 was collected by J. Hooper on July 20, 1988,

from about 20 km east-southeast of Easter Cape, northwest Baffin Island, District of Franklin, Northwest Territories ($70^{\circ}53'\text{N}$, $88^{\circ}54'\text{W}$), at an elevation of 98 m; submitted by A.S. Dyke.

The sample (30.5 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (24.4 g) yielded 5.47 L of CO_2 gas. The age estimate is based on two counts for 2320 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.455 ± 0.060 , 1.103 ± 0.016 , and 18.125 ± 0.099 cpm, respectively.

The uncorrected age is 8290 ± 100 .

Comment (J. Hooper): The sample is a surface collection of fragments and whole valves from a small deposit of grey stony clay on the south flank of a large moraine ridge. A large marine limit delta about 13 km east of this site was measured at 116 m. The date provides a minimum age for deglaciation and marine limit along the southwest part of the Bernier Bay coast.

GSC-4721. Easter Cape area 8470 ± 100
 $\delta^{13}\text{C} = +1.8\text{‰}$

The marine shells (*Mya truncata*; identified by J. Hooper) were enclosed in silt. Sample 88-DCA-523 was collected by J. Hooper on July 30, 1988, from about 46 km east-southeast of Easter Cape, northwest Baffin Island, District of Franklin, Northwest Territories ($70^{\circ}52'\text{N}$, $88^{\circ}12'\text{W}$), at an elevation of 114 m; submitted by A.S. Dyke.

The sample (35.7 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (28.8 g) yielded 6.18 L of CO_2 gas. The age estimate is based on two counts for 2620 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.323 ± 0.056 , 1.109 ± 0.018 , and 18.080 ± 0.095 cpm, respectively.

The uncorrected age is 8440 ± 100 .

Comment (J. Hooper): This sample of fragments of thick valves was collected from a pebbly lag about 1 km southeast of a large marine limit delta. The sample site is 11 m below the delta surface at 125 m. The date is a minimum age on marine limit and deglaciation of the south coast of Bernier Bay.

GSC-4776. Easter Cape area 4330 ± 70
 $\delta^{13}\text{C} = +1.0\text{‰}$

The marine shells (*Hiatella arctica*; identified by A.S. Dyke) were enclosed in sandy gravel. Sample 88-DCA-471 was collected by J. Hooper on July 23, 1988, from about 14 km east-northeast of Easter Cape, northwest Baffin Island, District of Franklin, Northwest Territories (70°57'N, 89°02'W), at an elevation of 24 m; submitted by A.S. Dyke.

The sample (33.4 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (26.7 g) yielded 5.84 L of CO₂ gas. The age estimate is based on one count for 2655 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.564 ± 0.069, 1.092 ± 0.018, and 18.072 ± 0.097 cpm, respectively.

The uncorrected age is 4310 ± 70.

Comment (J. Hooper): The sample consists of in situ paired whole valves excavated from a small section in gravelly mud. The sample dates an extensive level surface of gravelly marine sediment about 1 m above the collection site, interpreted as a former tidal flat. The date provides a minimum estimate of the amount of emergence that has occurred along the southwest portion of the Bernier Bay coast during the last 4.3 ka.

GSC-4777. Morin Point area 6600 ± 80
 $\delta^{13}\text{C} = +1.5\text{‰}$

The marine shells (*Mya truncata*; identified by A.S. Dyke) were enclosed in silt. Sample 88-DCA-405 was collected by J. Hooper on July 9, 1988, from about 30 km east of Morin Point, Brodeur Peninsula, northwest Baffin Island, District of Franklin, Northwest Territories (71°19'N, 88°50'W), at an elevation of 15 m; submitted by A.S. Dyke.

The sample (30.7 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (25.1 g) yielded 4.99 L of CO₂ gas. The age estimate is based on one count for 2520 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.967 ± 0.063, 1.092 ± 0.018, and 18.072 ± 0.097 cpm, respectively.

The uncorrected age is 6580 ± 80.

Comment (J. Hooper): The sample is a collection of in situ paired whole valves excavated from laminar sands in a small section. The shells were much older than their elevation suggests and probably grew in considerable depth of water. The date underestimates the amount of emergence that occurred at the site during the last 6.6 ka.

GSC-4695. Morin Point area 8240 ± 110
 $\delta^{13}\text{C} = +1.8\text{‰}$

The marine shells (*Mya truncata*; identified by J. Hooper) were enclosed in silt. Sample 88-DCA-409 was collected by J. Hooper on July 8, 1988, from about 2 km south of a large unnamed lake and 47 km east of Morin Point, Brodeur Peninsula, northwest Baffin Island, District of Franklin, Northwest Territories (71°18'N, 88°28'W), at an elevation of 92 m; submitted by A.S. Dyke.

The sample (31.9 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (25.6 g) yielded 5.61 L of CO₂ gas. The age estimate is based on two counts for 2160 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.526 ± 0.073, 1.103 ± 0.016, and 18.125 ± 0.099 cpm, respectively.

The uncorrected age is 8210 ± 110.

Comment (J. Hooper): The sample consists of fragments collected from a pebbly deflation lag on the surface of marine silts adjacent to a large marine limit delta. The collection site is 18 m below the flat delta surface at 110 m. The date is a minimum age for the deglaciation and marine limit along the north coast of Bernier Bay.

GSC-4754. Morin Point area 8140 ± 110
 $\delta^{13}\text{C} = +1.3\text{‰}$

The marine shells (*Hiatella arctica*; identified by A.S. Dyke) were enclosed in silt. Sample 88-DCA-566 was collected by J. Hooper on August 11, 1988, from about 18 km northeast of Morin Point, northwest Baffin Island, District of Franklin, Northwest Territories (71°23'N, 89°18'W), at an elevation of 95 m; submitted by A.S. Dyke.

The sample (30.0 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (24.0 g) yielded 4.67 L of CO₂ gas. The age estimate is based on two counts for 2195 minutes in the 2 L

counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.559 ± 0.061 , 1.072 ± 0.016 , and 18.025 ± 0.147 cpm, respectively.

The uncorrected age is 8120 ± 110 .

Comment (J. Hooper): The sample is a collection of fragments and occasional whole valves found eroding from the surface of marine silt. The sample provides a minimum estimate of the amount of emergence along the northwest part of the Bernier Bay coast, which occurred during the last 8.1 ka.

GSC-4742. Morin Point area 8630 ± 90
 $\delta^{13}\text{C} = +1.9\text{‰}$

The marine shells (*Mya truncata* and *Hiatella arctica*; identified by A.S. Dyke) were exposed on a marine silt surface. Sample 88-DCA-569 was collected by J. Hooper on August 12, 1988, from about 25 km northeast of Morin Point, northwest Baffin Island, District of Franklin, Northwest Territories ($71^{\circ}26'\text{N}$, $89^{\circ}07'\text{W}$), at an elevation of 118 m; submitted by A.S. Dyke.

