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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES XXIII

W. BLAKE, JR.

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The present date list, GSC XXIII, is the twelfth 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 XXIII

Abstract

This list includes 152 radiocarbon age determinations made by the Radiocarbon Dating Laboratory. They are on 150 geological samples from various areas as follows: Labrador Shelf (7); Labrador (3); Newfoundland (16); Nova Scotia (6); New Brunswick (8); Quebec (16); Ontario (9); Alberta (17); British Columbia (29); Yukon Territory (2); Northwest Territories, Mainland (29); Northwest Territories, Arctic Archipelago (10). Details of background and standard for the 2 L and 5 L counters during the period from November 3, 1982 to November 2, 1983 are summarized in Tables 1 and 2; Table 3 gives the number of counts used to determine the average background and standard counting rates; and Table 4 lists the number of different background and standard gas preparations used for counting.

Résumé

Ce rapport présente les résultats de 152 datations effectuées sur 150 échantillons géologiques par le Laboratoire de datation au radiocarbone. Ces échantillons proviennent des régions suivantes: plateau continental du Labrador (7); Labrador (3); Île de Terre-Neuve (16); Nouvelle-Ecosse (6); Nouveau-Brunswick (8); Québec (16); Ontario (9); Alberta (17); Colombie-Britannique (29); Yukon (2); Territoires du Nord-Ouest, continent (29); Territoires du Nord-Ouest, archipel Arctique (10). Les valeurs de mouvement propre et de l'étalonnage des compteurs 2 L et 5 L, pour la période allant du 3 novembre 1982 au 2 novembre 1983, sont présentées dans les tableaux 1 et 2; le tableau 3 donne le nombre de coups utilisés pour déterminer la moyenne des taux d'impulsions du mouvement propre et de l'étalonnage; et, le tableau 4 donne le nombre de préparations de gaz pour le mouvement propre et pour l'étalonnage utilisées pour le comptage.

INTRODUCTION[1]

During the period November 1982 through October 1983, both the 2 L counter (Dyck and Fyles, 1962) and the 5 L counter (Dyck et al., 1965) were operated for the entire 12 months. The 2 L counter was operated at 2 atmospheres (atm) and the 5 L at 1 atmosphere except for May, June, and July 1983, when it was operated at 4 atmospheres.

The average background and oxalic acid standard counting rates which were used for age calculations are shown in Tables 1 and 2, respectively. On a monthly basis, the counting rates were within statistical limits. Table 3 lists the number of one-day counts used to determine the average background and oxalic acid standard counting rates for the period noted above, and Table 4 gives the number of different background and (oxalic acid) standard-gas preparations used.

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).

Age calculations were done on a CDC Cyber 70 Series/Model 74 computer. 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

Table 1. Monthly Average Count for Background During the Period November 3, 1982 to November 2, 1983

Month	2 L Counter (2 atm) cpm*	5 L Counter (1 atm) cpm*
November 1982	1.108 ± 0.046	2.186 ± 0.031
December	1.112 ± 0.040	2.233 ± 0.040
January 1983	1.145 ± 0.023	2.333 ± 0.026
February	1.163 ± 0.027	2.286 ± 0.046
March	1.169 ± 0.018	2.249 ± 0.053
April	1.172 ± 0.028	2.322 ± 0.032
May	1.128 ± 0.019	
June	1.127 ± 0.035	2.806 ± 0.026**
July	1.138 ± 0.028	
August	1.103 ± 0.018	2.159 ± 0.036
September	1.175 ± 0.029	2.258 ± 0.040
October	1.170 ± 0.025	2.218 ± 0.026

* cpm = counts per minute
** counted at 4 atmospheres

Table 2. Monthly Average Count (N_0)* for Oxalic Acid Standard During the Period November 3, 1982 to November 2, 1983

Month	2 L Counter (2 atm) cpm	5 L Counter (1 atm) cpm
November 1982	17.973 ± 0.106	27.837 ± 0.124
December	18.066 ± 0.103	27.898 ± 0.125
January 1983	17.994 ± 0.098	27.686 ± 0.153
February	17.936 ± 0.097	27.759 ± 0.125
March	18.001 ± 0.097	27.811 ± 0.126
April	17.972 ± 0.098	27.727 ± 0.122
May	18.016 ± 0.095	
June	18.065 ± 0.092	103.944 ± 0.181**
July	17.859 ± 0.121	
August	17.962 ± 0.098	27.825 ± 0.125
September	17.997 ± 0.104	27.917 ± 0.132
October	18.146 ± 0.098	27.767 ± 0.121

* N_0 = 0.95 of the net counting rate of the NBS oxalic acid standard
** counted at 4 atmospheres

[1] The introduction was prepared by R.N. McNeely, Laboratory Supervisor since November 1981. The date list has been compiled by W. Blake, Jr. from descriptions of the samples and interpretations of age determinations provided by the collectors and submitters.

Table 3. Number of One-Day Counts Used to Determine Average Counting Rates for Background and Oxalic Acid Standard During the Report Period

Month	Background 2 L	Background 5 L	Standard 2 L	Standard 5 L
November 1982	4	4	3	3
December	4	4	3	3
January 1983	4	4	3	3
February	4	4	3	3
March	4	4	3	3
April	4	4	3	3
May	4	-	3	-
June	4	13*	4	11*
July	4	-	2	-
August	4	5	3	3
September	4	4	3	3
October	4	4	3	3

* high pressure (4 atm) May-July.

Table 4. Number of Monthly Background and Standard Gas Preparations Used During the Report Period

Month	Background 2 L	Background 5 L	Standard 2 L	Standard 5 L
November 1982	3	2	2	2
December	4	4	2	2
January 1983	2	2	2	2
February	3	3	2	2
March	4	4	2	2
April	3	3	2	2
May	2	4	2	2
June	4	3	2	2
July	2	4	2	2
August	3	4	2	2
September	3	4	2	2
October	3	3	1	1

* high pressure (4 atm) May-July.

standard, and the error in the half-life of ^{14}C (Lowdon et al., 1977). Finite dates are based on the 2σ criterion (95.5% probability) and "infinite" dates on the 4σ criterion (99.9% probability).

If $^{13}C/^{12}C$ ratios were available, a correction for isotopic fractionation was applied to the sample date, and the $\delta^{13}C$ value reported. The "normal" values used for correction relative to the PDB standard are $\delta^{13}C$ = -25.0‰ for wood, terrestrial organic materials, and bones (terrestrial and marine), and 0.0‰ for marine shells. All $^{13}C/^{12}C$ determinations were made on aliquots of the sample gas used for age determinations. Since 1975 all $^{13}C/^{12}C$ ratios have been determined under contract by Professor P. Fritz and 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.

Acknowledgments

Appreciation is expressed to I.M. Robertson, S.M. Chartrand, J.E. Tremblay, and A.M. Telka for the preparation, purification, and counting of samples in the laboratory. Between 1965 and October 1981 the laboratory was supervised by J.A. Lowdon; since November 1981, R.N. McNeely has been in charge.

Identification of materials used for dating or associated with the material being dated has been carried out by the following specialists, to whom I extend my sincere thanks: R.J. Mott and L.D. Farley-Gill (wood and pollen); S. Rowe, Forintek, Vancouver (wood); J.V. Matthews, Jr. (plant macrofossils and fossil arthropods); M. Kuc, formerly GSC and J.A.P. Janssens, formerly University of Alberta, Edmonton, now University of Minnesota, Minneapolis (mosses); C.R. Harington, National Museum of Natural Sciences, Ottawa (mammals); M.F.I. Smith, National Museum of Natural Sciences, Ottawa, and F.J.E. Wagner, formerly Atlantic Geoscience Centre, Dartmouth (marine molluscs); E.L. Bousfield, National Museum of Natural Sciences, Ottawa (barnacles); S. Lichti-Federovich (diatoms). A.C. Roberts, Mineralogy Section, made the X-ray diffraction determinations on shell samples. R.J. Richardson, J.A. Snider, and J.E. Dale assisted in the processing and examination of samples prior to their submission to the laboratory.

GEOLOGICAL SAMPLES

Eastern Canada

Labrador Shelf

Labrador Shelf Series

Pelecypod shells and marine sediment from piston core HU 77-021-23 taken in a water depth of 236 m in a trough between Okak and Saglek Banks, Labrador Shelf (58°11.52'N, 60°14.76'W). Collected August 2, 1977 from **CSS Hudson** by R.H. Fillon, then Atlantic Geoscience Centre, Bedford Institute of Oceanography, Dartmouth, now Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Columbia, South Carolina[1].

GSC-3266. Labrador Shelf, 213 cm — 9240 ± 610

A single marine pelecypod shell (2.6 g; **Clinocardium ciliatum**, identified by W. Blake, Jr.) from 213 cm depth. The enclosing sediment was marine mud which forms the lower part of an acoustically defined unit immediately above hummocky marine "till" (Unit II, Fillon and Harmes, 1982). Because of the small sample size, the HCl leach was omitted from sample pretreatments. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3106. Labrador Shelf, 248-257 cm — 9770 ± 330, $\delta^{13}C$ = +0.9‰

Marine pelecypod shells and fragments (2.6 g; material used included fragments of **Nuculana** sp. and **Megayoldia traciaeformis**, a single valve of **Paliolum imbrifer**, and fragments of **Macoma** sp., probably **M. calcarea**, identified by F.J.E. Wagner) from 248 to 257 cm depth. These shells were from lower in the same marine mud (acoustically defined Unit II) from which the shells used for GSC-3266 (this series) were recovered. Because of the small sample size, the HCl leach was omitted. Sample was mixed with dead gas for counting. Date is based on one 4-day count in the 2 L counter.

GSC-3304. Labrador Shelf, 230-250 cm — 20 800 ± 390, $\delta^{13}C$ = -26.1‰

Total organic fraction of marine mud (592.8 g) from 230 to 250 cm depth was dated for comparison with shell dates in the same core. GSC-3304 is from approximately the same level as GSC-3106 (9770 ± 330 BP), on marine shells.

[1] All persons referred to as collectors or submitters of samples are with the Geological Survey of Canada unless otherwise specified.

NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3312. Labrador Shelf, 265-290 cm — 11 500 ± 220; $\delta^{13}C$ = -24.5‰

Total organic fraction of marine mud (508.3 g) from 265 to 290 cm depth. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 4-day count in the 2 L counter.

GSC-3343. Labrador Shelf, 630-670 cm — 22 600 ± 330; $\delta^{13}C$ = -14.5‰

Total organic fraction of marine mud (1072.4 g) from 630 to 670 cm depth. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3350. Labrador Shelf, 780-800 cm — 17 400 ± 400; $\delta^{13}C$ = -24.7‰

Total organic fraction of marine mud (549.5 g dry) from 780 to 800 cm depth. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3352. Labrador Shelf, 800-830 cm — 20 300 ± 470; $\delta^{13}C$ = -20.9‰

Total organic fraction of marine mud (567.4 g dry) from 800 to 830 cm depth. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

Comment (R.H. Fillon): The two dates obtained on well preserved shells in core HU 77-021-23, 9770 ± 330 BP (GSC-3106) and 9240 ± 610 BP (GSC-3266), are closely bracketed by total organic fraction dates of 22 160^{+960}_{-860} BP (GX-5418; Fillon et al., 1981) (above), 20 800 ± 390 BP (GSC-3304) (between), and 11 500 ± 220 BP (GSC-3312) (below). Moreover, the total organic fraction dates farther down the core, 22 600 ± 330 BP (GSC-3343), 17 400 ± 400 BP (GSC-3350), 20 300 ± 470 BP (GSC-3352), and 25 900^{+1590}_{-1325} BP (GX-5419; Fillon et al., 1981), are not statistically different from total organic fraction dates (GX-5418 and GSC-3304) obtained adjacent to the two shell horizons. Together with a date of 8380 ± 210 BP (GSC-2686; GSC XXI, 1981, p. 3), obtained on **Chlamys islandicus** shells from another core in the same acoustically defined deglacial unit as HU 77-021-23, these new dates cast strong doubt on the quality of total-organic ^{14}C dates on the Labrador Shelf (Fillon et al., 1981). It is therefore likely that a significant proportion of the fine grained organic matter in the sediment is older material that has been reworked.

Comment (W. Blake, Jr.): All five marine mud samples exhibited a very strong reaction with HCl during pretreatment.

Labrador

GSC-2480. Woolfrey's Brook, Cape Porcupine — 5640 ± 100

Compressed peat (sample A0304; 14.9 g dry) from a 5 cm-thick stratum overlain by 1 m of sand and pebbles, in the bank of Woolfrey's Brook, 9 km west of Cape Porcupine, Labrador (53°57'N, 57°14'W), at an elevation of 9 m. Pollen analysis of the sample (by J.B. Macpherson, Memorial University of Newfoundland, St. John's) indicates 45% **Picea** and 51% **Betula,** typical of a spruce-birch forest and similar to Morrison's zone 3 from interior Labrador which terminated approximately 5200 BP (Morrison, 1970). Collected August 1974 by R.J. Rogerson, Memorial University of Newfoundland, St. John's.

Comment (R.J. Rogerson): The stratigraphic location of the peat indicates that it was deposited prior to a period of marine transgression when sea level was approximately 10 m higher than now in this location. The transgression deposited a sand/pebble unit approximately 1 m thick over lagoonal peats, whereas south of Cape Porcupine it cut a major 12 m cliff face across older raised beaches. Emergence since then has left raised beaches parallel to the present shore. Marked contrasts in morphology of beaches above and below the 10 to 12 m level are evident: Above, they are largely reworked into dunes which are now stabilized and have deep humic acid/iron oxide cementation. Below, the beaches are fresh sand/pebble with berms still preserved on them. The beaches may be very old, although the sequence has been interpreted as caused by a brief marine transgression (Rogerson, 1977). Date is based on three 1-day counts in the 2 L counter.

GSC-2196. Dove Brook, Sandwich Bay — 7980 ± 100; $\delta^{13}C$ = +0.7‰

Marine shells (sample 1004, 17.7 g; **Clinocardium ciliatum,** identified by W. Blake, Jr.) from a clay/silt bed beneath the foreset beds of the Dove Brook delta, Sandwich Bay, Labrador (53°38'N, 57°26'W), at an elevation of 2 m. The upper surface of the delta is at 37 m, grading into a valley sandur at an elevation of approximately 60 m. Collected July 1974 by R.J. Rogerson.

Comment (R.J. Rogerson): The stratigraphic location of the sand/silt unit suggests that it is the oldest postglacial deposit in the Dove Brook area. Since the delta was thought to have formed during a major period of ice melt, the sample should date, approximately, the time of deglaciation of Sandwich Bay (Rogerson, 1977). This occurred with the abandonment of a major moraine (moraine 2) which inclines to intercept present sea level 19 km to the east, near the mouth of Sandwich Bay. In the hills behind Dove Brook a higher moraine (moraine 1) is thought to represent the Late Wisconsinan ice limit, largely on morphological grounds.

The 42 m difference in elevation of marine limits on either side of moraine 2 allows some estimate of the time of deglaciation from moraine 1 as between 9400 and 12 200 years ago, depending on the probable rate of emergence (Rogerson, 1977).

Comment (W. Blake, Jr.): Recent work on lake sediments to the southwest, south, and south-southeast of Sandwich Bay indicates that deglaciation occurred earlier than approximately 8000 years ago (GSC-2196). Basal dates are 10 550 ± 290 BP (SI-3139) for Eagle Lake and 9810 ± 120 BP (SI-3348) for Paradise Lake; both dates are reported in Lamb (1980). For Lake Hope Simpson the basal date is 10 400 ± 140 BP (GSC-3022), and for Moraine Lake, located on the Paradise Moraine, the age of the basal organic sediments is 9640 ± 170 BP (GSC-3067; both in GSC XXII, 1982, p. 2-3; Engstrom and Wright, in press).

GSC-2196 comprised at least 25 valves. All valves were broken, had chalky exteriors, but retained lustre on interior surfaces. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-2465. The Backway — 6890 ± 190

Marine shells and fragments (sample 12102, 5.0 g; **Hiatella arctica,** identified by R.J. Richardson) from a silt/clay bed at the eastern end of The Backway, Labrador (54°05'N, 58°47'W), at an elevation of 1.5 m. Collected July 1975 by R.J. Rogerson.

Comment (R.J. Rogerson): The silt/clay bed appears to be the earliest postglacial sediment deposited at the head of The Backway and associated with the sandur/delta feature about 7 km to the east. This latter has a beach surface at an elevation of 82 to 90 m on its outer lip. If the date is a true reflection of the date of deglaciation, it is much later than most estimates and would require that late ice remained in The Backway while deglaciation had proceeded to the vicinity of Goose Bay along the line of Groswater Bay/Lake Melville. (Rogerson, 1977).

Comment (W. Blake, Jr.): Barnacle shells at Northwest River are 7600 ± 100 years old (GSC-2970; GSC XX, 1980, p. 3) and **Hiatella arctica** shells near Muskrat Falls on Churchill River are 7490 ± 150 years old (GSC-1254; GSC XV, 1975, v. 7). As both sites are far to the west of The Backway, it seems unlikely that deglaciation was at least 500 years later at the latter site (see also comments with regard to GSC-2196, this list).

The **Hiatella arctica** shells in GSC-2465 were mainly juvenile individuals, with little periostracum preserved. The largest valve was estimated to be <2.5 cm long, the smallest was 0.8 cm long. The sample also contained a whole valve of **Macoma balthica** plus fragments of **Balanus** sp., **Mytilus** sp. (identified by W. Blake, Jr.), and an unidentified gastropod. Because of the small sample size, the HCl leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Newfoundland

GSC-3618. Kenny's Pond 8570 ± 90
$\delta^{13}C = -23.5‰$

Basal clay-gyttja (sample KP 293-298; 118.4 g wet) from 293 to 298 cm below the sediment/water interface in a core from Kenny's Pond (47°35'25"N, 52°42'50"W), 4 km north of the head of St. John's harbour, Newfoundland, at an elevation of approximately 70 m, water depth 2.23 m. The dated sediment overlies 8 cm of silty clay resting on fine gravel of unknown thickness. Collected July 9, 1983 by J.B. Macpherson, Memorial University of Newfoundland, St. John's.

Comment (J.B. Macpherson): The date is a minimum for deglaciation of the site. This interpretation is supported by pollen analysis of the dated sediment, which contains a shrub-tundra assemblage, transitional between the sedge-tundra assemblage of the upper part of the underlying inorganic sediment and the boreal forest assemblages of the overlying gyttja. However, the date is almost 700 years younger than the minimum date for deglaciation from the Bell Island site (elevation 95 m, GSC-3166, 9240 ± 190 BP; GSC XXI, 1981, p. 3), previously the youngest date indicating deglaciation from the eastern Avalon Peninsula. Dates from other cores with similar sedimentary and pollen sequences indicate earlier deglaciation with increasing elevation: GSC-2601 (9270 ± 150 BP, 100 m; GSC XVIII, 1978, p. 3; Macpherson, 1982); GSC-3182 (9440 ± 360 BP; 134 m), and GSC-3136 (10 100 ± 250, 208 m; both in GSC XXI, 1981, p. 3-4). Stagnation and downwasting of the Avalon Peninsula ice cap is suggested. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

Leading Tickles Series

A sediment core from the second headwater pond (49°28'17"N, 55°28'23"W) of a small stream draining to Cumlin Cove, on the west side of Route 350 and 3.2 km south of Leading Tickles South, Notre Dame Bay, Newfoundland, at an elevation of approximately 105 m, water depth 3.3 m. The core consisted of 400 cm of gyttja, grading to clay-gyttja and silty clay of unknown thickness, within which was a 13 cm layer of clay-gyttja. Collected July 1982 by J.B. Macpherson.

GSC-3610. Leading Tickles, 405-415 cm 10 500 ± 140
$\delta^{13}C = -18.6‰$

Clay-gyttja (sample Lt 405-415; 116.6 g wet) from immediately above the silty clay near the base of the core, 405 to 415 cm below the sediment/water interface.

GSC-3608. Leading Tickles, 433-443 cm 13 200 ± 300
$\delta^{13}C = -20.9‰$

Clay-gyttja (sample LT-433-443; 155.1 g wet) consisting of the lowest 10 cm of the 13 cm layer of clay-gyttja within the silty clay at the base of the core, 433 to 443 cm below the sediment/water interface.

Comment (J.B. Macpherson): GSC-3608 is a minimum date for deglaciation of the site, which appears to be above the local marine limit (cf. Lundqvist, 1965; Tucker, 1974). Deglaciation here preceded that of the head of Halls Bay, 50 km to the west-southwest, where bottomset beds in a raised delta contain shells dated at 12 000 ± 220 BP (GSC-1733; Tucker, 1974; this list). Pollen analysis of the lower clay-gyttja indicates almost complete absence of local land plants, but abundant **Pediastrum** occurred in the pond. The overlying 15 cm of silty clay is attributed to a return to more severe conditions. Organic sedimentation, indicating warming, had recommenced by 10 500 ± 140 BP (GSC-3610); pollen analysis indicates a sparse tundra vegetation at that time.

This sequence mirrors that reported by Anderson (1983, and personal communication, 1983) for the south coast of Burin Peninsula, southern Newfoundland, where the initial phase of amelioration is dated at 13 400 ± 140 (GSC-3559) to 11 300 ± 120 BP (GSC-3649), and the onset of the main period of organic sedimentation at 10 700 ± 110 BP (GSC-3572; all three dates in this list). NaOH leach was omitted from the pretreatment of both samples, and both samples were mixed with dead gas for counting. Each date is based on one 3-day count in the 2 L counter.

GSC-3634. Bay d'Espoir Highway 11 300 ± 100
$\delta^{13}C = -26.7‰$

Clay-gyttja (sample BDH 395-405; 166.9 g wet) from near the base of a core (water depth 0.64 m) from a pond on the plateau in the headwaters of Conne River, central Newfoundland (48°14'50"N, 55°29'35"W), at an elevation of approximately 200 m. The site is on the west side of Route 360, 85 km south of Bishop's Falls. The sample was collected 395 to 405 cm below the sediment/water interface and was underlain by 30 cm of silty clay resting on gravel of unknown thickness. Collected July 1982 by J.B. Macpherson.

Comment (J.B. Macpherson): The date is a minimum for deglaciation, and is approximately 500 years younger than the minimum date for deglaciation of the Bishop's Falls site, 75 km to the north (GSC-3647, 11 800 ± 200 BP, this list). Pollen analysis of the dated sediment indicates a shrub-tundra vegetation. Deglaciation of this part of the central Newfoundland plateau appears to have been complete before the climatic deterioration which occurred after 11 300 ± 120 BP (GSC-3649, this list) on southern Burin Peninsula (Anderson, 1983). NaOH leach was omitted from sample pretreatment. Date is based on one 4-day count in the 2 L counter.

GSC-3647. Bishop's Falls 11 800 ± 200
$\delta^{13}C = -28.5‰$

Clay-gyttja (sample BF 314-319; 75.8 g wet) from near the base of a core from a kettle pond, west side of Route 360, 9.5 km south of Bishop's Falls, central Newfoundland (48°56'10"N, 55°30'20"W), at an elevation of approximately 75 m, water depth 3.2 m. The sample, from 314 to 319 cm below the sediment/water interface, was underlain by 25 cm of silty clay and at least 27 cm of stony silty clay. Collected July 1982 by J.B. Macpherson.

Comment (J.B. Macpherson). The date is a minimum for the deglaciation of the site, which lies above marine limit in lower Exploits valley (Twenhofel, 1947), and a few kilometres inland of Lundqvist's (1965) supposed "line of retardation". Deglaciation occurred between 1900 and 900 years later than at the Leading Tickles site (GSC-3608, 13 200 ± 300 BP, this list), 65 km to the north. Pollen analysis of the dated sediment indicates a sedge-tundra vegetation. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Burin Peninsula Series

Lake sediment cores were collected from an unnamed lake (46°55'10"N, 55°36'45"W), 2 km from the coast and 6 km southwest of Lawn, Burin Peninsula, Newfoundland. The lake is at an elevation of approximately 115 m (from contour map), water depth 3.2 m. Basal gyttja overlies sandy clay (till). Except for a clay layer at 457 to 464 cm depth, gyttja is continuous to the surface. Collected August 24, 1982 by T.W. Anderson with a 7.6 cm-diameter modified Livingstone corer.

GSC-3572. Burin Peninsula, 455-457 cm 10 700 ± 110
$\delta^{13}C = -21.5‰$

Gyttja (sample AP-7-82B; 220 g wet) from 455 to 457 cm below the sediment/water interface. Sample is from immediately above grey silty clay layer at 457-464 cm. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

GSC-3649. Burin Peninsula, 464-466.5 cm 11 300 ± 120
$\delta^{13}C = -23.8‰$

Gyttja (sample AP-7-82C; 231.7 g wet) from 464 to 466.5 cm below the sediment/water interface. Sample is from immediately below grey silty clay layer at 457 to 464 cm. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

GSC-3559 Burin Peninsula, 497-500 cm 13 400 ± 140
$\delta^{13}C = -19.7‰$

Basal gyttja (sample AP-7-82A; 233.8 g wet) from 497 to 500 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

Comment (T.W. Anderson): Pollen analysis of the lowermost 50 cm of the core provides significant insight into Late Wisconsinan climatic fluctuations (Anderson, 1983). The 13 400 ± 140 BP date extends the Late Wisconsinan pollen stratigraphy of southeastern Newfoundland an additional 4000 years farther back in time than was known previously (Macpherson, 1982). Shrub-tundra vegetation characterized the area around the lake from 13 400 to 11 300 BP on the basis of high percentages of **Salix, Betula,** Ericaceae, **Myrica,** and herbs including Cyperaceae, Gramineae, and **Artemisia.** A decrease in shrub pollen and corresponding increase in **Oxyria digyna** and **Artemisia** at 11 300 BP denote a change in vegetation of major proportions, i.e., from shrub tundra to herb tundra. This is interpreted as a climatic deterioration which lasted to 10 700 BP. The complete disappearance of **Oxyria digyna,** a decrease in **Artemisia,** and the re-establishment of shrub vegetation by 10 700 years ago indicate a return to warmer conditions on Burin Peninsula by this time.

The inferred climatic changes are tentatively correlated with fluctuations of the North Atlantic polar front during Late Wisconsinan time (Ruddiman and McIntyre, 1981). By 13 400 years ago the polar front was displaced well into the North Atlantic which caused climatic warming in regions to the south and is believed to have initiated seasonal freeze-thaw cycles at the lake site. The clay layer is a reflection of a rejuvenated glacial-type climate and is considered to be derived from erosion of open-ground areas which had increased as a result of the reduced plant cover and cooler climate inferred during the clay deposition. The climatic reversal is correlated with the readvance of North Atlantic polar water between 10 000 and 11 000 years ago (Ruddiman and McIntyre, 1981); the postglacial warming trend followed.

Northern Coast of Newfoundland Series

GSC-2134. Exploits River 11 600 ± 210

Platelets of barnacles (sample GSm-74-148; 8.4 g; **Balanus crenatus** and **Balanus hameri,** identified by E.L. Bousfield, (National Museum of Natural Sciences, Ottawa) culled from a 10 kg bulk sample of laminated sandy silt with a few small stones exposed in the floor of a borrow pit in gravel along highway 351, on the east side of the estuary of Exploits River, Notre Dame Bay, northern Newfoundland (49°03.08'N, 55°22.35'W), at an elevation of 12 m. Collected 1974 by P.E. Miller, field assistant to D.R. Grant.

Comment (D.R. Grant): Fauna and sedimentary texture indicate deposition at depths of a few tens of metres, although lack of data prevents estimate of sea level position at the time of deposition relative to the 50 m local limit of marine submergence. In the absence of any relation to specific ice-marginal features, the date only corroborates the inference, based on similar dates in the region, that the Notre Dame Bay coast was deglaciated approximately 12 000 years ago. This site is 8 km northeast of a shell occurrence of similar age and context reported from Bishop's Falls powerhouse (GSC-3687, 11 400 ± 100 BP, this series).

Comment (W. Blake, Jr.): Numerous pelecypod fragments also occurred in the sample, but these were not used for dating. Because of the small sample size, only the outer 5 per cent was removed with HCl leach. Sample was mixed with dead gas for counting. Date is based on one 2-day count in the 2 L counter.

GSC-3687. Bishop's Falls 11 400 ± 100
$\delta^{13}C = +1.4‰$

Paired and in situ marine pelecypod shells (sample 83-0001; 41.0 g; **Hiatella arctica,** identified by W. Blake, Jr.) from a 0.3 to 0.5 m-thick grey sand, silt, and clay unit exposed in a freshly cut embankment immediately downstream of the Abitibi-Price dam and powerhouse at Bishop's Falls on Exploits River, Newfoundland (49°01'N' 55°28'20"W), at an elevation of 3 ± 1 m. The fresh cut resulted from diversion of the river following the failure of the dam or retaining wall. The shell-bearing unit overlies 2 m of silt and clay rhythmites and is overlain by approximately 6 m of stratified gravel and sand. Collected January 1983 by D.G. Vanderveer, Department of Mines and Energy, Government of Newfoundland and Labrador, St. John's.

Comment (D.G. Vanderveer): The date of these shells, from a site 8 km to the southwest of the borrow pit where GSC-2134 (11 600 ± 210, this series) was collected, provides a minimum age for the marine incursion some 10 to 15 km from Bay of Exploits as well as for the time of glacial retreat; cf. GSC-3647 (11 800 ± 200 BP, this list), a date on basal clay gyttja in a kettle pond 9.5 km south of Bishop's Falls.

The sample also contains **Mya truncata**, a few barnacle fragments, and some unidentified pelecypods. The dated shells were in general well preserved, with both external ornamentation and bits of periostracum intact. Most shells retained internal lustre, but some orange and black staining was observed. The largest valve measured 4.0 x 1.8 cm, and most of the shell material was <1 mm thick. No pitting, some chalkiness, and juvenile shells <1 cm long were present. Only the outer 10 per cent was removed by HCl leach. Date is based on one 3-day count in the 5 L counter.

GSC-2318. Triton Island 11 500 ± 220

Fragments of marine pelecypod shells (sample GS-75-041; 8.6 g; **Mya truncata**, identified by D.R. Grant) in massive grey silty marine clay exposed at 0.5 m above sea level in a sewer excavation along highway 380 at the head of Great Triton Harbour, 0.7 km southwest of Triton village on Triton Island, outer Notre Dame Bay, northern Newfoundland (49°31.25'N, 55°37.33'W). Collected 1975 by C.M. Tucker, then assistant to D.R. Grant, now National Defence Headquarters, Ottawa.

Comment (C.M. Tucker): Shelly sediment is interpreted as in situ marine mud. It is overlain by a stony diamicton thought to be a till produced by a glacier readvance over the seafloor.

Comment (D.R. Grant): On stratigraphic grounds, evidence for a post-11 500 year readvance remains equivocal despite the apparently similar occurrence nearby at Pilleys Island (see GSC-1505, 11 900 ± 200 BP, this series), because the overlying diamicton is not demonstrably a till, nor is there a two-till sequence in the area. On the other hand, a two-flow sequence is widely represented by crossing striations. If a readvance did occur, it stemmed from a local ice cap in the New Bay Pond area (Grant, 1974) and may correlate with the Ten Mile Readvance ca. 10 900 years ago (Grant, 1969a).

Comment (W. Blake, Jr.): The dated fraction was associated with **Hiatella arctica, Macoma** sp., and **Balanus** sp. The **Mya truncata** used (13 fragments) were all identified on the basis of the truncated posterior ends. Although some of the **Mya** were chalky and worn on the exterior, several had the periostracum and internal lustre preserved (shells were aragonitic). Because of the small sample size, only the outer 10 per cent was removed by HCl leach. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-1505. Pilleys Island 11 900 ± 200

Fragments of marine pelecypod shells (sample NOD-70-0005-HM-N; 16 g; **Mya truncata**, identified by W. Blake, Jr.) picked from a 20 kg sample of grey stony diamicton exposed in mining excavation just north of the northeast corner of Cobbs Pond (Mine Pond on topographic map), southern Pilleys Island, inner Notre Dame Bay, northern Newfoundland (49°30.9'N, 55°43.0'W), at an elevation of 27 m. Collected 1970 by Neil O'Donnell, then with British Newfoundland Exploration Limited; submitted by D.R. Grant.

Comment (N. O'Donnell): The grey drift, though rare compared with the typical loose sandy tills of the area, is interpreted as marine sediment overridden by a readvancing glacier. Hence shells predate an implied late glacial expansion of the Newfoundland ice cap.