The sample (26.7 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (21.3 g) yielded 4.67 L of CO_2 gas. The age estimate is based on one count for 4200 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.147 ± 0.046 , 1.114 ± 0.019 , and 17.921 ± 0.095 cpm, respectively.

The uncorrected age is 8600 ± 90 .

Comment (J. Hooper): This sample, consisting of fragments and whole valves, was collected from the surface of marine silts north of Morin Point. The collection site was the highest occurrence of shells found in the vicinity and is slightly below the planar upper limit of marine silts, at about 124 m, in a large unnamed valley. The date is a minimum age for deglaciation and marine limit along the northwest part of the Bernier Bay coast.

GSC-4785. Fitzgerald Bay head 8620 ± 90
 $\delta^{13}\text{C} = +0.9\text{‰}$

The marine shells (*Mya truncata*; identified by A.S. Dyke) were enclosed in fine sand and silt. Sample 88-DCA-67 was collected by A.S. Dyke on July 20, 1988,

5 km southeast of the head of Fitzgerald Bay on the west coast of Brodeur Peninsula, northwest Baffin Island, District of Franklin, Northwest Territories ($72^{\circ}08'\text{N}$, $89^{\circ}29'\text{W}$), at an elevation of 64 m; submitted by A.S. Dyke.

The sample (51.3 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (35.6 g) yielded 7.35 L of CO_2 gas. The age estimate is based on one count for 2235 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.751 ± 0.076 , 2.153 ± 0.022 , and 28.455 ± 0.126 cpm, respectively.

The uncorrected age is 8600 ± 90 .

Comment (A.S. Dyke): The sample consisted of clean, whole valves of *Mya truncata*, many with partial periostraca. The shells come from freshly gullied exposures in horizontally bedded fine sand and silt, thought to be bottomset beds about 200 m in front of a prominent delta terrace at 79 m (elevation based on one altimeter measurement). The shells likely date the 79 m marine limit at the head of Fitzgerald Bay and support the determination of GSC-4704, for the age of marine limit at the mouth of the bay. The collection also includes *Hiatella arctica*, *Astarte borealis*, and *Serripes groenlandicus*.

GSC-4704. Fitzgerald Bay mouth 8810 ± 90
 $\delta^{13}\text{C} = +0.43\text{‰}$

The marine shells (*Hiatella arctica*; identified by A.S. Dyke) were enclosed in fine sand. Sample 88-DCA-45 was collected by A.S. Dyke on July 15, 1988, from 5 km southeast of mouth of Fitzgerald Bay, west coast of Brodeur Peninsula, northwest Baffin Island, District of Franklin, Northwest Territories ($72^{\circ}03'\text{N}$, $89^{\circ}52'\text{W}$), at an elevation of 77 m; submitted by A.S. Dyke.

The sample (50.3 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (35.2 g) yielded 7.88 L of CO_2 gas. The age estimate is based on two counts for 2530 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.409 ± 0.076 , 2.166 ± 0.034 , and 28.137 ± 0.173 cpm, respectively.

The uncorrected age is 8800 ± 90 .

Comment (A.S. Dyke): The sample consisted of whole clean valves of *Hiatella arctica* collected from the surface of freshly gullied fine marine sand. The recent nature of the exposure is indicated by salt (NaCl) crusts on the surface of the sediment and on some shells resulting from the melting of saline permafrost. The outcrops of fossiliferous fine sand occur about 200 m in front of the lip of a glaciomarine delta with a gravel surface at 95-97 m altitude (two altimeter measurements), only slightly lower than the marine limit, which is recorded by a washing limit and weakly developed beach with remains of a juvenile bowhead whale at 102 m. The shells are thought to be from prodelta sediment and hence date a 96 m relative sea level. They are slightly younger than a previous determination from the area (GSC-392; 9260 ± 150 BP; Dyck et al., 1966; shells from surface of silt at 95 m near Cape Kater). The sample also contained a few *Mya truncata*, *Astarte borealis*, and *Clinocardium ciliatum*.

GSC-4744. McBean Bay 8980 ± 90
 $\delta^{13}\text{C} = +2.0\text{‰}$

The marine shells (*Mya truncata* and *Hiatella arctica*; identified by A.S. Dyke) were enclosed in stony mud. Sample 88-DCA-18 was collected by A.S. Dyke on July 11, 1988, from 4 km southeast of McBean Bay on the west coast of Brodeur Peninsula, northwest Baffin Island, District of Franklin, Northwest Territories (72°37'N, 89°26'W), at an elevation of 81 m; submitted by A.S. Dyke.

The sample (29.2 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (23.4 g) yielded 5.06 L of CO₂ gas. The age estimate is based on one count for 3820 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.935 ± 0.047, 1.092 ± 0.018, and 18.072 ± 0.097 cpm, respectively.

The uncorrected age is 8940 ± 90.

Comment (A.S. Dyke): The sample consisted of clean fragmented stony mud 10 m beyond a small glaciomarine delta. The lowest delta terrace is at 77 m altitude; the highest terrace representing marine limit was inaccessible. Another small delta 2 km to the west has a single terrace marking marine limit at 99 m altitude. Sample elevation is based on a single altimeter measurement. The sample dates the marine limit 3 km inland of the head of McBean Bay on the Prince Regent Inlet coast of Brodeur Peninsula and is slightly younger than an earlier determination on shells from

the vicinity at 81 m (GSC-241; 9280 ± 150 BP, Dyck et al., 1965).

Banks Island

'Big Sea' Series

Shell fragments, recovered in sands and gravels of two raised deltas built into the assumed Middle Pleistocene 'Big Sea' (see Vincent, 1983, and 1989) were dated by Beta Analytic Inc. In eastern and southern Banks Island, the fossiliferous 'Big Sea' deltas are often exposed along streams and overlain by Jesse Till deposited by the Prince of Wales Lobe during the M'Clure Stade of Amundsen Glaciation.

Beta-11182. (AMS) 'Big Sea' (I) >29 800

The marine shell fragments, sample VH-77-075, were collected by J-S. Vincent on June 28, 1977, from 'Big Sea' deltaic sands and gravels, east of the mouth of Nelson River on southern Banks Island, District of Franklin, Northwest Territories (71°16'N, 122°21.5'W), at an elevation of about 180 m; submitted by J-S. Vincent.

Comment (J-S. Vincent): At the dated site, the fossils were recovered from the surface on a gravel slope on the right bank of a small stream. A Th/U corrected age estimate of 19 100 ± 1900 (UQT-221) was obtained from other shell fragments in this collection (Causse and Vincent, 1989).

Beta-11181. (AMS) 'Big Sea' (II) >30 000

The marine shell fragments, sample VH-77-051, were collected by J-S. Vincent on June 22, 1977, from 'Big Sea' deltaic sands and gravels, east of the mouth of Nelson River on southern Banks Island, District of Franklin, Northwest Territories (71°15.7'N, 122°20.0'W), at an elevation of between 106 and 121 m; submitted by J-S. Vincent.

Comment (J-S. Vincent): At the dated site, the fossils were recovered on the surface of a sequence of cross-stratified sands and gravels on the right bank of a small stream. A corrected Th/U age estimate of 40 300 +5000 -4600 (UQT-220) was obtained from other shell fragments in this collection (Causse and Vincent, 1989).

General Comment on 'Big Sea' Series:

As discussed in Vincent (1983, and 1989) 'Big Sea' sediments, which are present at the surface on western Banks Island and which underlie the interglacial Cape Collinson Formation sediments and Late Pleistocene glacial sediments laid down during the M'Clure Stade of Amundsen Glaciation on the southern and eastern portion of the island, are believed to be of Middle Pleistocene age. The 'Big Sea' is in fact thought to be a glacio-isostatic sea associated with the advance and retreat of continental ice during the Thomsen Glaciation. The age determinations were made to check the relatively young ages obtained on the same shell collections by the Th/U method. As discussed in Causse and Vincent (1989), these determinations must represent minimum age values. Other Th/U age estimates on 'Big Sea' shells, in this same area of Banks Island, were as old as 107 800 +19 100 -17 900 (UQT-144). The accelerator mass spectrometry dates can only serve to confirm the antiquity of the 'Big Sea'.

TO-650. (AMS) 'East Coast Sea' 24 730 ± 260

The marine shell fragments (unidentified, but shells in the remaining collection were identified as *Hiatella arctica* (Linné) and *Mytilus edulis* (Linné) by A. Aitken) were from a surface collection on deltaic fine to medium sand and interstratified fine gravel. Sample VH-77-104 (0.293 g dry weight) was collected by J-S. Vincent on July 6, 1977, from 25 km south of Jesse Harbour on the east coast of Banks Island, District of Franklin, Northwest Territories (72°2.3'N, 120°16.5'W), at an elevation of 36.5 m. The sample's age was corrected for the marine reservoir effect (equivalent to $\delta^{13}\text{C} = 0\text{‰}$, cf. GSC shell dates).

Comment (J-S. Vincent): The dated deltaic or nearshore marine sediments postdate Jesse Till since they overlie this till immediately upslope from the collection site. On the basis of this stratigraphic relationship and of the altitude of the site, the marine deposits were assigned to the 'East Coast Sea', a glacio-isostatic sea which inundated eastern and southern Banks Island, up to about 120 m, following the retreat of the Prince of Wales Lobe of the Late Pleistocene M'Clure Stade of Amundsen Glaciation (Vincent, 1983, and 1989). Although it could be argued that the dated shells are reworked from older marine deposits, such as those of the Middle Pleistocene 'Big Sea', or belong to the Late Wisconsinan / Holocene Schuyter Point Sea, results of amino acid analyses confirm the intermediate age of the dated collection. The alle:lle (total) ratios for six fragments of *Hiatella arctica* shells from the dated site vary between 0.04

and 0.09 (AAL-895). These ratios differ markedly from the average of 0.19 for shells of the Middle Pleistocene 'Big Sea' and of 0.02 from the Late Wisconsinan / Holocene Schuyter Point Sea. The results appear to confirm that the M'Clure Stade and its associated Jesse Till and East Coast Sea deposits predate the Late Wisconsinan. A corrected Th/U age estimate of 31 800 +3800 -3600 (UQT-142) was also obtained from the same shell collection (Causse and Vincent, 1989). This age is considered a minimum value because of contamination caused by the uptake of low but non-negligible secondary uranium. The accelerator mass spectrometry result discussed here, could also be considered a minimum values because of the usual problems associated with dating older shells. On the other hand, as was the case for the Meek Point Sea results discussed in these reports, it could be argued that the accelerator radiocarbon and Th/U age determinations indicate that a glacio-isostatic sea associated with Prince of Wales Lobe of M'Clure Stade covered eastern Banks Island in the Middle Wisconsinan. Whatever the case, all these results confirm the existence of a Late Pleistocene sea, in the area, which distinctly predates the Late Wisconsinan (see the discussion in Vincent, 1992).

Meek Point Sea Series

The following age determinations were obtained on shells and a marine mammal (seal) from raised marine deposits of the Meek Point Sea which covered western Banks Island in preLate Wisconsinan time (Vincent, 1983, and 1989).

GSC-4710. Lennie Harbour 34 200 ± 1400
 $\delta^{13}\text{C} = +1.0\text{‰}$

The marine shells (possibly *Astarte*; identified by J-S. Vincent) were enclosed in gravelly sand. Sample VH-88-24 was collected by J-S. Vincent on July 3, 1988, from the south shore of Lennie Harbour, about 500 m from the beginning of a spit which extends from the Worth Point Bluffs on the west coast of Banks Island, District of Franklin, Northwest Territories (72°15.6'N, 125°38.2'W), at an elevation of about 0.5 m; submitted by J-S. Vincent.

The sample (14.8 g dry weight) was treated with an acid leach to remove the outer 10% of the sample. The treated sample (13.4 g) yielded 2.77 L of CO₂ gas. The age estimate is based on one count for 2790 minutes in the 2 L counter with a mixing ratio of 1.66. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.256 ± 0.044, 1.103 ± 0.016, and

18.125 ± 0.099 cpm, respectively.

The uncorrected age is 34 200 ± 1400.

Comment (J-S. Vincent): The shells were collected in sands of a low marine terrace of the Meek Point Sea. At the collection site, a 1 m high wave-cut section exposed about 50 cm of fossiliferous sands overlain by some 50 cm of silts.

Worth Point Series

A series of marine shells samples and a marine mammal sample from 10 km south of Worth Point, Banks Island, District of Franklin, Northwest Territories (72°10.6'N, 125°39.6'W), at an elevation of 2 m, were collected by J-S. Vincent and D.A. Hodgson on July 1, 1990; submitted by J-S. Vincent.

GSC-5095. Worth Point (I) >35 000
 $\delta^{13}\text{C} = +1.8\text{‰}$

The marine shells, sample VH-90-019 (47.9 g dry weight; *Astarte borealis*; identified by J-S. Vincent), enclosed in nearshore marine sand, were treated with an acid leach to remove the outer 20% of the sample. The treated sample (38.1 g) yielded 8.15 L of CO₂ gas. The age estimate is based on one count for 3500 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.077 ± 0.037, 1.150 ± 0.032, and 18.513 ± 0.124 cpm, respectively.