Comment (D.R. Grant): Re-examination of the diamicton suggests that it is more probably a glaciomarine drift like that commonly found in patches at low elevations throughout the region. By this interpretation, the date relates to late-glacial ice recession in a higher sea, and it is within the range of ages on similar sediment in the region (cf GSC-55, -75, and -87, all GSC II, 1963, p. 41-42; and GSC-2134, -3687, and -2318, this series). Moreover, the inferred readvance is difficult to reconcile with a date of 12 000 ± 220 BP (GSC-1733, this series) on an ice-marginal delta, 25 km farther inland from this locality.

Comment (W. Blake, Jr.): All **Mya truncata** shells, both whole and fragments, regardless of size, have periostracum partly intact; no large or thick shells were present. These shells occur in association with **Hiatella arctica, Balanus** sp, echinoid plates, and an unidentified gastropod. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 5 L counter.

GSC-1733. South Brook 12 000 ± 220

Platelets of barnacle (sample GS/72-54; 7.7 g; **Balanus** sp.; identified by D.R. Grant) picked from the rain-washed surface of 4+ m of stony mud underlying 3 m of pebble gravel exposed in a borrow pit on the north side of the Trans-Canada Highway at an elevation of 20 m. The mud, originally interpreted as delta bottomset sediment, may also be glaciomarine drift or true till; it occupies a swale at the foot of a massive ice-marginal marine delta, one of several in the area, whose top at 76 m represents local marine limit. The locality is 1.6 km west of the village of South Brook, at the head of Halls Bay, one of the major glacial troughs leading to Notre Dame Bay, Newfoundland (49°25.50'N, 56°06.50'W). Collected 1972 by D.R. Grant.

Comment (D.R. Grant): The date is the oldest of several on postglacial marine overlap, both on the outer headlands and in the inner bays (ref. GSC-55, -75, and -87, GSC II, 1963, p. 41-42; GSC-1505, -2134, and -2318, this series). The date is approximately 1000 years older (the range is 590 to 1410 years) than that obtained on **Hiatella arctica** from apparently similar sediment at a similar elevation 2 km to the east (GSC-2085, 11 000 ± 190 BP; GSC XV, 1975, p. 5). Depending on the origin of the enclosing diamicton, the shells provide a variably minimal date for construction of the delta and hence the position of a significant ice-marginal stand in northern Newfoundland (Tucker, 1974). On this basis, the age corresponds well with a major moraine-building phase on the west coast ca. 12 600 years ago represented by the Robinsons Head Readvance (Brookes, 1977) and Piedmont moraines (Grant, 1969a,b).

Comment (W. Blake, Jr.): Because of the small sample size, only the outer 5 per cent was removed by HCl leach. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

Postglacial Emergence Series, Northern Peninsula (III)

GSC-3316. Croque 10 800 ± 110
$\delta^{13}C = +1.4‰$

Fragments of marine pelecypod shells (sample 80-GS-37; 26.5 g; **Mya truncata**, identified by D.R. Grant) picked from the till surface on a freshly excavated cut along the highway, 1 km west of the village of

Croque on the Atlantic Ocean side of Northern Peninsula, Newfoundland (51°03.36'N, 55°50.78'W), at an elevation of 24 m. Collected 1980 by D.R. Grant.

Comment (D.R. Grant): The shells are not included in till but evidently represent a molluscan fauna that populated the till surface when it was submerged during the Late Wisconsinan Goldthwait Sea (or Daly Sea) phase (Grant, in press). Though well below the local marine limit of 135 m, the deposit is nonetheless interesting in that it dates from the time of the Ten Mile Readvance when the Newfoundland ice cap expanded into the sea. The date bears on the question of the extent of Late Wisconsinan ice in the area, and the date of its retreat. No deposits older than 11 000 BP have been found, implying that ice cover persisted until then and/or that submergence began then.

Comment (W. Blake, Jr): Only the distinctive truncated posterior ends of the shells (both right and left valves) were included in the dated sample. The 13 fragments were up to 5 mm thick in the hinge area, had no periostracum, and were chalky; no internal lustre remained. Date is based on one 3-day count in the 2 L counter.

GSC-3328. Tom Roses Lake 9600 ± 90
$\delta^{13}C = +1.2‰$

Whole shells (sample 80-GS-38; 46.5 g; **Mya truncata**, identified by D.R. Grant) found intact and in growth position in 4 m of sand under 2 m of gravel as a possible beach or bar in generally rocky terrain, exposed in a highway borrow pit along the road to Croque, near Tom Roses Lake, 7 km southeast of Main Brook town, Northern Peninsula, Newfoundland (51°07.64'N, 55°58.50'N), at an elevation of 48 m. Collected 1980 by D.R. Grant.

Comment (D.R. Grant): The age and elevation of the beach support the general trend of sea-level regression determined from other tide-level indicators in the area (Grant, 1972). The deposit covers the end moraine of the Ten Mile Readvance, dated 10 900 to 11 000 BP (Grant, 1969a), and hence provides an indication of the time of retreat from that ice-marginal stand.

Comment (W. Blake, Jr.): Although in situ, the aragonitic shells were chalky, had no periostracum or internal lustre, and were enclosed in calcareous mineral sediment derived from the local limestone terrane. Most shells were only about 1 mm thick, except in the hinge area. Date is based on two 1-day counts in the 5 L counter.

GSC-2919. Bustard Cove 11 000 ± 180

Fragments of marine shells (sample 78-3819; 12.4 g; **Mya truncata**, identified by W. Blake, Jr.) in 1+ m of stratified grey silt under 5 m of gravel exposed in a borrow pit on the east side of highway 430, 12 km east of Port au Choix town, and 3.5 km inland from Bustard Cove on Northern Peninsula, Newfoundland (50°42.86'N, 57°11.61'W), at an elevation of 75 m. Collected 1978 by R.J. Ricketts and D.G. Vanderveer, Department of Mines and Energy, Government of Newfoundland and Labrador, St. John's; submitted by D.R. Grant.

Comment (D.R. Grant): The deposit lies on the north flank (Labrador side) of Doctors Interlobate Moraine (Grant, 1969a), which was formed by the confluence of Labradorean and Newfoundland ice streams. As the shells were from a relatively deepwater facies, it was hoped that they would date from the time of marine limit at 140 m (estimated at 13 000 BP), and hence that they would record the deglacial transgression following the retreat of the Belle Isle ice stream. Although the date is the oldest in the area, it is much younger than expected and may call for a revision of inferred ice-marginal ages. Perhaps Labradorean ice persisted while west Newfoundland glaciers retreated before 12 600 BP.

Comment (W. Blake, Jr.): All valves were broken to some degree; none had any periostracum, but internal lustre was intact; some iron stain was present on exterior surfaces. The sample used was five fragments, all of which included the truncated posterior end typical of the species. The fragments in part derive from large valves (>4.8 x >3.0 cm). Most fragments are >1 mm but <2 mm in thickness. Because of the small sample size, only the outer 10 per cent was removed by HCl leach. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Nova Scotia

Holocene Submergence Series

Wood, organic detritus, and marine shells, which provide information on submergence of the land relative to the sea in Holocene time. Older series dealing with submergence in the Maritime Provinces were reported in GSC IX (1970, p. 51-54) and GSC XI (1971, p. 266-267), and the general problem of submergence is discussed in Grant (1970, 1975).

GSC-1597. Pennant Cove 560 ± 130
$\delta^{13}C = -23.8‰$

Wood (sample GS-71-1; 13.2 g; **Abies balsamea;** unpublished GSC Wood Identification Report No. 71-53 by R.J. Mott) from the root crown of a tree stump whose base, at 1.35 m below high tide level, is rooted in till and is overlain by turf containing remains of the high-tide grass **Spartina patens.** The stump was exposed in a tidal creek on the north side of Pennant Cove 0.3 km west of the mouth of Pennant Creek, Halifax County, Nova Scotia (44°28.87'N, 63°37.89'W). Collected 1971 by D.R. Grant.

Comment (D.R. Grant): The death of the tree is interpreted to mark the first arrival of marine waters and the ensuing deposition of tidal mud. Age/depth relations are consistent with the average rate of rise of 30 cm/100 years determined for the Nova Scotia region, and they agree with detailed local sea-level history for the Halifax area, determined independently on the basis of foraminifera method in marsh cores for Chezzetcook (Marine Emergence and Submergence in the Maritimes; unpublished Progress Report to EMR on Research Agreement EMR 45-4-79, by D.B. Scott and F.S. Medioli, 1979; Department of Geology, Dalhousie University, Halifax). The date conflicts with DAL-32 (1060 ± 130 BP; Dalhousie I, 1976, p. 46), which is purportedly on the same sample although the elevation is cited as -0.41 m. Similarly, overlying freshwater peat (DAL-33, 315 ± 85 BP, same list) is considerably younger, although possible contamination from modern **Spartina** roots was admitted.

Comment (W. Blake, Jr.): The submitter had the sample sitting on a garage roof for three months, exposed to much rain and some sun, in order to allow the wood to be washed clear of salt and to expel a number of boring worms. The sample submitted comes from the clean, damp white wood representing the outer 2 to 3 cm; it was dried in an electric oven. Date is based on two 1-day counts in the 5 L counter.

GSC-2911. Head of St. Mary Bay 2090 ± 70
$\delta^{13}C = -25.9‰$

Wood (sample 79-GS-171; 11.7 g; probably **Acer saccharum;** unpublished GSC Wood Identification Report No. 79-45 by L.D. Farley-Gill) from the base of the trunk of small tree stump rooted in till (bleached A soil zone still intact), veneered by a few centimetres of bog peat and overlain by upper tidal marsh mud containing remains of **Spartina patens** grass; exposed on the intertidal flat at 2.55 m below mean annual high tide, at the head of St. Mary Bay, Bay of Fundy coast, 10 km south of Digby, Digby County, Nova Scotia (44°34.94'N, 65°51.49'W). Collected 1979 by D.R. Grant.

Comment (D.R. Grant): The date improves documentation of the transgressive sequence in this area (Grant, 1980). Compared to the date on **Scirpus** of 720 ± 130 BP (GSC-997; GSC IX, 1970, p. 52) from a few centimetres higher, it shows that the local forest was killed by paludification about 1300 years before the first arrival of tide level at this elevation is recorded by brackish-water marsh. Together with GSC-2912 and -2914 (this series), these dates suggest that on gently shelving coasts, the rise of tide level is generally manifest on land first as widespread development of peat bogs as the groundwater table is raised towards the surface. Hence, dating the arrival of marine conditions directly by using submerged tree stumps, especially where even a thin bog horizon is present, is unlikely to give satisfactory results, but neither is dating of the high tide muds themselves practicable.

Comment (W. Blake, Jr.): Upon oven drying the wood decreased in weight from 72.2 to 18.08 g. Date is based on two 1-day counts in the 5 L counter.

GSC-2914. Church Point 4490 ± 80
$\delta^{13}C = -24.3‰$

Wood (sample 79-GS-115; 11.7 g; **Pinus strobus;** unpublished GSC Wood Identification Report No. 79-44 by L.D. Farley-Gill) from the root/trunk area of a tree stump rooted in till, surrounded by patches of compressed bog peat, and locally overlain by **Scirpus**-bearing clay. The wood was exposed on intertidal flats 4.4 m below mean annual high tide (1.4 m below MSL), in a cove 0.2 km north of the lighthouse at Church Point, St. Mary Bay, Bay of Fundy coast of Nova Scotia (44°20.00'N, 66°07.50'W). Collected 1979 by D.R. Grant.

Comment (D.R. Grant): Although the exposure gives every indication that the tree was killed by the submersion that produced the overlying brackish water mud, the date is 3500 years too old in relation to all other indicators that have been used to construct a late Holocene submergence curve for the Bay (Grant, 1975). The discrepancy is presumed to be the result of a lengthy interval of terrestrial paludification, represented by the bog peat, before the arrival of high tide which produced the overlying tidal deposits (Grant, 1980). A similar case was reported in reference to GSC-957 (GSC IX, 1970, p. 53). Date based on two 1-day counts in the 5 L counter.

GSC-1686. Yarmouth Harbour 5040 ± 140

Organic detritus (sample GS-72-2 = DPW Borehole 12, sample 55; 148 g damp) beneath Holocene tidal mud. The measured depth was 16.9 m below "Low Water Ordinary Spring Tides" or 21.6 m below Higher High Water, in a borehole to test foundation conditions for the causeway 0.8 km north of Doctors Island, in Yarmouth Harbour, Nova Scoita (43°50.60'N, 66°07.76'W). Collected 1971 with a Shelby tube sampler by G. Wilson, Public Works Canada, Ottawa; submitted 1972 by D.R. Grant.

Comment (D.R. Grant): The material was interpreted to mark the terrestrial surface just prior to the deposition of tidal mud. Hence the age is equated with the arrival of rising tide level at this site. M. Kuc (unpublished GSC Bryological Report No. 169) identified the material as "terrestrial humic sapropel" containing algae, diatoms, and spicules; this is consistent with the notion of saltwater overlap onto an Ae soil horizon. The date was intended to extend the submergence curve (Grant, 1970, 1975) but, compared to the average regional rate, the date is 2000 years younger than would be expected for material at that depth (or, conversely, it is 5 m deeper than would be expected for its age). When compared to the more local submergence history developed for Chebogue, 8 km to the south (Marine Emergence and Submergence in the Maritimes; unpublished Progress Report to EMR on Research Agreement EMR 45-4-79, by D.B. Scott and F.S. Medioli, 1979; Department of Geology, Dalhousie University, Halifax), there is reasonable agreement with an extrapolated trend of their results. There is growing evidence of large intra-regional differences in submergence rate which may be attributed to varying subsidence and tidal history.

Comment (W. Blake, Jr.): NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 5 L counter.

GSC-2906. Bunker Island 1570 ± 60
$\delta^{13}C = +2.8‰$

Marine pelecypod shells (sample 79-GS-32; 46.5 g; **Mya arenaria,** identified by D.R. Grant) from an Indian kitchen midden (refuse heap) at elevation 0.5 m above mean high tide level (+2.9 m MSL) being exposed by wave erosion of a low bench on the flank of a drumlin knoll known as Bunker Island, in Yarmouth Harbour, Nova Scotia (46°48.92'N, 66°08.16'W). Collected 1979 by D.R. Grant.

Comment (D.R. Grant): The shell heap also contains bits of charcoal, bone, jasper flakes, and worked stones (Grant, 1980). The date is the first on pre-colonial archeological material on this coast and, if this site can be compared to others of similar content along St. Mary Bay, it gives evidence of thriving shore-based settlements of Mic Mac people. Additionally, the occurrence offers indirect control on the rate of modern rise of tide level in that the site, despite its youthfulness and obviously much larger original size, is now almost wholly consumed by the sea.

Comment (W. Blake, Jr.): Three intact left valves, the largest measuring 7.6 x 4.8 cm, of aragonitic composition were used for dating. Only the outer 10 per cent was removed by HCl leach. Date is based on one 3-day counter in the 5 L counter.

GSC-2912. Barton 2730 ± 70
$\delta^{13}C = -25.7‰$

Wood (sample 79-GS-155; 10.7 g; **Pinus strobus;** unpublished GSC Wood Identification Report No. 79-43 by L.D. Farley-Gill) from the upper part of a root of a large tree stump rooted in till (with leached soil horizon intact) and overlain by high-tide marsh-mud facies containing the characteristic remains of **Spartina patens.** The stump is exposed on intertidal flats 3.5 m below mean annual high tide level (0.2 m below MSL), 1 km northeast of the mouth of Bingay Brook, near Barton, on the Bay of Fundy shore, Digby County, Nova Scotia (44°32.91'N, 66°52.05'W). Collected 1979 by D.R. Grant.

Comment (D.R. Grant): Like GSC-2914 (this series), the date was intended to refine the submergence curve for this part of the Fundy shore, but the date is older than the average of other paleo-high-tide indicators at this level. The discrepancy might be explained by supposing an erosional hiatus between the death of the forest (perhaps by paludification as groundwater level rose in response to the approaching sea) and the arrival of marine water over the stump to produce the tidal-marsh mud.

Comment (W. Blake, Jr.): On oven drying, the wood decreased in weight from 159.7 to 53.0 g. Date is based on two 1-day counts in the 5 L counter.

New Brunswick

Hillsborough Mastodon Series

An assemblage of 312 skeletal fragments was found associated with peat, organic silt, and a number of coprolites during excavation for a dam foundation in a sinkhole pond in gypsum on the estate of Captain Conrad Osman, 2 km southwest of the village of Hillsborough, west side Petitcodiac River estuary, about 22 km south of the city of Moncton, New Brunswick (45°54.6'N, 64°39.8'W), at an elevation of approximately 30 m. Collected 1936 by William MacIntosh, New Brunswick Museum, Saint John; submitted by D.R. Grant.

GSC-1222. Hillsborough A 13 600 ± 220
$\delta^{13}C = -21.1‰$

Bone fragments (sample GS/69-1; 505 g; identified as **Mammut americanum** (American Mastodon) by C.R. Harington, National Museum of Natural Sciences, Ottawa).

GSC-1680. Hillsborough B >43 000

Peat (sample GS/72-1; 40 g; identified as "woody swamp product" (containing strongly compressed but not rounded twigs, and stems of **Drepanocladus exannulatus**), unpublished GSC Bryological Report No. 152 by M. Kuc) found associated with the bones cited above.

GSC-2467. Hillsborough C 51 500 ± 1270
$\delta^{13}C = -18.8‰$

Carbonate detritus and/or cement (sample Osman (1936); 105 g + 272.3 g) composing bulk of the matrix of the coprolite (lithified dung ball), one of several found associated with the mastodon bones referred to under GSC-1222.

GSC-2469. Hillsborough D 37 200 ± 1310
$\delta^{13}C = -29.1‰$

Organic detritus (sample Osman (1936); 32.6 g; residue consisting mainly of wood splinters leached from carbonate matrix by H_3PO_4) contained in coprolite mentioned above, in association with mastodon bones documented under GSC-1222.

Comment (D.R. Grant): This is the best documented occurrence of a Pleistocene elephant east of Hudson River; details on its discovery and subsequent history are outlined by Squires (1966; cf. also Harington, 1978). Late glacial elephants are unknown in the region, but this occurrence is one of a growing number of finds of mid-Wisconsinan age. The bone date was originally considered consistent with the time of deglaciation of southern New Brunswick, based on shell dates near Saint John and from Prince Edward Island (cf. Prest, 1970; also comments by N.R. Gadd concerning GSC-3354, 13 900 ± 620 BP, this list). Moreover the boreal forest aspect, deduced from pollen analysis of associated peat, seemed to match that of the late glacial in southern New Brunswick (unpublished GSC Palynological Report No. 72-2 by R.J. Mott). The nonfinite date on the enclosing peaty sediment, however, casts doubt on the bone date because of inherent uncertainties with such material and because the bone had been treated with "preservative" (Squires, 1966, p. 29). Unaccountably, Schroeder and Arsenault (1978) reported these results prematurely without the benefit of GSC-2467 and -2469. They concluded that a late glacial mastodon fell into much older sediment. Dating of the coprolites, however, gives a definitive age for the animal. GSC-2469, in particular, being the age of its stomach contents, seems to be good evidence for concluding that the animal lived in Middle Wisconsinan time. It thus died by becoming mired in a swamp, whose basal layers, at least, predate 43 000 BP. A lengthy nonglacial interval is implied and, as such, is the first chronometric indication of this for the entire region. However, this unique occurrence and the possibility of contamination, render this hypothesis tentative at best. The late glacial character of the organics may be reconciled with the interstadial age by supposing that 37 000 years ago the area was characterized by a boreal forest similar to that which existed 12 000 to 13 000 years ago.

It may be noted that the site occurs between two major ice-marginal positions which, according to Rampton and Paradis (1981; see also Rampton et al., in press) are the Kent Phase (Middle Wisconsinan?) and the Sackville Phase (Late Wisconsinan). There is thus no blatant contradiction of current inferences about glacial chronology.

Comment (W. Blake, Jr.): Pretreatment of GSC-1222 included a 1-hour NaOH leach plus the normal HCl leach to remove carbonates. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter. GSC-1680 is based on two 1-day counts in the 5 L counter. As noted above, GSC-2467 was prepared in two batches, and there was no pretreatment; CO_2 from the first preparation was given one 1-day count in the 2 L counter and an age of >37 000 years was calculated. The CO_2 from the second preparation was combined with the first, and the final date was based on one 5-day count in the 5 L counter at 4 atmospheres. GSC-2469 was based on one 4-day count in the 5 L counter.

GSC-1383. Shippegan 12 600 ± 400

Marine shells (sample 69-GS-160; 7.4 g; **Mytilus edulis**, identified by M.L.H. Thomas) found in life position in sand resting on barren grey clay, 1 m below sea level, exposed in an excavation for an oyster farm, 50 to 250 m inland from the present shore on Taylor Island, 3 km west of the town of Shippegan, New Brunswick (47°44.00'N, 64°46.50'W). Collected 1969 by M.L.H. Thomas, then with Fisheries Research Board, Halifax, now University of New Brunswick at Saint John; submitted by D.R. Grant.

Comment (D.R. Grant): The mussels are associated with 19 other species, mostly deepwater, of Mollusca, Crustacea, Bryozoa, and Echinodermata. Most reflect cold deep water, but the dated sample, together with **Macoma balthica** and others, indicates warmer, shallower water. These latter thus represent a late glacial paleoshore coinciding with present sea level. This unique relationship permits construction of a hypothetical sea-level curve showing deglaciation at approximately 14 000 BP, marine limit at 70 m when the cold deepwater fauna was deposited, regression to a Holocene low stand at approximately 20 m, and final transgression to present level (Thomas et al., 1973). The date is in good agreement with others in the Chaleur Bay area, in respect of Late Wisconsinan ice withdrawal (cf. GSC-1018, 12 200 ± 180 BP; GSC XI, 1971, p. 267 and GSC-1557, 12 500 ± 170, this list).

Comment (W. Blake, Jr.): The dated sample was a single valve (fractured into three pieces) measuring 7.5 x 4.0 cm and lacking the usual **Mytilus** coloration. Date is based on two 1-day counts in the 1 L counter.

GSC-1557. Jacquet River 12 500 ± 170

Marine shells (sample no. 874-G-1-16, Nova Scotia Museum; 26.3 g; **Hiatella arctica**) from sand 4 m below the surface, overlying marine silt and clay, exposed in a cutting of the Intercolonial Railway (now Canadian National Railway) on the north side of Jacquet River, 0.4 km inland from the shore of Chaleur Bay, northern New Brunswick (47°55.3'N, 66°01.0'W), at an elevation of 13 m. Collected 1874 by David Honeyman, Dalhousie University, Halifax; submitted by D.R. Grant.

Comment (D.R. Grant): The sample was "re-discovered" by the submitter in the large collection of invertebrate fossils, plus cetacean bones (**Beluga** sp.) at the Nova Scotia Museum, where they have remained since collection. No subsequent study has been undertaken since the first reports by Gilpin (1874) and Matthew (1878). Together with GSC-1018 (12 200 ± 180 BP; GSC XI, 1971, p. 261), this date was the basis for Prest's (1970) map of deglacial isochrones. It also helps to define the early transgressive phase of the Goldthwait Sea into Chaleur Bay following westward retreat of a lowland ice lobe. However, it remains in marked conflict with the interpretation by Loring and Nota (1973) that ice advanced out of this area after 10 200 ± 440 BP (GSC-1528, GSC XVII, 1977, p. 5) and deposited "till" over marine sediment at the mouth of Shediac Trough. Loring's date is difficult to reconcile with the chronology of any land-based glacier in the area; an ice dome on western Magdalen Shelf may thus be implicated.

Comment (W. Blake, Jr.): The sample consisted of 18 whole valves, all 3 to 4 cm long, some with internal lustre, none excessively thick. Date is based on one 3-day count in the 2 L counter.

GSC-3354. Sheldon Point 13 900 ± 620
$\delta^{13}C = +0.9‰$

Marine pelecypod shells (sample 89 RC-C; 6.0 g; **Hiatella arctica**, identified by N.R. Gadd) from till or marine diamicton in a morainic ridge overlain by fossiliferous stratified sand and clay that is draped over the eroded moraine surface at Sheldon Point, in the vicinity of the harbour of Saint John, New Brunswick (45°13'30"N, 66°06'35"W), at an elevation of approximately 45 m. Collected 1981 by V.N. Rampton, Terrain Analysis and Mapping Services, Ltd., Stittsville, Ontario, and N.R. Gadd.

Comment (N.R. Gadd): As anticipated, the till-derived shell material proved somewhat older than previous age determinations obtained on overlying marine sediments (see especially GSC-1340, 13 000 ± 170 BP; GSC XI, 1971, p. 267). The new date represents either glacial deposition directly into the sea or early reworking of till in relatively deep marine water prior to uplift and nearshore reworking that produced overlying shallow-water sediment facies and younger dates.

Comment (W. Blake, Jr.): The sample consisted of three whole valves (the largest was 3.5 cm long and 1.7 cm high) plus numerous fragments. Most shells had the periostracum preserved in part; otherwise the exterior surfaces were chalky but lustre was preserved in the interiors. Some of the aragonitic shells, originally intact and paired, were broken during removal from the desiccated matrix; others were found crushed. **Mya truncata** was also present in the sample. Because of the small sample size, only the outer 10 per cent was removed by HCl leach. Sample was mixed with dead gas for counting. Date is based on one 5-day count in the 2 L counter.

GSC-1095. Utopia Plain bog, 1020-2025 cm 7130 ± 140

Basal organic lake sediment (sample TB-68-26; 72.6 g damp) from a small depression (kettle) on the Utopia Plain, approximately 9 km east-northeast of St. Georges, New Brunswick (45°09.2'N, 66°43.5'W), at an elevation of 76 m. Cores were recovered with a GSC piston corer from the bog surface in the centre of the depression, adjacent to a small remnant pool. Peat and organic lake sediment occurred to a maximum depth of 1025 cm and were underlain by sand and gravel. Collected 1968 by J. Terasmae, now at Brock University, St. Catharines, Ontario, and R.J. Mott.

Comment (R.J. Mott): The sample was dated to provide a minimum date for formation of the Utopia Plain, a glacial outwash plain graded to a sea level slightly below the maximum for the area (Gadd, 1973). However, the date is much too young and relates to the beginning of organic accumulation in the depression at a later date. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

Quebec

GSC-3325. Lac Salé de l'Est 8930 ± 80
$\delta^{13}C = +1.8‰$

Marine pelecypod shells (sample 80-GS-34; 46.2 g; **Mya pseudoarenaria**, identified by D.R. Grant) occurring intact and in growth position in sand approximately 2 m above mean sea level, in a gully at the roadside near the shore of Lac Salé de l'Est, a shallow coastal inlet along the northern part of the Gulf of St. Lawrence, about 3 km southeast of Rivière Saint-Paul, Quebec (51°26.9'N, 57°41.6'W). Collected 1980 by D.R. Grant.

Comment (D.R. Grant): While the occurrence is not definitive in terms of dating paleoshores, it compares reasonably well with I-8365 (7200 ± 125 BP, shells at the base of marine sand over glaciomarine (?) diamicton; de Boutray and Hillaire-Marcel, 1977) and with GSC-2825 (10 900 ± 140 BP; GSC XIX, 1979, p. 4) in helping to date the marine transgression in the Strait of Belle Isle area as 10 000 to 8000 BP. More significantly, it bears on the age of major ice-marginal positions because the sample is from between the inner two of three major moraines on this coast, of which the outer, the Belles Amours Moraine, is dated to 12 700 BP by correlation with the Piedmont Moraines in western Newfoundland (Grant, in press).

Comment (W. Blake, Jr.): The sample used for dating comprised five partially intact valves (the largest measuring 7.7 x 5.0 cm) plus one intact pair (6.2 x 3.8 cm). The aragonitic shells were up to 3 mm thick in the hinge area, otherwise all shell material was <2 mm thick. Date is based on one 3-day count in the 5 L counter.

GSC-3531. Castle Brook 1950 ± 50
$\delta^{13}C = -24.4‰$

Wood (sample GB-82-11; 11.3 g; **Tsuga canadensis**; unpublished GSC Wood Identification Report No. 82-36 by R.J. Mott) from a sample approximately 8.5 x 7.0 cm in size that was cut from one of several tree-length logs found in gravel overlain by silty sand and silt and underlain by an irregular erosional surface in laminated silty sediments and older diamicton. The collection site was on the west bank of Castle Brook (45°15'50"N, 72°11'50"W) a north end tributary to Lac Memphrémagog, Quebec about 0.6 km north of the lake. Collected August 1982 by P. Lasalle, Ministère de l'Énergie et des Ressources, Gouvernement du Québec, Québec, and N.R. Gadd.

Comment (N.R. Gadd): The locality lies 4.5 km south of the Cherry River Moraine as described and mapped by McDonald (1967). Surficial sandy silt deposits in this area, mapped as glaciolacustrine by McDonald (1967), by virtue of this discovery of underlying Holocene wood, must be considered fairly recent alluvium. Gadd (1983) discussed the implications of this discovery and of other data; he suggested that the Lac Memphrémagog basin was occupied by stagnant ice for a time during the formation of the deltaic portions of Cherry River Moraine, and he re-interpreted a part of that complex as an older deposit related to the stagnant ice. Date is based on two 1-day counts in the 5 L counter.

GSC-3539. Granby 10 300 ± 90
$\delta^{13}C$ = +0.9‰

Marine pelecypod shells (sample GB-82-8; 48.0 g; **Hiatella arctica**, identified by N.R. Gadd) were selected from an assemblage of **Hiatella arctica, Portlandia arctica, Balanus crenatus** (some attached to pebbles), and **Macoma calcarea** (also present at the site but not found in situ were **Mya arenaria** and **Mya truncata**). The shells were collected from a shallow drainage ditch exposure of stratified sand and silty sand overlying laminated marine clay and till (the sample was extracted from the lowermost 5 cm band of pebbly sand overlying 1 m of clay and till), 3.2 km northwest of Granby, and 4.8 km east-southeast of Mont Yamaska, Quebec (45°26'10"N, 72°46'30"W), at an elevation of approximately 85 m. Collected 1982 by N.R. Gadd.

Comment (N.R. Gadd): In an area previously considered to have a limit of postglacial marine submergence near 155 m (Goldthwait, 1913), it has been shown that ice-marginal drainage systems occur at lower levels (Prichonnet et al., 1982; Gadd, 1983). This site and others in the vicinity (viz. GSC-3574, Cowansville, this list) suggest that areas between Mont Yamaska and Lake Champlain were submerged by the Champlain Sea only to levels near 100 m and during a late phase (**Mya** phase) of the sea. Gadd (1983) suggested that a large mass of the stagnating Hudson-Champlain ice lobe controlled ice-marginal drainage and marine submergence in the region bounded by Mont Yamaska, Lake Champlain, and Monts Sutton (Green) during early Champlain Sea time.

Comment (W. Blake, Jr.): The sample used was 100 right valves, 2.6 to 1.6 cm long and 1.5 to 1.0 cm high. The well preserved shells exhibited only a little chalkiness; many valves had good internal lustre. Date is based on one 3-day count in the 5 L counter.

GSC-3574. Cowansville 10 800 ± 100
$\delta^{13}C$ = +1.1‰

Marine pelecypod shells (sample GB-82-7; 27.0 g; **Hiatella arctica**, identified and selected by W. Blake, Jr., from a large sample including **Macoma calcarea, Mya** sp., and **Balanus crenatus**) from an erosional contact zone between fossiliferous stratified marine sand and underlying reddish grey till 6.4 km northwest of Cowansville, Quebec, along Yamaska River valley (45°14'15"N, 72°29'40"W), at an elevation of approximately 95 m.

Comment (N.R. Gadd): Like GSC-3539 (this list), this sample comes from an area previously considered to have a limit of postglacial marine submergence near 155 m (Goldthwait, 1913), but more recently shown (Prichonnet et al., 1982; Gadd, 1983) to contain ice-marginal glacial and lacustrine features at lower elevations. Only 2 km east of the dated locality (GSC-3574), at an elevation of approximately 105 m, undisturbed surface features include an esker grading into and overlapped by glaciolacustrine varves. From such evidence Gadd (1983) postulated that the area between Mont Yamaska, Lake Champlain, and Monts Sutton (Green) was occupied by a remnant mass of the Hudson-Champlain ice lobe during early stages of the Champlain Sea. Marine submergence of the areas around Granby and Cowansville is, therefore, thought to have occurred only to levels near 100 m a.s.l. and in the later **Mya** phase of the Champlain Sea, whereas adjacent St. Lawrence Lowland areas were submerged about 1000 years earlier: see, for example, GSC-505 (11 880 ± 180 BP) at L'Avenir, elevation approximately 122 m; and GSC-475 (11 530 ± 160 BP) at Sainte-Christine, elevation approximately 144 m (both in GSC VI, 1967, p. 159-160).