Comment (J-S. Vincent): In situ shells (siphons in many instances still attached to the valves) were collected in nearshore sands and fine gravels of a marine terrace of the Meek Point Sea. At the collection site, 5 m of nearshore sediments were exposed in a wave-cut cliff. The very well preserved *Astarte borealis* shells were grouped in a pocket about 2 m asl. A thorium/uranium age estimate of 40 900 +300/-400 (UQT-467, -470, Causse and Vincent, 1989) was also obtained from the same shell collection. It should also be noted that an age of >19ka (GSC-1478) was obtained, by D.M. Barnett (see Lowdon and Blake, 1973 and Vincent, 1983), from the same raised marine deposit but not at the same locality.

TO-2206. Worth Point (II) 41 090 ± 770

The marine shell (*Astarte borealis*) an aliquot of sample VH-90-019 from the collection used for GSC-5095 was dated at the IsoTrace Laboratory.

TO-2294. Worth Point (III) 41 910 ± 800

Bone fragments (sample VH-90-20) of a left pelvis (NMC 47751A) and of the distal portion of a right scapula (NMC 47751B) of a small, gracile-boned seal, identified as probably *Phoca* cf. *hispida* by C.R. Harington of the National Museum of Canada, were collected in association with the above dated *Astarte borealis* shells; submitted by J-S. Vincent.

The sample (0.358 g dry weight) provided an age normalized to a $\delta^{13}\text{C} = -25\text{‰}$ of 42 320 ± 800.

Comment (J-S. Vincent): The seal bones were recovered with the cluster of shells which gave the finite and nonfinite ages mentioned above.

General comment on Meek Point Sea Series:

As discussed in Vincent (1992), the Meek Point Sea is considered to postdate or at least be coextensive with the Thesiger and Prince Alfred lobes of the M'Clure Stage of Amundsen Glaciation. These lobes may have respectively impinged on the southwestern and northern coasts of Banks Island as early as the Sangamonian sensu lato to Early Wisconsinan. Although some finite ages were obtained for the shell and seal bone samples, much care must be taken when interpreting the results. As is often the case for older age determinations on shells, it may be best to consider the obtained ages as nonfinite. On the other hand it could be argued that the results of the conventional and accelerator radiocarbon and Th/U age determinations indicate that a glacio-isostatic sea covered western Banks Island in the Middle Wisconsinan. The presence of this sea could be associated with the crustal depression of the west coast by ice which impinged on the north coast (Prince Alfred Lobe), east coast (Prince of Wales Lobe), and southwest coast (Thesiger Lobe) of Banks Island. Whatever the case, the ages are of much interest since they clearly demonstrate that the last sea to have covered western Banks Island undoubtedly predates the Late Wisconsinan. It should also be stressed that there are apparently no raised Late Wisconsinan / Holocene age marine deposits on the western coast of the island.

GSC-4245. Prince of Wales Strait (I) 10 800 ± 130
 $\delta^{13}\text{C} = +0.5\text{‰}$

The marine shells (*Hiatella arctica*; identified by J-S. Vincent) were on the surface of stratified fine-grained marine sediments. Sample VH-77-202 was collected by J-S. Vincent on August 11, 1977, from 52.5 km southwest of Passage Point on Prince of Wales Strait, Banks Island, District of Franklin, Northwest Territories (73°13.1'N, 116°40'W), at an elevation of 5.5 to 9 m; submitted by J-S. Vincent.

The sample (46.3 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The age estimate is based on two 1-day counts (2310 minutes) in the 5 L counter with a mixing ratio of 1.00.

The uncorrected age is 10 800 ± 130.

Comment (J-S. Vincent): The shells are from the Schuyter Point Sea which flooded the eastern coast of Banks Island, up to a maximum elevation of 25 m, in the Late Wisconsinan (Vincent, 1983). It is likely that the shells date a somewhat higher water plane since other shells in the vicinity, from 16 m altitude, provided an age of 11 000 ± 40 (GSC-2413, Lowdon and Blake, 1980). A few valves of *Astarte borealis* (identified by A. Aitken) were found with the *Hiatella arctica* shells.

GSC-4263. Prince of Wales Strait (II) 9730 ± 150
 $\delta^{13}\text{C} = +0.2\text{‰}$

The marine shells (*Hiatella arctica*; identified by J-S. Vincent) were on the surface of fine to medium sand and silt. Sample VH-77-186 was collected by J-S. Vincent on July 29, 1977, from 64 km southwest of Passage Point on Prince of Wales Strait, Banks Island, District of Franklin, Northwest Territories (73°14.1'N, 116°54.3'W), at an elevation of 15.5 m; submitted by J-S. Vincent.

The sample (19.4 g dry weight) was treated with a 5% acid leach. The age estimate is based on one 3-day count (4050 minutes) in the 2 L counter with a mixing ratio of 1.06.

The uncorrected age is 9730 ± 150.

Comment (J-S. Vincent): The shells are from the Schuyter Point Sea which flooded the eastern coast of Banks Island, up to a maximum elevation of 25 m, in the Late Wisconsinan (Vincent, 1983). The age is younger than

anticipated since other shells in the area, at similar elevations (e.g. 11 000 ± 400 BP, GSC-2413, Lowdon and Blake, 1980), or at lower elevations (e.g. 10 800 ± 130 BP, GSC-4245; and 10 200 ± 170 BP, GSC-2099, Lowdon and Blake, 1980) have provided distinctly older ages.

GSC-5096. Mercy Bay 11 300 ± 190
 $\delta^{13}\text{C} = +1.0\text{‰}$

The marine shells (*Hiatella arctica*; identified by J-S. Vincent) were enclosed in silt. Sample VH-90-014 was collected by J-S. Vincent and D.A. Hodgson on June 26, 1990, from the west side of Mercy Bay, about 5.7 km south of Investigator Point, northern Banks Island, District of Franklin, Northwest Territories (74°9.4'N, 119°4.4'W), at an elevation of 1.75 m; submitted by J-S. Vincent.

The sample (13.3 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (12.0 g) yielded 2.42 L of CO₂ gas. The age estimate is based on one count for 3680 minutes in the 2 L counter with a mixing ratio of 2.07. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.471 ± 0.079, 1.092 ± 0.024, and 18.125 ± 0.241 cpm, respectively.

The uncorrected age is 11 200 ± 190.

Comment (J-S. Vincent): Shells are the only ones collected, up to now, on the north coast of Banks Island south of M'Clure Strait. Vincent (1983) proposed, on the basis of the presence of raised deltas at the head of Mercy Bay and of low lying washed surfaces on the north slope of Banks Island, that a sea, called the Investigator Sea, had flooded the area south of M'Clure Strait following the retreat of the Prince Alfred Lobe of the M'Clure Stage of Amundsen Glaciation in the Early Wisconsinan. Re-interpretation of the extensive glacial record in the western Arctic has led Vincent (1992) to argue that continental ice may have advanced in the area early in the Late Pleistocene (Sangamonian sensu lato to Early Wisconsinan) and finally retreated only in the Late Wisconsinan. If the Prince Alfred Lobe retreated late from M'Clure Strait then the Investigator Sea could be Late Wisconsinan and the dated shells would testify to the limited crustal depression of the area in the postglacial. It should be noted that the low-lying shells (1.75 m asl) were the only ones found during an extensive search of the washed surfaces and raised deltas around Mercy Bay.

GSC-4701. Nelson River 7680 ± 80
 $\delta^{13}\text{C} = -29.1\text{‰}$

The wood (*Salix*; identified by H. Jetté (unpublished GSC Wood Report No. 88-30)) was enclosed in peat. Sample VH-88-19 was collected by J-S. Vincent on June 29, 1988, from the right bank of a small stream, 6.5 km northeast of mouth of Nelson River, Banks Island, District of Franklin, Northwest Territories (71°15.6'N, 122°19.9'W), at an elevation of about 90 m; submitted by J-S. Vincent.

The sample (11.4 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.7 g) yielded 8.13 L of CO₂ gas. The age estimate is based on one count for 2790 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.758 ± 0.081, 2.122 ± 0.043, and 28.206 ± 0.127 cpm, respectively.

The uncorrected age is 7740 ± 80.

Comment (J-S. Vincent): The wood was collected at the base of a 5.5 m thick sequence of woody peat directly overlying alluvial sands and gravels. Compared to other organic sequences on Banks Island (see Appendix D in Vincent, 1983), this peat accumulated at the relatively rapid rate of 0.72 mm per annum.

Ellesmere Island

GSC-4692. Cape Discovery modern
 $\delta^{13}\text{C} = -26.6\text{‰}$

The driftwood (*Pinus*; cf. *P. sylvestris* / *P. resinosa*; identified by R.J. Mott (unpublished GSC Wood Report No. 88-7)) was enclosed in multiyear landfast sea ice. Sample 86052101 was collected by M. Jeffries, H. Serson, and O-P. Nordlund on May 21, 1986, from about 10 km west of Cape Discovery, M'Clintock Inlet, Ellesmere Island, District of Franklin, Northwest Territories (82°59'N, 78°07'W), at an elevation of 0 m; submitted by M. Jeffries and W. Blake, Jr.

The sample (11.4 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.3 g) yielded 7.37 L of CO₂ gas. The

age estimate is based on two counts for 2050 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 28.294 ± 0.129, 2.122 ± 0.043, and 28.206 ± 0.127 cpm, respectively.

Comment (M. Jeffries): Radiocarbon dated driftwood abundances have been used to interpret ice shelf and multiyear landfast sea ice variations in this region, the northernmost coast of Canada. This particular sample of wood was removed from a log stuck in the multiyear landfast sea ice at the mouth of M'Clintock Inlet. The log was protruding about 1 m above the surface of the ice, its diameter was 0.7 m and more than 100 growth rings were counted. A ¹⁴C date for this wood was of interest for two reasons. First, to add to, and compare with, the growing database of radiocarbon-dated driftwood abundances in this region. Second, at the time of collection the multiyear landfast sea ice in that area had a maximum age of 20 years, having grown since the disintegration of the M'Clintock Ice Shelf in 1966, thus, in view of the knowledge of ice variations in the area it was of interest to date the wood to obtain some indication of its age relative to the ice. The modern ¹⁴C date for the wood is consistent with the age of the ice and the recent ice shelf changes at the mouth of M'Clintock Inlet.

GSC-4697. South Bay / 7930 ± 70
Wolf Valley $\delta^{13}\text{C} = +1.3\text{‰}$

The marine shells (in situ *Mya truncata*; identified by V. Sloan) were enclosed in silt. Sample IB-BTP-27/07/88 was collected by J. England and V. Sloan on July 27, 1988, from the west side of Canon Fiord, southwest end on point between South Bay and Wolf Valley, west-central Ellesmere Island, District of Franklin, Northwest Territories (79°42'N, 81°40'W), at an elevation of 90 m; submitted by J. England.

The sample (50.4 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (36.1 g) yielded 7.78 L of CO₂ gas. The age estimate is based on one count for 4200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.512 ± 0.063, 2.221 ± 0.031, and 28.121 ± 0.123 cpm, respectively.

The uncorrected age is 7900 ± 70.

GSC-4706. Caledonian Bay 8020 ± 90
 $\delta^{13}\text{C} = +1.8\text{‰}$

The whole marine shells (in situ *Mya truncata*; identified by V. Sloan) were enclosed in glaciomarine deltaic silts. Sample FC-H-11/07/88 was collected by J. England and V. Sloan on July 11, 1988, from the east side of Canon Fiord, south of Caledonian Bay, west-central Ellesmere Island, District of Franklin, Northwest Territories (79°45'N, 81°30'W), at an elevation of 94 m; submitted by J. England.

The sample (31.9 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (25.8 g) yielded 5.40 L of CO₂ gas. The age estimate is based on two counts for 2740 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.683 ± 0.057, 1.109 ± 0.018, and 18.080 ± 0.095 cpm, respectively.

The uncorrected age is 7990 ± 90.

GSC-4626. Cape Lockwood
uncorrected 8290 ± 100

The marine shells (*Hiatella arctica*; identified by J. England) were found on the surface of marine silts. Sample CL-8-5-87 was collected by J. England on July 6, 1987, from south side of the unnamed river about 5 km from coast, about 7 km from Cape Lockwood, Canon Fiord, Ellesmere Island, District of Franklin, Northwest Territories (80°12'N, 81°37'W), at an elevation of 121 m; submitted by J. England.

The sample (21.3 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (17.1 g) yielded 3.74 L of CO₂ gas. The age estimate is based on two counts for 2400 minutes in the 2 L counter with a mixing ratio of 1.18. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.420 ± 0.065, 1.035 ± 0.010, and 18.029 ± 0.088 cpm, respectively.

GSC-4635. Canon Fiord 38 200 ± 1510
 $\delta^{13}\text{C} = -28.3\text{‰}$

The terrestrial organics (bryophytes), sample CL-3-Org-87, were collected by J. England in June 1987, from outer east coast of Canon Fiord, west central Ellesmere Island, District of Franklin, Northwest Territories (80°12'N,

81°36'45"W), at an elevation of about 111 m; submitted by J. England.

The sample (29 g dry weight) was treated with cold base, hot acid, and distilled water rinses (moderately calcareous). The treated sample (14.4 g) yielded 4.44 L of CO₂ gas. The age estimate is based on two counts for 2330 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.155 ± 0.029, 1.035 ± 0.018, and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 38 200 ± 1510.