Comment (W. Blake, Jr.): The valves were all well preserved and intact; the sample submitted comprised 37 left and 34 right valves, ranging in size between 1.6 and 2.9 cm in length, 0.9 and 1.8 cm in height. Most valves were <1 mm thick, with good external ornamentation and some internal lustre. No periostracum, pitting, or encrustations. Date is based on one 3-day count in the 2 L counter.

GSC-3614. Saint-Lazare-de-Vaudreuil 10 600 ± 100
$\delta^{13}C$ = -1.1‰

Marine pelecypod shells (sample RAB-81-40+RAB-82-24; 27.1 g; **Macoma calcarea**, identified by W. Blake, Jr.) from the upper part of a dark grey, stony, sandy, silty till or diamicton unit (containing numerous striated clasts and wood fragments) underlying a sandy deltaic unit containing articulated marine pelecypods, gastropods, terrestrial wood, and coleoptera fauna in a sand pit (sablière Barbe) located 3.5 km southwest of Saint-Lazare-de-Vaudreuil, Vaudreuil County, Quebec (45°23'00"N, 74°10'30"W), at an elevation of approximately 82 m. Collected 1981 and 1982 by S.H. Richard.

Comment (S.H. Richard): The marine shells dated were found upright in living position in a pebbly, silty fine sand bed in the upper part of a till or debris flow unit containing wood fragments and overlain by a sandy deltaic unit 6 to 7 m thick. The contact between these two units appears to be transitional as thin and highly fossiliferous clay and sand horizons, alternately bedded, occur between the lower unsorted debris unit and the upper planar, cross-stratified medium sand deltaic unit. Although there are clear textural changes, no clear breaks in sedimentation occur and the whole suite of sediments exposed at this site appears to represent continuous deposition (D.R. Sharpe, personal communication, 1983). This lithostratigraphy suggests that the whole sequence is a glaciomarine unit deposited in an ice-contact deltaic environment at the margin of an ice lobe grounded in the Champlain Sea (Richard, 1976, 1982).

GSC-3614 is the second radiometric determination obtained for marine shells from this stony silty marine sand unit. It is of the same age as GSC-2265 (10 600 ± 130 BP; GSC XIX, 1979, p. 10; Richard, 1982) obtained earlier for a different species of marine pelecypods (**Hiatella arctica**) recovered from the same unit but in another exposure some 0.5 km farther west.

Comment (W. Blake, Jr.): Other pelecypod species present included **Mya truncata, Hiatella arctica**, and **Portlandia arctica**, but only **Macoma calcarea** (whole shells and fragments) was used for dating. Nearly all of the **Macoma** shells were without periostracum, and a few retained internal lustre. The thin (<1 mm) shells were characterized by holes drilled by predators. The largest valve was 3.1 x 2.1 cm. Date is based on one 3-day count in the 2 L counter.

GSC-3670. Shawville 11 400 ± 190
$\delta^{13}C$ = +1.7‰

Shells (sample FI-80-27; 12.0 g; **Macoma balthica**, identified by J.E. Dale) from 15 to 40 cm of boulder gravel overlying >3 m of glaciofluvial sand and underlying 1 to 2 m of eolian sand exposed in a gravel pit on the north side of the main street, 800 m west of the traffic light in the centre of Shawville, Quebec (45°36'35"N, 76°30'00"W), at an elevation of 170 m. Collected 1980 and 1981 by R.J. Fulton, S.H. Richard, W. W. Shilts, and others.

Comment (R.J. Fulton): The boulder gravel is considered to be a coarse beach lag deposit of the Champlain Sea. Much of the sample consisted of paired valves collected in growth position from under boulders, so the sample is thought to closely date a sea level of 170 m in this area.

The position of the marine limit is not precisely known, but Lac Thorne, 14 km to the northeast at an elevation of about 188 m, contains crustaceans which suggest that it was flooded by the sea (Dadswell, 1974), and a terrace cut in an outwash fan 16 km to the northeast suggests that the Champlain Sea may have reached 200 m. This date is slightly older than one from 158 m near Beachburg, Ontario, 32 km to the northwest (11 000 ± 160 BP; GSC-1664) for which **Macoma balthica** was also used, and it is similar to a date on whale bone from 170 m near White Lake, Ontario, 29 km to the south (11 500 ± 90 BP; GSC-2269; both in GSC XIX, 1979, p. 13). It is considerably younger than dates on **Macoma balthica** from elevations of 194 m at Cantley in Gatineau River valley, 55 km to the east (12 200 ± 160 BP; GSC XIII, 1973, p. 16) and from 168 m near Clayton, about 43 km to the south (12 700 ± 100 BP; Richard, 1978).

GSC-2243. "Firefighters" Lake 190-195 cm — 5570 ± 150; $\delta^{13}C = -26.0‰$

Basal organic lake sediment (sample MS-74-22; 95 g wet) from a small unnamed lake adjacent to the highway at mile 364, Baie James Hydro Project, Quebec (53°33'35"N, 77°40'45"W), at an elevation of approximately 174 m. Cores were taken with a Livingstone sampler in 1.7 m of water. A total of 195 cm of algal gyttja and clayey gyttja overlies grey clay with minor organic content to a depth of 207 cm and grey silty clay to a depth of 223 cm below the mud/water interface. The core bottomed in pebbly and sandy clay below 223 cm. Collected September 1974 by R.J. Mott and J-S. Vincent.

Comment (R.J. Mott): The lake is below marine limit in the area and provides a minimum date for isolation of the basin from the regressing Tyrrell Sea. It also gives an indication of the lag time between emergence and invasion of vegetation by comparison with GSC-1959 (6500 ± 90 BP; GSC XVII, 1977 p. 7). NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Lac l'Espérance Series

Catastrophic drainage of a small lake in 1974 uncovered in situ tree strumps on its floor. The lake is located approximately 65 km east of Senneterre, Quebec (48°11'10"N, 76°26'30"W) near Lac l'Espérance. Collected July 1978 by J.J. Veillette, J.M. Moisan, and M. Veillette.

GSC-3479. Lac l'Espérance (I) — 3690 ± 70; $\delta^{13}C = -26.4‰$

A flat topped 20 cm-diameter stump (sample VJ-78-161-1; 10.0 g; **Larix laricina**; unpublished GSC Wood Identification Report No. 78-55 by R.J. Mott) covered by 5 m of water prior to lake drainage in 1974, and at an elevation of 402 m.

GSC-3501. Lac l'Espérance (II) — 2910 ± 80; $\delta^{13}C = -26.2‰$

A pointed stump (sample VJ-78-161-2; 11.2 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 78-55 by R.J. Mott), 17 cm in diameter at the base and at an elevation of 404 m, was covered by 3 m of water prior to lake drainage in 1974.

Comment (J.J. Veillette): The dates support the interpretation that the creation of this lake and its evolution resulted from a gradual accumulation of fine organic material that acted as a seal against the flank of a nearby esker and retained the lake water. It is probable that a small brook flowing towards the esker and similar to the one now present in the dry lake basin was first dammed by beavers prior to 3690 ± 70 years ago (GSC-3479). The pond that resulted favoured the accumulation of fine organic matter. Continued sedimentation and effective sealing of the basin against the flank of the pervious esker led to a rise in water level which culminated in the formation of a small lake (750 x 200 m and 8 m maximum depth). It is reported that human intervention caused breaching of the esker and sudden drainage of the lake in 1974 (Veillette, 1983a).

Comment (W. Blake, Jr.): After the outermost wood of GSC-3479 was removed by scraping, the 5 to 10 outer rings were used to obtain the sample for dating. GSC-3501 was sampled in the same way. Each date is based on two 1-day counts in the 5 L counter.

Lac Témiscamingue Series

A group of eleven dates (seven in Quebec and four in Ontario, to follow later in this date list) are reported from an area roughly centred on Lac Témiscamingue. All dates are from cores of basal organic sediments obtained in small ponds, and thus they represent minimum ages for deglaciation. The dates are part of a wider investigation that provided basal organic cores and dates at 31 locations. The program objectives are (1) to establish an absolute deglaciation chronology to be correlated with other geological information on deglaciation gathered in the field as part of a regional surficial geology mapping project and (2) to reconstruct the early postglacial vegetation history. The latter objective is the responsibility of P. Richard, Laboratoire de Palynologie, Université de Montréal, Montréal, assisted by A. Larouche. All sites were investigated in late winter and coring was done from the ice with a modified Livingstone sampler. At each site a 1 m-long core of basal material containing the organic/mineral sediment interface was obtained. Material at the base was kept for dating and the core was analyzed for palynological information. Most sites investigated are at or above the maximum elevation reached by glacial Lake Barlow or Lake Ojibway. Some sites are located outside of the area formerly covered by these large glacial lakes.

Lac Simard Series

Gyttja samples from two sediment cores recovered from a pond of irregular outline (main axes 700 x 300 m) in a bedrock basin 5 km north of Lac Simard, Quebec (47°44'02"N, 78°40'00"W), at an elevation of 369 m.

GSC-3374. Lac Simard (I) — 10 600 ± 770

Basal grey gyttja (sample CGC-13; 437-442 cm; 83.1 g) from a 4.70 m-long sediment core. Water depth was 3 m at the sampling site. At 4.42 m a distinct contact was recorded between the gyttja and the underlying clayey silt. At 4.70 m solid refusal occurred in till. Collected March 19, 1981 by J.J. Veillette and A. Larouche.

Comment (J.J. Veillette): The pond surface at 369 m is slightly above the maximum glaciolacustrine level in the area (357 m). The lake was sounded at different locations with a Hiller probe to determine the greatest thickness of sediments in the basin. Following deglaciation the immediate area around the site was an island. The age seems too old when viewed in a regional context.

Comment (W. Blake, Jr.): The large error term is a result of the extremely small amount of CO_2: 31.0 g burned yielded only 1.8 cm of CO_2, and 29.6 g remained as ash. Even if the error term is subtracted the resultant age, 9830 years, is older than most other dates on basal organic material in the region. With samples so low in organic carbon there are two dangers: 1) any admixture of 'old' carbon, such as graphite from bedrock or carbon derived from black shale, will have a disproportionate effect on the age (cf. Nambudiri et al., 1980) and 2) when a sample has to be mixed with so much dead gas to fill the counter, the effect of any mistake in reading the manometer becomes magnified (cf. Blake, 1975). NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3405. Lac Simard (II) 7790 ± 220
$\delta^{13}C = -26.5‰$

Grey gyttja (sample CGC-13; 432-437 cm; 77.9 g wet) immediately above sample used for GSC-3374.

Comment (J.J. Veillette): The age is believed to be too young for the deglaciation of the area (cf. Veillette, 1983b). NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3440. Lac Simard (III) 8800 ± 250
$\delta^{13}C = -26.1‰$

Basal gyttja mixed with silt and clay (sample CGC-13; 525-530 cm; 238.6 g) from two cores recovered when the site was revisited on March 23, 1982. The sampling location was estimated to be within 8 m of the core from which Lac Simard (I) and (II) were extracted. Water depth was 3.70 m and two cores, A (4.60-5.44 m) and B (4.68-5.45 m), 20 cm apart were secured to provide sufficient dating material because of the gradual transition between the gyttja and the mineral substrate.

Comment (J.J. Veillette): This age is in close agreement with ages obtained from other sites in the general area (Veillette, 1983b, and this list). The bottom of this basin appears to be highly irregular and thus it is difficult to select suitable sites for oldest minimum ages. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3493. Lac des Cinq Milles 9380 ± 200
$\delta^{13}C = -28.7‰$

Basal gyttja (sample CGC-31; 400-410 cm; 163.9 g dry) from a 4.55 m-long sediment core recovered from an oval-shaped pond (60 x 40 m) in a bedrock basin located 4 km north of Lac des Cinq Milles, Quebec (47°15'17"N, 78°44'40"W), at an elevation of 390 m. Water depth at the sampling site was 4.20 m. Gyttja from pond bottom to 4.00 m; a gradual transition from gyttja to clayey silt from 4.00 to 4.08 m; clayey silt from 4.08 to 4.25 m; till from 4.25 m to refusal at 4.55 m. Collected March 22, 1982 by P. Richard and A. Larouche, both at Université de Montréal, Montréal, and J.J. Veillette.

Comment (J.J. Veillette): The site is both above and beyond the limit (at 350 m) reached by proglacial waters. Along with GSC-3442 (9310 ± 270 BP, this list) and GSC-1585 (9630 ± 300 BP; GSC XIII, 1973, p. 18), this date confirms an earlier deglaciation along the axis of the Harricana Moraine in this sector.

Comment (W. Blake, Jr.): The uncorrected value for GSC-3493, 9440 ± 200 BP, was used in Veillette (1983b). NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3442. Lac Bonvalot 9310 ± 270
$\delta^{13}C = -31.3‰$

Basal gyttja (sample CGC-33; 450-457.5 cm; 189.1 g) from a 4.65 m-long sediment core recovered from an oval-shaped (120 x 90 m) pond in a bedrock basin located 2 km southeast of Lac Bonvalot, Belle Terre area, Quebec (47°27'40"N, 78°46'10"W), at an elevation of 343 m. Water depth was 6.85 m at the sampling site. From 4.40 to 4.45 m a gradual transition from gyttja to organic silty clay was observed, and from 4.45 to 4.65 m organic silty clay was present, with decreasing organic content towards the base. At 4.65 m was solid refusal. Collected March 24, 1982 by J.J. Veillette, P. Richard, and A. Larouche.

Comment (J.J. Veillette): This pond is below the maximum glaciolacustrine level, estimated to be 355 m in the immediate area. The age is a minimum for an area northwest and in the vicinity of the southern extension of the interlobate Harricana Moraine. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3412. Lac Caron 8690 ± 150
$\delta^{13}C = -22.4‰$

Basal grey gyttja (sample CGC-12; 355-360 cm; 92.6 g) from a 3.70 m-long sediment core recovered from a pond (250 x 100 m) in a bedrock basin located 1.5 km west of Lac Caron, Quebec (47°55'33"N, 78°59'30"W), at an elevation of 367 m. Water depth was 2.70 m at the sampling site. At 3.65 m a distinct contact was observed between the gyttja and the underlying silt, and at 3.70 m solid refusal occurred in till. Collected March 19, 1981 by J.J. Veillette and A. Larouche.

Comment (J.J. Veillette): This pond is only 4 km north of the Roulier Moraine, and as its elevation (373 m for the pond surface) is slightly above the maximum glaciolacustrine level (369 m for this area), the date is believed to give a reliable minimum age for the formation of the moraine (Veillette, 1983b). NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 5-day count in the 2 L counter.

GSC-3334. Roulier Moraine 7040 ± 80
$\delta^{13}C = -27.3‰$

Basal gyttja and herbaceous material (sample CGC-22; 275-280 cm; 131.1 g) from a 2.80 m-long core recovered from a circular bog (75 m diameter) in a kettle of the Roulier moraine, 1 km southwest of Lac Lévesque, Quebec (47°51'15"N, 79°01'10"W), at an elevation of 322 m. The water table was 15 cm below the surface. Telmatic peat was penetrated to a depth of 2.65 m and gyttja and herbaceous material to 2.80 m; refusal was in gravel. Collected March 19, 1981 by J.J. Veillette and A. Larouche using a Russian sampler.

Comment (J.J. Veillette): The bog was sounded in five places with a Hiller probe to select the thickest accumulation of organic material. The age is considered too young to date the regional deglaciation. A possible reason for this is that the pond level (322 m) is considerably lower than the maximum glaciolacustrine level (370 m) attained in this area. This, however, probably does not account for the marked difference in age with other sites in the vicinity (cf. GSC-3440, 8800 ± 250 BP; and GSC-3412, 8690 ± 150 BP; Veillette, 1983b, and this list) It is more likely that late melt-out conditions were present at the site. It is located in a large deltaic complex which is connected to the Roulier Moraine. The surface of the deltaic complex contains numerous large kettle depressions and kettle lakes in sand and gravel. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

Ontario

Green Creek Series

A wood-bearing calcareous concretion presumed to have originated in a 3 m riverbank exposure of laminated sediments in the right bank of Ottawa River at Hiawatha Park, 1.6 km northwest of Orleans, Ontario (45°29'N, 75°32'W), at an elevation of 50 m. Collected 1961 by N.R. Gadd.