GSC-4755. northeast flank of 4500 ± 90
Sawtooth Range $\delta^{13}\text{C} = +1.4\text{‰}$

The marine shells (*Hiatella arctica* and *Mya truncata*; identified by J. England) were enclosed in marine silt and clay. Sample STV-2-5-88 was collected by J. England and T. Bell on June 28, 1988, from the northern side of the river draining north to Canon Fiord, on the northeast flank of Sawtooth Range, Fosheim Peninsula, Ellesmere Island, District of Franklin, Northwest Territories (79°54'N, 82°32'W), at an elevation of 6 m; submitted by J. England.

The sample (23.9 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (19.1 g) yielded 3.85 L of CO₂ gas. The age estimate is based on two counts for 2140 minutes in the 2 L counter with a mixing ratio of 1.17. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.322 ± 0.082, 1.072 ± 0.016, and 18.025 ± 0.147 cpm, respectively.

The uncorrected age is 4480 ± 90.

GSC-4741. eastern flank of 7900 ± 100
Sawtooth Range $\delta^{13}\text{C} = +1.4\text{‰}$

The marine shells (*Mya truncata*; identified by J. England) were excavated from silt on the surface. Sample STV-3-5-88 was collected by J. England and T. Bell on June 28, 1988, from dissected silt plain about 2 km inland from Canon Fiord, north of a river on the eastern flank of the Sawtooth Range, Fosheim Peninsula, Ellesmere Island, Northwest Territories (79°54'N, 82°34'W), at an elevation of 65 m; submitted by J. England.

The sample (30 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated

sample (24.8 g) yielded 5.24 L of CO₂ gas. The age estimate is based on two counts for 2180 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.723 ± 0.063, 1.114 ± 0.019, and 17.921 ± 0.095 cpm, respectively.

The uncorrected age is 7880 ± 100.

GSC-4784. Hot Weather Creek 10 600 ± 90
δ¹³C= +1.0‰

The marine shells and fragments, sample EJ-88-92S, were collected by S.A. Edlund and J.G. Fyles on July 23, 1988, from a bluff overlooking a major western tributary of Hot Weather Creek, about 25 km east of Eureka, 3.5 km north of Slidre River, Ellesmere Island, Northwest Territories (80°00'N, 84°30'W), at an elevation of 122-123 m; submitted by S.A. Edlund.

The sample (45.1 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (36.2 g) yielded 7.94 L of CO₂ gas. The age estimate is based on one count for 3795 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.665 ± 0.056, 2.153 ± 0.022, and 28.445 ± 0.126 cpm, respectively.

The uncorrected age is 10 500 ± 90.

Comment (S.A. Edlund): This sample provides the oldest finite date from marine shells on Fosheim Peninsula. The 122-123 m elevation of the collection is well below the highest Pleistocene / early Holocene shell collections at 140 m by Fyles (GSC-254 at 8710 ± 140 BP, Dyck et al., 1965) and the 145+ m marine limit. It represents either shells deposited into a sea maintained at a high level from the late Pleistocene into the Holocene or may represent a transgression that preceded the Holocene regression (Hodgson et al., 1991). Caution is urged when using this date, because it is 1.0 ka older than any other sample from marine deposits on the Fosheim Peninsula (personal communication, Bell and England, University of Alberta, 1991).

GSC-4708. Black Top Ridge 8520 ± 80
δ¹³C= +1.3‰

The marine shells (*Mya truncata*; identified by T. Bell) were enclosed in marine silt. Sample LC-4-S-88 was

collected by T. Bell on July 4, 1988 between Black Top Ridge and Slidre Fiord, in the valley that enters the fiord north of Remus Creek, 11.75 km east-southeast of Eureka, Ellesmere Island, Northwest Territories (79°57'49"N, 85°21'42"W), at an elevation of 100 m; submitted by T. Bell.

The sample (52.0 g dry weight) was treated with an acid leach to remove the outer 30% of the sample. The treated sample (36.8 g) yielded 7.56 L of CO₂ gas. The age estimate is based on one count for 3765 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.828 ± 0.062, 2.135 ± 0.026, and 28.327 ± 0.120 cpm, respectively.

The uncorrected age is 8500 ± 80.

Comment (T. Bell): This sample was collected from fossiliferous silt that likely was deposited during melting of a local ice cap on adjacent Black Top Ridge. At this time sea level was between 111 and 146 m higher than present.

GSC-4618. Phillips Inlet 7920 ± 110
δ¹³C= +4.2‰

The marine shells (*Mya truncata*; identified by D.J.A. Evans), sample 85072004, were collected by D.J.A. Evans on July 20, 1985, from Phillips Inlet, northwest Ellesmere Island, District of Franklin, Northwest Territories (82°02'N, 85°05'W), at an elevation of 28 m; submitted by J. England.

The sample (37.0 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (29.5 g) yielded 6.04 L of CO₂ gas. The age estimate is based on two counts for 2360 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.805 ± 0.082, 0.994 ± 0.021, and 18.078 ± 0.096 cpm, respectively.

The uncorrected age is 7850 ± 110.

Wootton Peninsula Series

A series of peat samples from Phillips Inlet, Wootton Peninsula, northwest Ellesmere Island, District of Franklin, Northwest Territories (82°23'N, 85°35'W), at an elevation of 32 m, were collected by D.J.A. Evans on July 20, 1986; submitted by D.J.A. Evans and A.S. Dyke.

TO-485. Wootton Peninsula (I) 39 270 ± 640

GSC-4612 HP. Wootton Peninsula (II) >51 000

The peat sample 86072001/2 (125.6 g wet weight; GSC Palynological Report No. 88-8 by R.J. Mott), enclosed in sand, was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (72.8 g) yielded 39.2 L of CO₂ gas. The age estimate is based on three counts for 6570 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.030 ± 0.037, 2.695 ± 0.020, and 107.110 ± 0.259 cpm, respectively.

Comment (D.J.A. Evans and A.S. Dyke): An extensive stratigraphic section at Cape Alfred Ernest, on the Wootton Peninsula, northwest Ellesmere Island, contains five lithofacies, which record two glacial phases separated by a radiocarbon dated peat layer:

1. a lower massive fines records a pre-ice advance outwash phase;
2. massive fines record a period of nonglacial marine deposition when sea level was higher than present;
3. a massive diamicton records the first ice advance at the site;
4. intermediate stratified beds record a supraglacial / proglacial outwash and include a peat layer;
5. massive diamicton grading downvalley to stratified diamicton and the massive, sheared diamicton and overlain by laminated fines with dropstones record the last (late Wisconsinan) glaciation and;
6. upward coarsening sands and gravels record proglacial outwash and grade to raised marine deltas.

Radiocarbon dates of 39 270 ± 640 BP (TO-485) and >51 ka were obtained on the peat by accelerator mass spectrometry and conventional radiocarbon dating, respectively. Paleoecological data (specifically pollen) suggest that the peat accumulation in an environment that was warmer than present and therefore it records a former interglacial (Cape Alfred Ernest Interglacial). This site constitutes the northernmost interglacial stratigraphy in the Canadian Arctic and may correlate with the Stuart River Interglacial on Bathurst Island. Furthermore, if the peat is of last interglacial age, the site contains stratigraphic evidence for only one Wisconsinan stadial (late Wisconsinan) and this supports interpretations from other important sites in the Canadian and Greenland High Arctic.

Victoria Island

GSC-4723. Wellington Bay 3230 ± 70
δ¹³C= +1.4‰

The marine shells were enclosed in fine sand. Sample EK-88-100-A was collected by P.A. Egginton on July 3, 1988, from 2 km west of the head of Wellington Bay near the foot of Sussex Hills, southern Victoria Island, District of Franklin, Northwest Territories (69°29'N, 106°40'W), at an elevation of 36 m; submitted by P.A. Egginton.

The sample (31.2 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (25.0 g) yielded 5.49 L of CO₂ gas. The age estimate is based on two counts for 2200 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.130 ± 0.080, 1.109 ± 0.018, and 18.080 ± 0.095 cpm, respectively.

The uncorrected age is 3210 ± 70.

Comment (P.A. Egginton): This date relates to the sea-level history of the area.

GSC-4679. Washburn Lake area 7810 ± 120
δ¹³C= -30.7‰

The lake sediment, plant material including moss, was enclosed in laminated buff clay. Sample AP-87-8 (263-265 cm) was collected by T.W. Anderson and C. DeCuypere on July 10, 1987, about 6.2 km northeast of Washburn Lake, east-central Victoria Island, District of Franklin, Northwest Territories (70°30'15"N, 106°20'06"W), at an elevation of about 119 m; submitted by T.W. Anderson.

The sample (5.1 g dry weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (3.1 g) yielded 2.43 L of CO₂ gas. The age estimate is based on two counts for 3635 minutes in the 2 L counter with a mixing ratio of 1.87. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.714 ± 0.079, 1.052 ± 0.017, and 17.959 ± 0.159 cpm, respectively.

The uncorrected age is 7900 ± 120.

Comment (T.W. Anderson): The moss band occurs within a unit of laminated clay interpreted as glacial lake sediment. Sample dates a glacial lake phase on east-central Victoria Island.

GSC-4642. Cape Peel 1550 ± 60
 $\delta^{13}\text{C} = -28.2\text{‰}$

The algal peat (blue-green algae; identified by P. Hamilton) was enclosed in a loose mat of monocot root. Sample OG-87-7-3-2 No.1 was collected by L. Ovenden and S.A. Edlund on July 3, 1987, from 22 km west of Cape Peel, 9 km inland from the south coast of Victoria Island, District of Franklin, Northwest Territories (69°03'N, 107°50'W), at an elevation of 190 m; submitted by L. Ovenden.

The sample (224.4 g wet weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (55.6 g) yielded 10.30 L of CO₂ gas. The age estimate is based on one count for 2520 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.765 ± 0.081, 1.035 ± 0.018, and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 1600 ± 60.

Comment (L. Ovenden): The peat consists primarily of the gelatinous matrix of colonies of the blue-green algae. Occasional mandibles of chironomids and tadpole shrimp suggest a shallow water deposit. The sample was taken 35-45 cm from the surface of a peat bed now dissected into polygons by 1 m deep gullies that carry water from one pond to another. The upper 45 cm is predominantly algal peat with a few thin, darker layers that are mostly moss or twigs. The underlying peat was frozen and of unknown depth.

Hadley Bay Series

A series of samples from the southeast corner of Hadley Bay, Storkerson Peninsula, Victoria Island, District of Franklin, Northwest Territories (71°54'N, 107°15'W) were collected by M. Nixon and T. Holden on July 15, 1987; submitted by D. Sharpe.

GSC-4689. Hadley Bay (I) 610 ± 60
 $\delta^{13}\text{C} = -23.2\text{‰}$

The wood sample 87-NJ-43f (10.6 g dry weight; *Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 88-27)), enclosed in sand and gravel at an elevation of 4 m, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.5 g) yielded 7.99 L of CO₂ gas. The age estimate is based on three

counts for 3100 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 26.245 ± 0.158, 2.122 ± 0.043, and 28.206 ± 0.127 cpm, respectively.

The uncorrected age is 580 ± 60.

GSC-4690. Hadley Bay (II) 4380 ± 80
 $\delta^{13}\text{C} = -26.5\text{‰}$

Sample 87-NJ-64f (36.7 g wet weight), an organic mat of vegetation, from a large river bend 2 km from the southeast corner of Hadley Bay, at an elevation of 11 m, was enclosed in sand. The sample was treated with cold base, hot acid, and distilled water rinses (slightly calcareous). The treated sample (4.55 g) yielded 3.53 L of CO₂ gas. The age estimate is based on two counts for 2370 minutes in the 2 L counter with a mixing ratio of 1.33. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.472 ± 0.085, 1.103 ± 0.016, and 18.125 ± 0.099 cpm, respectively.

The uncorrected age is 4410 ± 80.

GSC-4691. Hadley Bay (III) 4380 ± 70
 $\delta^{13}\text{C} = -26.6\text{‰}$

The peat (moss, willow leaves, etc.) sample from a large river bend 2 km from the southeast corner of Hadley Bay, at an elevation of 11 m, was enclosed in fine sand and silt. Sample 87-NJ-65f (19.4 g dry weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (4.7 g) yielded 3.55 L of CO₂ gas. The age estimate is based on one count for 3900 minutes in the 2 L counter with a mixing ratio of 1.28. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.471 ± 0.066, 1.103 ± 0.016, and 18.125 ± 0.099 cpm, respectively.

The uncorrected age is 4410 ± 70.

GSC-4688. Hadley Bay (IV) 6580 ± 110
 $\delta^{13}\text{C} = -23.2\text{‰}$

The marine shells from a riverbank 4 km from the southeast corner of Hadley Bay, at an elevation of 9 m, were enclosed in silt and fine sand. Sample 87-SBB-H2 (17.0 g dry weight; *Mya truncata*; identified by D. Sharpe) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (14.2 g) yielded 2.95 L of

CO₂ gas. The age estimate is based on two counts for 2160 minutes in the 2 L counter with a mixing ratio of 1.53. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.958 ± 0.089 , 1.103 ± 0.016 , and 18.125 ± 0.099 cpm, respectively.

The uncorrected age is 6610 ± 110 .