GSC-2498. Green Creek (I) 9960 ± 820
$\delta^{13}C = -26.3‰$

Wood (sample GB-61-GC-1; 0.6 g; "some characteristics similar to willow (**Salix** sp.)"; unpublished GSC Wood Identification Report No. 77-14 by R.J. Mott) that was completely enclosed in a calcareous concretions.

Comment (N.R. Gadd): This specimen, collected at the classical Green Creek site of Dawson and Logan (cf. Logan, 1863, p. 916-917) is the first known to contain a piece of wood. The broken and worn condition of the fragment clearly indicates that the specimen must predate the sediment surrounding it (i.e., it was not introduced as a rootlet) and is therefore used as an indicator of the maximum age of the sediment enclosing the specimen and of the concretionary cementation of that sediment. The radiocarbon date of the carbonate concretion surrounding the wood (see Green Creek (II), below) is considered anomalous. Despite the large error term (±820), a function of the miniscule size of the sample, the wood date appears to be compatible with those for freshwater shells and wood from similar laminated sediments in nearby abandoned channels of the proto-Ottawa River drainage system; cf. GSC-1968 (10 200 ± 40 BP for (freshwater shells at Bourget; GSC XVI, 1976, p. 6) and BGS-257 (9860 ± 230 BP for wood at Hawkesbury; Gadd, 1980). NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-2530. Green Creek (II) 14 400 ± 250
$\delta^{13}C = -20.1‰$

Calcareous material (sample GB-61-GC-1; 14.1 g) from the concretion containing a wood fragment.

Comment (N.R. Gadd): A cemented sediment surrounding a piece of wood is necessarily younger than the material it surrounds. The age recorded for the total carbonate content of the concretion (14 400 ± 250 BP) is considerably greater than that obtained on the enclosed piece of wood – 9960 ± 820 BP (GSC-2498, this series) – and is therefore considered anomalous. Gadd (1980) suggested that the anomaly may be due in part to the presence in the original sediment of sedimentary carbonate grains of Paleozoic, or even of Precambrian, age, and in part to the carbonate content of groundwater that may have been involved in the cementation of the concretion. Gadd recommended that great caution be taken in the evaluation of radiocarbon dates based on total carbonate content of calcareous concretions.

Comment (W. Blake, Jr.): The concretion was determined to be composed of calcite plus quartz and aragonite by X-ray diffraction. No pretreatment was done. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3641. Twin Elm 11 200 ± 200
$\delta^{13}C = -2.8‰$

Marine pelecypod shells (sample RAB-82-8; 10.2 g; **Portlandia arctica**, identified by S.H. Richard) from a 25 cm-thick bed of highly fossiliferous, pebbly, gritty, silty marine clay found inside the core of a glaciomarine ridge in the lower part of a gently dipping unit of ice-contact outwash gravels. The shell-bearing bed was exposed just above floor level, some 9 to 10 m below the ridge crest, in a gravel and sand borrow pit (Burnside Pit) 2.8 km northeast of Twin Elm and 7.0 km west of Manotick, Carleton County, Ontario (45°14'25"N, 75°46'45"W), at an elevation of approximately 105 m. Collected 1982 by S.H. Richard.

Comment (S.H. Richard): GSC-3641 is the first radiocarbon age determination obtained for shells of the high arctic species **Portlandia arctica** from the western Champlain Sea basin. A large number of single valves and numerous articulated valves were recovered from the lowest of eight thin (<25 cm) silty clay beds found alternating with gently dipping gravel beds in a unit of ice-contact outwash gravels. Laterally, this unit grades into a very coarse and deformed boulder gravel showing some beds upturned into a vertical position. Along the east side of the pit wall, this high energy gravel unit is cut into by thick massive diamict-till or debris-flow sediments. An angular unconformity separates the collapsed gravel beds from steeply dipping, fossiliferous, marine sand and clay beds and small debris units that fill a depression between ridges of coarse gravel and diamict units (D.R. Sharpe, personal communication, 1982).

The radiocarbon-dated marine clay beds originated as fine suspended sediment (rock flour) supplied to the marine environment in relatively deep water (<15 m) by glacial meltwaters issuing from the ice margin. The occurrence of coarse facies over fine sandy and silty clay is the result of fluctuating discharge of water and sediment to a submarine outwash fan lobe. This lithostratigraphy suggests that the sequence of sediments making up the Twin Elm ridge is a glaciomarine unit deposited in an ice-contact outwash delta or fan environment at the margin of an ice lobe grounded in the Champlain Sea (Richard, 1982; D.R. Sharpe, personal communication, 1982).

GSC-3641 provides an age for the time of deposition of the interstratified thin marine clay beds within the ice margin outwash gravel unit early during the construction of the submarine fan on the proximal side of the Twin Elm ridge. The southwestern distal side of the ridge was built somewhat later and shows a sandy deltaic unit consisting of a lower, horizontally bedded bottomset or density current sand, containing several thin interbedded marine algal horizons, overlain by an upper, steeply bedded sand representing the foreset beds of a prograding delta (Fig. 8-13 in Mott, 1968). Three radiocarbon dates – GSC-588 (10 880 ± 160 BP); GSC-570 (10 800 ± 150 BP); GSC-587 (10 620 ± 200 BP) – were obtained for marine shells and algae recovered at various levels from these sands (Mott, 1968, p. 322; GSC IX, 1970, p. 60). Together with GSC-3641, these three ^{14}C dates bracket the time of deposition of the Twin Elm end moraine and ice marginal delta plain between approximately 11 200 and 10 600 BP. Because of the small sample size, only the outer 10 per cent was removed by HCl leach. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Clement Lake Series

Two samples were dated from a 625 cm-long core from Clement Lake, a small lake within Canadian Forces Base, Camp Petawawa, located approximately 10 km northwest of Petawawa, Ontario (45°59'N, 77°21'W), at an elevation of 124 m. Cores were recovered with a Livingstone sampler in June 1974 and 1975 by R.J. Mott, C.C. Kennedy, and others in a water depth of 7.6 m. Black algal gyttja and clayey gyttja to a depth of 571 cm below the mud/water interface overlie 30 cm of grey clay and basal sand.

GSC-2681. Clement Lake, 345-350 cm — 3860 ± 150; $\delta^{13}C = -32.6‰$

Black algal gyttja (sample MS-74-3; 345-350 cm; 77.7 g moist) from a depth of 345 to 350 cm below the mud/water interface. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in 2 L counter.

GSC-2153. Clement Lake, 567-571 cm — 9640 ± 130; $\delta^{13}C = -35.6‰$

Black clayey gyttja (sample MS-74-3; 567-571 cm; 105 g wet) from a depth of 567 to 571 cm below the mud/water interface. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Comment (R.J. Mott): The basal organic sediment (GSC-2153) was dated to provide a minimum age for abandonment of a channel of the ancestral Ottawa River that occurred when the river eroded another channel below an elevation of about 127 m. This would then act as a guide as to the elevation at which late Paleo-Indian sites might be found (Kennedy, 1976). GSC-2681 provides a date on the pollen assemblage at a depth of 345 to 350 cm in the core.

Comment (W. Blake, Jr.): See the comments for GSC-1516 (9830 ± 250 BP; GSC XV, 1975, p. 13), basal gyttja in Perch Lake (elevation approximately 165 m), 6.1 km northeast of Chalk River, Ontario.

Lac Témiscamingue Region Series (continued)

The following four age determinations are a continuation of the seven dates reported for the Lac Témiscamingue Region Series of Quebec (p. 12-13, this list).

GSC-3294. Big Moose Lake (I) — 6490 ± 110; $\delta^{13}C = -31.2‰$

Basal laminated black and brown gyttja (sample CGC-1; 160-165 cm; 76.7 g) from a 1.68 m-long sediment core recovered from an elliptical pond (200 x 100 m) in a bedrock basin located 4 km northeast of Big Moose Lake, Ontario (47°59'40"N, 79°33'00"W), at an elevation of 373 m. Water depth at the sampling site was 9 m. Gyttja extended from the pond bottom to solid refusal at 1.68 m depth. Collected March 19, 1981 by J.J. Veillette and A. Larouche.

Comment (J.J. Veillette): The elevation of the pond (373 m) is slightly above the maximum level (362 m) reached by the glaciolacustrine transgression in the area. The age is too young to date deglaciation. Date GSC-3438 (8820 ± 270 BP, this list), from a similar site in the vicinity, is more realistic in a regional context. Following deglaciation the area surrounding the site was an island. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3438. Big Moose Lake (II) — 8820 ± 270; $\delta^{13}C = -26.5‰$

Basal green gyttja (sample CGC-2; 218-223 cm; 98.0 g) from a 2.30 m-long sediment core recovered from a circular pond (100 m in diameter) in a bedrock basin 4 km northeast of Big Moose Lake, Ontario (47°59'50"N, 79°33'40"W), at an elevation of 348 m. Water depth at the sampling site was 7.40 m. Gyttja extended from the pond bottom to 2.23 m depth and clayey silt from 2.23 to 2.30 m, where solid refusal was encountered. Collected March 19, 1981 by J.J. Veillette and A. Larouche.

Comment (J.J. Veillette): The elevation of the pond surface (358 m) is close to the maximum glaciolacustrine level (362 m) reached in this area. Following deglaciation the area surrounding the site was an island. The date provides a minimum age for deglaciation of the area and suggests that the age of 6490 ± 110 BP (GSC-3294, this list), on basal gyttja from a nearby pond, does not date regional deglaciation. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3247. Goodwin Lake — 9320 ± 160; $\delta^{13}C = -28.8‰$

Basal dry gelatinous gyttja (sample CGC-3; 687-692 cm; 86.6 g wet, 27.8 g dry) from a 7.50 m-long sediment core recovered from a circular pond (100 m in diameter) in a bedrock basin 1 km east of Goodwin Lake, Ontario (47°19'50"N, 79°35'00"), at an elevation of 358 m. Water depth was 2 m at the sampling site. Gyttja extended from the pond bottom to 6.87 m, and a gradual transition to fine sand and silt occurred from 6.87 to 6.97 m. From 6.97 to 7.50 m gradual refusal in silty sand. Collected March 19, 1981 by J.J. Veillette, P. Richard, and A. Larouche.

Comment (J.J. Veillette): Pond level at an elevation of 358 m is well above the maximum level (300 m) reached by the glaciolacustrine transgression in this area. Following deglaciation the area surrounding the site was an island in proglacial Lake Barlow (Veillette, 1983b). NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3315. Kitt Lake — 8430 ± 90; $\delta^{13}C = -30.4‰$

Basal dark brown gyttja (sample CGC-6A; 485-490 cm; 94.2 g) from a 4.90 m-long sediment core recovered from an elliptical pond (200 x 125 m) in a bedrock basin 1 km south of Kitt Lake, Ontario (47°20'16"N, 79°55'22"W), at an elevation of 322 m. Water depth was 1.40 m at the sampling site. Gyttja extended from the pond bottom to 4.70 m; below this level sand and gravel-sized fragments mixed with gyttja were encountered to solid refusal at 4.90 m. Collected March 18, 1981 by J.J. Veillette, P. Richard, and A. Larouche.

Comment (J.J. Veillette): The pond outline and the topography of the surrounding area suggested an uneven basin bottom. Soundings at different locations on the pond with a Hiller probe were done to select the site with the thickest organic sediments. The maximum glaciolacustrine level in the area is not known accurately but is believed to be in the vicinity of 300 to 310 m, slightly below the level of the pond surface (322 m).

Comment (W. Blake, Jr.): As a result of a mistake in 'rounding off' in the laboratory, this age determination was incorrectly reported as 8430 ± 95 BP, and it was published in this form by Veillette (1983 b). NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

Western Canada

Alberta

Mary Gregg Lake series

Two cores were obtained with a Livingstone piston corer from Mary Gregg Lake (0.08 km^2), Alberta (53°07'N, 117°28'W), at an elevation of 1540 m. The first core (MGL), taken under 10.8 m of water, consisted of eight segments of organic mud, 5.1 cm in diameter and 700 cm in total length, which overlay barren gravel (probably slumped morainal material). The second core (2MGL), taken under only 40 cm of water, consisted of five segments of fibrous organic mud, 5.1 cm in diameter and 429 cm in total length. Both cores were submitted to a multivariable analysis (stratigraphy, sedimentology, geochemistry, and micropaleontology), aiming at the reconstruction of the Holocene paleoecological evolution of the lake and its surrounding area in the Foothills of the Rocky Mountains (Bombin, 1982). Cored by C.E. Schweger, M. Hickman, E. Bombin and others in 1979; sampled and submitted by E. Bombin in 1979-1981; all of the University of Alberta, Edmonton.

GSC-3278. Mary Gregg Lake, 1: 0-10 cm — 2870 ± 110, $\delta^{13}C = -28.4‰$

Organic mud (sample MGL 0-10; 75 g wet, 14.0 g dry) from the top 10 cm of core 1. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3056. Mary Gregg Lake, 1: 40-50 cm — 2460 ± 150, $\delta^{13}C = -29.5‰$

Organic mud (sample MGL 40-45; 13.3 g dry) from 40 to 50 cm below the top of core 1. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3091. Mary Gregg Lake, 1: 150-155 cm — 4590 ± 120, $\delta^{13}C = -28.3‰$

Organic mud (sample MGL 150-155; 31.5 g dry) from 150 to 155 cm below the top of core 1. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-2941. Mary Gregg Lake, 1: 200-205 cm — 5300 ± 130, $\delta^{13}C = -30.3‰$

Organic mud (sample MGL 200-205; 95 g wet, 29.2 g dry) from 200 to 205 cm below the top of core 1. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-2894. Mary Gregg Lake, 1: 400-405 cm — 6110 ± 120, $\delta^{13}C = -28.9‰$

Organic mud (sample MGL 400-405; 97 g wet, 32.8 g dry) from 400 to 405 cm below the top of core 1. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-2901. Mary Gregg Lake, 1: 552-557.5 cm — 7220 ± 100, $\delta^{13}C = -28.7‰$

Organic mud (sample MGL 552-557.5; 116.1 g wet, 50.0 g dry) from 552 to 557.5 cm below the top of core 1. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 2 L counter.

GSC-3079. Mary Gregg Lake, 1: 625-630 cm — 8120 ± 100, $\delta^{13}C = -30.3‰$

Organic mud (sample MGL 625-630; 37.0 g dry) from 625 to 630 cm below the top of core 1. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 5 L counter.

GSC-2892. Mary Gregg Lake, 1: 664-669 cm — 7100 ± 70, $\delta^{13}C = -29.4‰$

Organic mud (sample MGL 664-669; 98 g wet, 37.2 g dry) from 664 to 669 cm below the top of core 1. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 5 L counter.

GSC-3061. Mary Gregg Lake, 1: 677-683 cm — 7480 ± 90, $\delta^{13}C = -28.8‰$

Organic mud (sample MGL 677-683; 35.8 g dry) from 677 to 683 cm below the top of core 1. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 5 L counter.

GSC-2935. Mary Gregg Lake, 1: 690-697 cm — 10 300 ± 220, $\delta^{13}C = -28.7‰$

Organic mud (sample MGL 690-697; 123 g wet, 78.9 g dry) from 690 to 697 cm below the top of core 1. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3276. Mary Gregg Lake, 2: 0-10 cm — 5290 ± 60, $\delta^{13}C = -25.3‰$

Fibrous organic mud (sample 2MGL 0-10; 80 g wet, 43.8 g dry) from the top 10 cm of core 2 NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 5 L counter.

GSC-3090. Mary Gregg Lake, 2: 71-76.5 cm — 5200 ± 90, $\delta^{13}C = -24.9‰$

Fibrous organic mud (sample 2MGL 71-76.5; 25.9 g dry) from 71 to 76.5 cm below the top of core 2. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 2 L counter.

GSC-3001. Mary Gregg Lake, 2: 159.5-164.5 cm — 8400 ± 100, $\delta^{13}C = -24.8‰$

Fibrous organic mud (sample 2 MGL 159.5-164.5; 105 g wet, 45.5 g dry) from 159.5 to 164.5 cm below the top of core 2. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 5 L counter.

GSC-3073. Mary Gregg Lake, 2: 270-275 cm — 9460 ± 90, $\delta^{13}C = -25.3‰$

Fibrous organic mud (sample 2 MGL 270-275; 50.9 g dry) from 270 to 275 cm below the top of core 2. NaOH leach was omitted from sample pretreatment. Date is based on one 2-day count in the 5 L counter.