GSC-4650. Hadley Bay (V) 8370 ± 90
 $\delta^{13}\text{C} = +1.1\text{‰}$

The marine shells from the southeast corner of Hadley Bay, at an elevation of 52 m, were enclosed in sand with pebbles. Sample 87-NJ-51f (43 g dry weight; mainly *Hiatella arctica*, *Mya truncata*, and *Mya arenaria*; identified by D. Sharpe), was treated with an acid leach to remove the outer 20% of the sample. The treated sample (34.6 g) yielded 7.83 L of CO₂ gas. The age estimate is based on two counts for 2390 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.930 ± 0.091 , 2.150 ± 0.021 , and 28.081 ± 0.126 cpm, respectively.

The uncorrected age is 8350 ± 90 .

GSC-4687. Hadley Bay (VI) 8630 ± 100
 $\delta^{13}\text{C} = +5.1\text{‰}$

The marine shells from the southeast corner of Hadley Bay were collected at an elevation of 49 m. Sample 87-NJ-52f (29.1 g dry weight; *Hiatella arctica*; identified by M. Nixon), was treated with an acid leach to remove the outer 20% of the sample. The treated sample (22.0 g) yielded 4.72 L of CO₂ gas. The age estimate is based on two counts for 2110 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.237 ± 0.062 , 1.109 ± 0.018 , and 18.080 ± 0.095 cpm, respectively.

The uncorrected age is 8550 ± 100 .

GSC-4620. Hadley Bay (VII) 8940 ± 90
 $\delta^{13}\text{C} = +2.9\text{‰}$

The marine shells from the southeast corner of Hadley Bay were collected at an elevation of 63 m. Sample 87-NJ-45f (49.0 g dry weight; *Hiatella arctica* and *Mya truncata*; identified by M. Nixon and D. Sharpe), enclosed in sand and mud boils, was treated with an acid leach to

remove the outer 30% of the sample. The treated sample (34.0 g) yielded 7.46 L of CO₂ gas. The age estimate is based on three counts for 3700 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.318 ± 0.081 , 2.094 ± 0.026 , and 28.208 ± 0.143 cpm, respectively.

The uncorrected age is 8900 ± 90 .

GSC-4625. Hadley Bay (VIII) 9300 ± 110
 $\delta^{13}\text{C} = +2.3\text{‰}$

The marine shells from the southeast corner of Hadley Bay were collected at an elevation of 79 m. Sample 87-NJ-54f (42 g dry weight; *Hiatella arctica* and *Mya truncata*; identified by M. Nixon and D. Sharpe), was treated with an acid leach to remove the outer 30% of the sample. The treated sample (29.3 g) yielded 6.50 L of CO₂ gas. The age estimate is based on two counts for 2100 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.705 ± 0.063 , 1.038 ± 0.027 , and 18.075 ± 0.093 cpm, respectively.

The uncorrected age is 9260 ± 110 .

GSC-4643. Point Caen 7350 ± 90
 $\delta^{13}\text{C} = +1.1\text{‰}$

The marine shells (*Clinocardium ciliatum* (Fabricius, 1780); identified by J.E. Dale), sample 87-NJ-22f, were collected by M. Nixon and T. Holden on July 5, 1987, from 5 km north-northwest of Point Caen, Wollaston Peninsula, Victoria Island, Dolphin and Union Strait, District of Franklin, Northwest Territories (69°01'N, 116°00'W), at an elevation of 19 m; submitted by D. Sharpe.

The sample (40.63 g dry weight) was treated with an acid leach to remove 20% of the outer material. The treated sample (32.4 g) yielded 7.14 L of CO₂ gas. The age estimate is based on one count for 2710 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.256 ± 0.058 , 1.053 ± 0.017 , and 18.090 ± 0.096 cpm, respectively.

The uncorrected age is 7340 ± 90 .

UNITED STATES OF AMERICA

New York

GSC-4664. Twin Ponds 12 300 ± 140
 $\delta^{13}\text{C} = -32.6\text{‰}$

The lake sediment, basal silty gyttja, was enclosed in brown gyttja with Fe-rich silty clay below. Sample AP-86-14 (16.46-16.54 m) was collected by T.W. Anderson and H. Jetté on September 23, 1986, from the north end of Twin Ponds, 16 km south of Malone, New York, U.S.A. (44°40'27"N, 74°20'09"W), at an elevation of 408 m; submitted by T.W. Anderson.

The sample (164.2 g wet weight) was treated with hot acid, and distilled water rinses; base treatment was omitted (noncalcareous). The treated sample (61.3 g) yielded 3.78 L of CO₂ gas. The age estimate is based on one count for 3890 minutes in the 2 L counter with a mixing ratio of 1.19. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.842 ± 0.044, 1.052 ± 0.017, and 17.959 ± 0.159 cpm, respectively.

The uncorrected age is 12 400 ± 140.

Comment (T.W. Anderson): The site lies about 45 km northeast of a northeast-southwest trending calcitic and dolomite marble belt. Carbonates from this marble belt may have been incorporated into the basal basin deposits by late Wisconsinan ice movement in a southeasterly direction across the marble belt. Based on basal lake sediment dating elsewhere (Boyd Pond, about 72 km to the southwest) the date may be up to 1000 years too old because of old carbon contamination.

DENMARK

Greenland

GSC-4645. Hall Land 39 200 ± 1450
 $\delta^{13}\text{C} = +2.4\text{‰}$

The marine shells (*Hiatella arctica*; identified by J. England) were enclosed in sand. Sample PPI-7-S-82 was collected by J. England on July 23, 1982, from about 1 km south of plateau to the north of the lower Graasten Elv., east-central Hall Land, northwestern Greenland (81°46'N, 59°06'W), at an elevation of 142 m; submitted by J. England.

The sample (30.1 g dry weight) was treated with an acid leach to remove the outer 20% of the sample. The treated sample (24.3 g) yielded 5.31 L of CO₂ gas. The age estimate is based on one count for 4270 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.137 ± 0.024, 1.035 ± 0.018, and 18.029 ± 0.088 cpm, respectively.

The uncorrected age is 39 200 ± 1450.

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-4440	5	-4651	18	-4708	76	-4759	50
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² HP - 'High Pressure' (5 L counter at 4 atmospheres)
 IP - 'inorganic portion'
 OP - 'organic portion'

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University of Arizona		Alberta Environmental Centre in Vegreville		Beta Analytic Inc.		IsoTrace Laboratory (University of Toronto)	
AA-7676	61	AECV-403Cc	58	Beta-11181	70	TO- 485	77
		-404Cc	57	-11182	70	- 650	71
		-444C	58			- 651	48
		-445C	57			- 807	21
		-446Cc	57			- 947	27
		-447Cc	57			- 948	27
		-448C	57			-1123	18
		-462Cc	58			-1231	56
		-472Cc	57			-2206	72
		-473Cc	58			-2294	72
		-474Cc	58				
		-642Cc	58				
		-643Cc	59				
		-644Cc	59				
		-645Cc	58				
		-646Cc	57				
		-712Cc	58				
		-713Cc	58				
		-717Cc	58				
		-946Cc	57				
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