GSC-3029. Mary Gregg Lake, 2: 338-342.5 cm — 9690 ± 130, $\delta^{13}C = -27.4‰$

Fibrous organic mud (sample 2 MGL 338-342.5; 113 g wet, 44.5 g dry) from 338 to 342.5 cm below the top of core 2. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 5 L counter.

GSC-2997. Mary Gregg Lake, 2: 425-429 cm — 11 000 ± 120, $\delta^{13}C = -25.5‰$

Fibrous organic mud (sample 2 MGL 425-429; 84 g wet, 34.1 g dry) from 425 to 429 cm below the top of core 2. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 5 L counter.

GSC-3400. Mary Gregg Lake, macrophytes — 720 ± 50; $\delta^{13}C = -18.2‰$

Mixed sample (MGL-M; 75.5 g dry) of living aquatic macrophytes (**Myriophyllum, Potamogeton, Chara, Callitriche,** and filamentous algae) collected September 1983 by M. Bombin under 50 cm of water. The sample was dated to evaluate the magnitude of the hard water effect in this lake. Date is based on two 1-day counts in 5 L counter. This sample reacted strongly with HCl.

Comment (E. Bombin): It is considered that the dates are too old, in average by approximately 2900 years in core 1, and 5100 years in core 2, in part because of contamination by coal from the Luscar Formation and in part as a result of the hard water effect (for a full discussion of the problem see Bombin, 1982). The sediment dated for GSC-2892 and GSC-3061 is apparently younger than the sediment above them (GSC-3079) because they have proportionally less contamination by coal. The biostratigraphy, geochemistry, and tephras confirm the correlation of the two cores. If the dates are corrected for contamination, they suggest that the available record spans the last 6000 years. During this period the watershed has been covered dominantly by boreal forest, although more open vegetation and mesic conditions are indicated before ca. 3500 BP. Diatoms, geochemistry, and other variables suggest that: between 6000 ± 200 and 3500 ± 200 BP the lake was relatively more eutrophic and supported high productivity; between 3500 ± 200 and 1000 ± 200 BP, the conditions were more oligotrophic, and the productivity was at a minimum; and after 1000 ± 200 BP, the aquatic system returned to its predominantly mesotrophic state of today. The details of these changes and their causes are described in Bombin (1982).

British Columbia

GSC-3601. Penticton — 8990 ± 80; $\delta^{13}C = -30.1‰$

A single piece of wood (sample FI-168; 12.2 g; angiosperm wood, but too poorly preserved to identify; unpublished GSC Wood Identification Report No. 83-13 by R.J. Mott) from 51 m below the ground surface in a cable tool drillhole near Okanagan River at Warren Avenue, Penticton, British Columbia (49°28'05"N, 119°35'20"W), at an elevation of 289 m. The drill penetrated to a depth of 96 m. The succession encountered from the top downward was as follows: 0 to 5 m, sand; 5 to 19 m, sandy and silty gravel; 19 to 42 m, gravelly sand and sand; 42 to 51 m, silt and pebbly silt; 51-83.5 m, coarse bouldery gravel; 83.5 to 96 m, gravelly grey sand. The top 5 units, were considered to be fan deposits; unit 6, below 83.5 m, was interpreted as part of the main Okanagan Valley fill (glaciolacustrine). The wood is from a horizon, at a depth of 51 to 53 m, that was present in two adjacent flowing artesian water wells drilled on the lower end of the combined fan of Ellis Creek and Penticton Creek. Collected December 1982 by E. Livingston, Pacific Hydrology Consultants Ltd., Vancouver, British Columbia; submitted by E.C. Halstead, Inland Waters Directorate, Vancouver, and R.J. Fulton.

Comment (E. Livingston): The fan deposits consist of an upper sandy silty section over a cleaner gravel part with the change at a depth of 55 m; the sample comes from near the base of the upper part, and it provides an indication of the rate (0.57 m/century) of filling of Okanagan valley in the Penticton area. Date is based on one 3-day count in the 5 L counter.

Otter Creek Series

Peat samples from Otter Creek bog, 40 km south-southeast of Merritt, British Columbia (49°53'00"N, 120°37'30"W), at an elevation of 975 m. Collected June 1972 by J.A. Westgate, then University of Alberta, Edmonton, now Scarborough College, University of Toronto, Scarborough, Ontario.

GSC-1950. Otter Creek bog (I) — 1860 ± 70

Peat and mucky peat (sample UA-558; 6.5 g dry) from 23 to 25.5 cm depth, immediately above a 2 mm-thick tephra, the uppermost of three tephra layers exposed in the bog.

GSC-1939. Otter Creek bog (II) — 2070 ± 80

Peat and mucky peat (sample UA-523-528; 4.9 g dry) from 25.5 to 27.0 cm depth, immediately below the first tephra layer and immediately above the second tephra layer (also only 2 mm thick) at 27 cm depth.

GSC-1946. Otter Creek bog (III) — 3220 ± 70

Peat and mucky peat (sample U-560; 10.5 g dry) from 45.0 to 47.5 cm depth, immediately above the third, 3.5 cm-thick, tephra layer at 47.5 to 51.0 cm depth.

Comment (J.A. Westgate): GSC-1950 provides a minimum age for the underlying Bridge River tephra and is stratigraphically compatible with GSC-1939. This latter date provides a maximum age for the overlying Bridge River tephra (Westgate, 1977). Because the major eruptive unit of Bridge River tephra is approximately 2350 years old (Mathewes and Westgate, 1980), it is likely that the Otter Creek occurrence is related to a slightly younger eruption of the same magma. In addition, GSC-1939 provides a minimum age for the underlying Mount St. Helens set P tephra (Mathewes and Westgate, 1980). This is the most distant occurrence of set P tephra known to date. GSC-1946 provides a minimum age for the underlying Mount St. Helens set Y_n tephra. It is compatible with GSC-298 (3390 ± 130 BP; GSC V, 1966, p. 110) which immediately underlies the same tephra layer and which was collected from the same bog with a Hiller peat borer in 1964 (Fulton and Armstrong, 1965).

Comment (W. Blake, Jr.): Although modern rootlets were present in the mucky peat, they were removed with tweezers by the submitter prior to ^{14}C analysis (Westgate, 1977). All three samples had been pretreated in 18 per cent HCl for approximately 1 day before submission to the laboratory, but each received the standard HCl treatment (approximately 6 per cent) at the GSC. Because of small sample size, the NaOH leach was omitted from the pretreatment of GSC-1939 and -1950; GSC-1946 received a cold NaOH leach for 5 minutes. GSC-1939 and -1950 were mixed with dead gas for counting. GSC-1939 is based on two 1-day counts in the 2 L counter; GSC-1546 is based on two 1-day counts in the 5 L counter; and GSC-1950 is based on one 2-day count in the 2 L counter.

Fraser Delta Series

Peat and shell fragments from cores taken from the Fraser Delta, southwestern British Columbia. The Fraser Delta, covering an area of about 570 km^2 above low tide level, has been built into Strait of Georgia by Fraser River during the last 10 000 years (Clague and Luternauer, 1982, 1983; Clague et al., 1983). The apex of the delta is located near New Westminster, and the front borders Strait of Georgia on the west and Boundary Bay and Mud Bay on the south. The dated peats of this series are basal bog samples which provide information on the timing of delta growth and on Holocene sea-level positions. The shell fragments (GSC-3084) were collected from sediments deposited in a shallow sublittoral environment, and they likewise help to date former shoreline positions.

GSC-3078. Fraser Delta (I) 3730 ± 90
$\delta^{13}C = -28.3‰$

Sedge peat (sample CIA-80-5-2; 42.2 g dry) 1.00 to 1.07 m beneath the surface of the tidal flat bordering Mud Bay at the end of 112th Street, 14 km south of New Westminster, British Columbia (49°05.0'N, 122°54.8'W). The tidal flat surface at the sample site is at mean sea level. The sample was collected at the base of a 50 cm-thick peat bed overlain by about 50 cm of organic-rich silt and underlain by 2.5 m of organic silt. Sand was recovered at the base of the 3.5 m-long core. Diatoms within the dated peat bed are dominantly freshwater taxa, although some brackish and marine forms are also present (unpublished GSC Diatom Report No. 80-9 by S. Lichti-Federovich). Collected March 1980 by R.J. Hebda, British Columbia Provincial Museum, Victoria, and J.L. Luternauer.

GSC-3045. Fraser Delta (II) 4650 ± 80

Sedge peat (sample CIA-80-2; 44.3 g dry) 3.0 to 3.1 m beneath the surface of a bog at Wiggins Road, 6 km west of New Westminster, British Columbia (49°11.9'N, 122°59.0'W); sample elevation is approximately mean sea level. The peat is underlain at 3.1 m depth by organic-rich silt which was cored to a depth of 12 m below the bog surface. The dated peat sample contains a freshwater diatom assemblage (unpublished GSC Diatom Report No. 80-10 by S. Lichti-Federovich). Collected February 1980 by J.J. Clague, J.L. Luternauer, and R.J. Hebda.

GSC-3066. Fraser Delta (III) 5510 ± 80
$\delta^{13}C = -26.4‰$

Sedges (sample CIA-80-4; 139.0 g dry) 2.60 to 2.75 m beneath the surface of a bog at Gilley Road, 6 km southwest of New Westminster, British Columbia (49°10.6'N, 122°58.6'W); sample elevation is approximately mean sea level. The sample was collected from the transition zone between peat and the underlying organic-rich silt. The latter is continuous to a depth of 7.5 m below the ground surface where it overlies sand. The dated sample contains a freshwater diatom assemblage (unpublished GSC Diatom Report No. 80-8 by S. Lichti-Federovich). Collected February 1980 by J.J. Clague, J.L. Luternauer, and R.J. Hebda.

GSC-3084. Fraser Delta (IV) 4100 ± 60
$\delta^{13}C = -0.2‰$

Fragments of marine molluscs including **Mytilus** sp. (sample CIA-80-11; 47.9 g), 6 to 7 m beneath the surface of the Fraser Delta near the end of 64th Street, 5 km south-southeast of Ladner and approximately 700 m north of the shore of Boundary Bay, British Columbia (49°03.2'N, 123°02.7'W); the elevation of the delta surface at this site is less than 1 m above mean sea level. The shells occur in muddy sand containing scattered granules. This sand grades upward into sandy silt which directly underlies the delta surface. Shells are present only below -4 m elevation and increase in abundance from -4 to -8 m, where drilling was discontinued. The shells probably became fragmented during drilling and recovery of the core. The dated sediments contain a marine diatom assemblage (unpublished GSC Diatom Report No. 80-13 by S. Lichti-Federovich). Collected May 1980 by J.J. Clague, J.L. Luternauer, and M.C. Roberts (Simon Fraser University, Burnaby).

Comment (J.J. Clague): The bogs which yielded GSC-3045 and GSC-3066 are part of an extensive organic mantle overlying intertidal and floodplain sediments on the eastern Fraser Delta. Peat deposition in this area began when the delta top was built up above sea level and became colonized by brackish and freshwater plants. This occurred in response to seaward progradation of the delta front and to stabilization of sea level near its present position approximately 5000 to 5500 radiocarbon years ago. In conjunction with other radiocarbon dates from bogs in this area (e.g., I-9595, 5085 ± 100 BP; Hebda, 1977), GSC-3045 and GSC-3066 indicate that significant growth of the Fraser Delta occurred before 5000 BP. Sea level probably has not fluctuated more than 1 to 2 m from its present position between the time that the peats began to accumulate and the present (Hebda, 1977; Clague et al., 1982, 1983).

GSC-3084 provides chronological control on shallow delta-slope (?) deposits near the southwest corner of the Fraser Delta. It also indicates that sea level was higher than -7 m elevation 4100 radiocarbon years ago.

GSC-3078 indicates that the southernmost part of the delta bordering Mud Bay was constructed before 3730 ± 90 BP. Palynological analysis of the peat at the site suggests a possible relative sea level rise of as much as 1 m some time after this date (Shepperd, 1981). GSC-3078 is comparable to other radiocarbon dates from what is probably the same peat bed at other sites in the Mud Bay-Boundary Bay area (e.g., GX-0781, 4350 ± 110 BP; Kellerhals and Murray, 1969; GSC-3181, 3910 ± 60 BP; GSC-3202, 3130 ± 50 BP, both in Shepperd, 1981).

Comment (W. Blake, Jr.): The three peat samples were dried in an electric oven. NaOH leach was omitted from the pretreatment of GSC-3066. GSC-3066 and -3078 were mixed with dead gas for counting. GSC-3045, -3078, and -3084 are each based on two 1-day counts in the 5 L counter; GSC-3066 is based on one 3-day count in the 5 L counter.

GSC-3075. Nicomekl-Serpentine Valley 5120 ± 70
$\delta^{13}C = -27.4‰$

Sedge peat (sample CIA-80-7-1; 41.7 g dry), 1.75 to 1.85 m beneath the surface of a bog on the Nicomekl-Serpentine flat at Colebrook Road, 14 km south-southeast of New Westminster, British Columbia (49°05.8'N, 122°49.8'W); sample elevation is approximately mean sea level. The peat is underlain at 1.85 m depth by shell-bearing marine silt which was cored to a depth of 10.5 m below the ground surface. The dated peat sample contains a mixture of fresh, brackish, and marine diatoms (unpublished GSC Diatom Report No. 80-11 by S. Lichti-Federovich). Collected March 1980 by J.J. Clague, J.L. Luternauer, and R.J. Hebda.

Comment (J.J. Clague): The surface peats of the Nicomekl-Serpentine valley are continuous with peats on the nearby eastern Fraser Delta. GSC-3075 indicates that the Serpentine-Nicomekl peats began to accumulate about the same time as the Fraser Delta peats (see GSC-3045 and GSC-3066, this list; also Hebda, 1977; Clague and Luternauer, 1982, 1983; Clague et al., 1983). The initiation of peat growth probably occurred in response to stabilization of sea level within 1 to 2 m of its present position about 5000 to 5500 radiocarbon years ago. Before this, Nicomekl-Serpentine valley most likely was a shallow arm of the sea. On oven drying, the sample weight decreased from 160.0 to 41.7 g. Date based on two 1-day counts in the 5 L counter.

GSC-3145. Pitt Meadows 2730 ± 70
$\delta^{13}C = -28.8‰$

Sedge peat (sample CIA-80-8; 16.7 g dry) 1.67 to 1.75 m beneath the present surface of a bog near the confluence of the Pitt and Fraser rivers, 3 km west of

Pitt Meadows, British Columbia (49°13.3'N, 122°43.7'W), at an elevation of about 1 m above mean sea level. The sample was collected with a piston coring device in a peat-cutting area (prior to sampling, the uppermost 1 m of peat had been removed). The peat is underlain at 1.75 m depth by silty sand and sandy silt; these sediments were cored to a depth of 7.5 m below the present bog surface. The dated peat sample contains a freshwater diatom assemblage (unpublished GSC Diatom Report No. 80-12 by S. Lichti-Federovich). Collected March 1980 by J.J. Clague, J.L. Luternauer, and R.J. Hebda.

Comment (J.J. Clague): Peat began to accumulate at this site about 2730 radiocarbon years ago. Since then, the bog has continued to build up under a relatively stable sea level regime. On oven drying the sample weight decreased from 109.5 to 16.7 g. Date is based on two 1-day counts in the 5 L counter.

GSC-3099. Pitt Meadows Airport 7710 ± 80
$\delta^{13}C = -27.8‰$

Peat (sample CIA-80-10; 9.3 g dry) 11.54 to 11.58 m below the surface of the Fraser River floodplain at the northwest corner of Pitt Meadows Airport, 2 km west of Pitt Meadows, British Columbia (49°13.3'N, 122°42.9'W); the elevation of the dated sample is -9.5 m (mean sea level datum). The peat, which is 4 cm thick, is overlain by interbedded clay, silt, and sand, and is underlain by clayey and sandy silt. A 2 cm-thick layer of Mazama tephra (ca. 6700 BP) is present 4.7 m above the peat. Collected May 1980 J.J. Clague, J.L. Luternauer, and M.C. Roberts.

Comment (J.J. Clague): The buried peat is terrestrial in origin (unpublished GSC Diatom Report No. 80-14 by S. Lichti-Federovich) and defines an alluvial surface graded to a sea level position at least 12 m lower than the present (Clague and Luternauer, 1982, 1983; Clague et al., 1982, 1983). This surface was similar in form to the present Fraser River floodplain. Buried organic deposits associated with the surface have been found at several sites in the Fraser Lowland and have yielded radiocarbon ages similar to GSC-3099 (S-99, 7300 ± 120 BP, Saskatchewan III, 1962; GSC-2, 7600 ± 150 BP, GSC I, 1962, p. 15; GSC-229, 8290 ± 140 BP, and GSC-225, 8360 ± 170 BP, both in GSC IV, 1965, p. 35). The mineral sediments above the peat contain brackish and freshwater diatoms (unpublished GSC Diatom Reports 81-7 and 81-8 by S. Lichti-Federovich) and probably were deposited in an estuarine environment in response to a rise in the level of the sea relative to the land. Silt directly underlying the peat contains a mixture of freshwater and marine diatoms (unpublished GSC Diatom Report No. 81-9 by S. Lichti-Federovich). On oven drying the sample decreased in weight from 17.1 to 9.3 g. Sample mixed with dead gas for counting. Date based on one 3-day count in the 5 L counter.

Slesse Creek Series

Wood collected from an erosional bluff bordering Slesse Creek, 1.5 km southeast of its confluence with Chilliwack River and 22 km east-southeast of Chilliwack, British Columbia (49°04.5'N, 121°41.4'W). The bluff, which is about 55 m high, exposes a thick succession of glaciofluvial and deltaic sand and gravel, overlying glaciolacustrine clayey silt and silty clay. The sediments underlie the leading edge of a well defined relict valley train that extends 20 km east to Chilliwack Lake, rising from about 300 to 600 m elevation over this distance.

GSC-3306. Slesse Creek (I) 11 900 ± 120
$\delta^{13}C = -26.4‰$

A single piece of wood (sample CIA-79-10011-2; 11.9 g; **Pinus** sp. cf. **P. contorta;** unpublished GSC Wood Identification Report No. 81-26 by L.D. Farley-Gill) from glaciolacustrine silty clay with scattered stones, at an elevation of about 259 m, 9 m above the base of the section. Collected July 1981 by J.J. Clague.

GSC-2966. Slesse Creek (II) 11 700 ± 100
$\delta^{13}C = -26.7‰$

A single piece of wood (sample CIA-79-10011(A); 11.2 g; **Abies** sp.; unpublished GSC Wood Identification Report No. 79-61 by L.D. Farley-Gill) from a thin stony silt bed within the glaciofluvial-deltaic sand and gravel sequence, at an elevation of about 287 m, 37 m above the base of the section. Collected October 1979 by J.J. Clague.

GSC-3308. Slesse Creek (III) 11 400 ± 140
$\delta^{13}C = -27.2‰$

The outermost 30 annual rings of a stump (sample CIA-79-10011-3; **Pinus** sp. cf. **P. contorta;** unpublished GSC Wood Identification Report No. 81-27 by L.D. Farley-Gill), at an elevation of about 300 m, 50 m above the base of the section and 5 m below the top. The stump was rooted in fetid mud and sand and was buried by glaciofluvial gravel and sand. Collected July 1981 by J.J. Clague.

Comment (J.J. Clague): The three dates of the Slesse Creek series provide valuable information on the timing of deglaciation in Chilliwack valley and the adjacent Fraser Lowland (Clague and Luternauer, 1982, 1983). The valley train between Chilliwack Lake and Slesse Creek formed at the close of the Pleistocene when deltaic and glaciofluvial sediments prograded westward from the snout of a glacier filling upper Chilliwack valley. At that time, the lower part of the valley was occupied by a lake dammed to the west by a piedmont glacier filling the eastern Fraser Lowland. The fine glaciolacustrine sediments at the base of the Slesse Creek section accumulated in this lake. Thus, at the time that the sediments exposed in the Slesse Creek bluff were laid down, lower Chilliwack valley was ice free whereas the upper reaches of the valley and parts of the Fraser Lowland still supported glaciers. GSC-3308 indicates that these glaciers persisted until after 11 400 ± 140 BP. When the uppermost glaciofluvial sediments at Slesse Creek were being deposited about 11 400 radiocarbon years ago, the Chilliwack valley glacier terminated at the west end of Chilliwack Lake. GSC-2966 is based on one 3-day count in the 5 L counter; GSC-3306 and -3308 are each based on two 1-day counts in the 5 L counter.

GSC-3305. Coquitlam Valley 21 300 ± 250

A single piece of wood (sample CIA-81-106; 11.6 g; **Abies** sp.; unpublished GSC Wood Identification Report No. 81-25 by L.D. Farley-Gill) from a bed of fine sand exposed in a gravel pit (Allard pit) in Coquitlam valley, 7 km north of Port Coquitlam, British Columbia (49°19.7'N, 122°46.4'W), at an elevation of approximately 126 m. The sand bed containing the dated wood is part of a sequence of horizontally stratified, glaciolacustrine silt and sand that is some 43 m thick at this site. The dated sample was collected 11 m above the base of this unit. The glaciolacustrine silt and sand are overlain across a gradational contact by diamicton and are sharply underlain by gravel. The latter was exposed down to an elevation of 89 m at the time the sample was collected, but has been encountered to lower elevations in drillholes in the vicinity of the Allard pit. The uppermost 5 m of the gravel is bouldery and much coarser than the remainder of the unit. Collected July 1981 by J.J. Clague.

Comment (J.J. Clague): The glaciolacustrine sediments containing the dated sample accumulated in a lake that was dammed at the mouth of Coquitlam valley by glacier ice during the early part of the Fraser Glaciation (Clague and Luternauer, 1982, 1983). Meltwater pouring off this ice deposited a thick wedge of ice-contact and proglacial sediments that fine northward up Coquitlam valley. GSC-3305 indicates that glaciers covered most or all of what is now the Strait of Georgia and the western Fraser Lowland south of Coquitlam valley at 21 300 ± 250 BP. GSC-3305 is in agreement with other dates from correlative deposits in the lower part of the valley south of the Allard pit (GSC-2203, 21 600 ± 200 BP, GSC XVII, 1977, p. 15; GSC-2535, 21 500 ± 240 BP; GSC-2335, 21 700 ± 240 BP; and GSC-2416, 21 700 ± 130 BP, all three in GSC XVIII, 1978, p. 8).

The diamicton exposed at the top of the Allard pit was deposited when a glacier advanced across the lake in which the glaciolacustrine silt and sand were accumulating. The diamicton is weakly stratified, especially in the zone of transition with underlying silt and sand, and may have been deposited in a subaqueous environment beneath a non-grounded glacier.

The gravel beneath the dated glaciolacustrine sediments is of glaciofluvial origin. Most or all of this unit was deposited by a meltwater stream flowing south down Coquitlam valley during the penultimate (pre-Fraser) glaciation; the uppermost bouldery gravel, however, possibly is younger. Correlative gravel at a site farther south in Coquitlam valley is older than 49 000 BP (GSC-2094-2, GSC XVII, 1977, p. 14-15).

Comment (W. Blake, Jr.): The piece of wood was 78+ cm long, 2.5 cm in diameter, and much of it still had the bark attached. Date is based on one 4-day count in the 5 L counter.

GSC-3437. Vancouver International Airport — 4150 ± 110

Wood fragments (Richmond sample 5; 4.0 g; strongly compressed and somewhat lignified – too poorly preserved to identify; unpublished GSC Wood Identification Report No. 82-10 by R.J. Mott), from 10.9 m below the surface in a borehole approximately 400 m south of North Arm of Fraser River and 2.2 km at N20°E from the Vancouver International Airport control tower, British Columbia (49°12'39"N, 123°10'12"W), at an elevation of -9.4 m geodetic. The sample was from a 15 m-thick succession of sand and minor silt. Collected May 1981 by P. Robertson, University of British Columbia, Vancouver; submitted by W.H. Mathews of the same institution.

Comment (W.H. Mathews): The sand and silt unit from which the dated sample was recovered is interpreted as channel fill in a northern distributary estuary of Fraser River. The date indicates growth of the Fraser Delta to this point by approximately 4040 to 4260 years ago. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Bridge Glacier Series

Logs on the ground surface approximately 6 km southeast of the shrinking snout of Bridge Glacier, British Columbia (50°48.3'N, 123°25.4'W), at an elevation of 1935 m. Collected 1978 by G. Rayner, Amax Northwest Mining Co., Vancouver; submitted by W.H. Mathews, University of British Columbia, Vancouver.

GSC-3173. Bridge Glacier (I) — 9070 ± 130
$\delta^{13}C = -25.6‰$

Log (sample G.R.-1978-2; 10.7g; **Pinus albicaulis,** identified by S. Rowe, Forintek, Vancouver).

GSC-3219 Bridge Glacier (II) — 5500 ± 70
$\delta^{13}C = -22.6‰$

Log (sample G.R.-1978-1; 11.9 g; **Abies lasiocarpa,** identified by S. Rowe, Forintek, Vancouver.

Comment (W.H. Mathews): GSC-3173 (9070 ± 130 BP) records a time of higher timberline (milder climate?) than at present, and the same is true of GSC-3219 (5500 ± 70 BP). The 4500 year-age difference between the two samples raises the question of preservation. Was the pine log (GSC-3173) exposed for this full period, or was there an ice advance protecting it, before the fir (GSC-3219) grew and, in turn, was overwhelmed by a later advance of this mountain glacier?

Comment (W. Blake, Jr.): GSC-3173 is the oldest date yet obtained on wood above (at least 75 m) present timberline; cf. GSC-1993 (7640 ± 80 BP; GSC XV, 1975, p. 20) from near Sphinx Glacier some 20 km to the south; other dates obtained earlier are referred to in the same date list. The portion of a log used for GSC-3173 had a maximum diameter of 7.5 cm; the outer 1 cm, comprising 10 to 15 annual rings, was used for dating. Part of the log used for GSC-3219 had a green stain, but this was avoided; not more than 50 annual rings were represented in the outer part used for dating (the outermost weathered wood was cut away). Each date is based on two 1-day counts in the 5 L counter.

Meager Creek Series

Meager volcanic complex, of Pliocene to Holocene age, lies northwest of the confluence of Meager Creek and Lillooet River valleys in southwestern British Columbia (Read, 1977, 1978). Adjacent to the complex, Holocene debris flows underlie both valley floors and locally veneer the lower parts of valley walls. The following four radiocarbon dates come from logs buried in volumetrically significant debris flows. The ages date only some of the major Holocene debris flows, and place age constraints on other undated flows. In Meager and Lillooet valleys, numerous minor and at least one major debris flow remain undated.

GSC-3498. Lillooet River — 900 ± 60
$\delta^{13}C = -25.0‰$

Wood (sample MM80-1-C14; 11.1 g; **Pinus contorta** (lodgepole pine), unpublished GSC Wood Identification Report No. 82-28 by R.J. Mott) from a 60 cm-diameter log projecting 2 m from a fresh roadcut, 1.1 km at 315° from the confluence of Salal Creek and Lillooet River (50°41'12"N, 123°30'00"W), at an elevation of approximately 695 m. The roadcut exposes 2 m of stream-deposited Bridge River air-fall tephra, unconformably overlain by 3 m of interbedded gravel and coarse sand which underlies a log-bearing debris flow up to 2 m thick. The dated log lies at the base of a debris flow composed of maroon and light grey rhyodacite clasts. Collected 1980 by P.B. Read, Geotex Consultants Limited, Vancouver.

GSC-3502. Meager Creek (I) — 4100 ± 70
$\delta^{13}C = -23.1‰$

Wood (sample R82-1-C14; 11.3 g; **Picea** sp. (spruce), unpublished GSC Wood Identification Report No. 82-27 by R.J. Mott) from a 50 cm-diameter log projecting 1 m from a cutbank on the right bank, approximately 30 m above Meager Creek, and 5.1 km upstream from the confluence of Meager and Capricorn creeks (50°34'07"N, 123°28'20"W), at an elevation of approximately 655 m. At this locality, a partly vegetated creek bank extends from 625 to 678 m with local exposures. An 8 m-high cutbank between 648 and 656 m exposes the dated log (at 655 m), which lies about 1 m under a surface supporting undisturbed grass and small evergreen trees less than 20 years old. The log lies within 6 m of the top of a debris flow characterized by plutonic clasts and altered acid volcanic fragments from The Devastator assemblage. At 661 m is the base of an overlying, undated debris flow which extends to 678 m and is typified by porphyritic andesite clasts of the Pylon assemblage. Collected 1982 by P.B. Read.

GSC-3506. Meager Creek (II) 40 ± 60

Wood (sample R82-2-C14; 11.0 g; **Thuja plicata** (western red cedar), unpublished GSC Wood Identification Report No. 82-26 by R.J. Mott) from a 70 cm-diameter log projecting about 3 m from a fresh cutbank on the right bank of a stream informally known as "Boundary" creek which drains the southwest side of The Devastator, 1.6 km at 030° from the junction of Meager and Devastation creeks (50°34'28"N, 123°33'15"W), at an elevation of approximately 1020 m. A 14 m-high cutbank exposes the upper part of a debris flow characterized by porphyritic dacite clasts with the sampled log 6 m from the base. Deciduous trees growing on the undisturbed surface above the cutbank are at least 60 years old. Collected 1982 by P.B. Read.

GSC-3509. Meager Creek (III) 370 ± 50
$\delta^{13}C = -24.2‰$

Wood (sample R82-3-C14; 11.4 g; **Tsuga** sp. (hemlock), unpublished GSC Wood Identification Report No. 82-29 by R.J. Mott) from a 30 cm-diameter log projecting about 1 m from a fresh cutbank on the right bank of a stream informally known as "Nogood" creek which drains the south side of The Devastator, 2.2 km east of the confluence of Devastation and Meager creeks (50°33'53"N, 123°31'52"W), at an elevation of approximately 840 m. The log lies in the middle of a 12 m-high cutbank exposing the upper part of a single debris flow. Collected 1982 by P.B. Read.

Comment (P.B. Read): Lillooet River valley adjacent to the Meager volcanic complex contains the products of the Bridge River tephra and a later major debris flow. Within Lillooet valley, radiocarbon ages of 2480 ± 60 BP (GSC-2587; GSC XVIII, 1978, p. 10) and 2500 ± 50 BP, corrected to 2350 ± 50 BP for the age of the tree (GSC-2571; GSC XVIII, 1978, p. 10), date the initial air-fall tephra event which was followed quickly by welded ash and breccia flows. The Plinth debris flow, composed of detritus from the Plinth assemblage adjacent to the Bridge River tephra vent, overlies the unweathered upper surface of the welded ash and breccia flows. A radiocarbon date from wood, taken from the periphery of an entrained log lying at the base of the debris flow, indicates that the flow is no older than 900 ± 60 years (GSC-3498). It covers sediments deposited as a result of the damming and subsequent ponding of Lillooet River by the Bridge River tephra. At the sampled locality, the debris flow is less than 2 m thick and contains numerous logs. It originated between 1525 and 2125 m levels on the northeast flank of Plinth Peak, fell to about the 670 m level in Lillooet valley, and climbed the opposite side of the valley to a maximum of 940 m. Plinth debris flow temporarily dammed Lillooet River resulting in the deposition of sediments on the valley floor for about 10 km upstream.

Meager Creek valley adjacent to the Meager volcanic complex contains deposits of several major debris flows. The oldest one outcrops for several kilometres along Meager Creek upstream from the hot springs. It contains acid volcanic detritus of The Devastator assemblage which outcrops only on the flanks of The Devastator and implies that the debris flow originated 8 to 12 km from the sample locality and flowed down Meager Creek valley to at least the hot springs. Wood from the periphery of a log 6 m from the top of the debris flow indicates that the flow is no older than 4100 ± 70 years (GSC-3502). The undated Pylon debris flow, composed of porphyritic andesite clasts, overlies the dated locality and must be younger than 4100 ± 70 years, but probably older than 370 ± 50 years (GSC-3509). The two youngest radiocarbon ages of 370 ± 50 BP (GSC-3509) and 40 ± 60 BP (GSC-3506) date debris flows issuing from two small, south-flowing tributaries of Meager Creek which drain the south side of the complex.

Comment (W. Blake, Jr.): Each age determination was carried out on a single piece of wood. GSC-3498, -3502, and -3509 are each based on two 1-day counts in the 5 L counter. GSC-3506 is based on one 1-day count in the 5 L counter.

Forrest Kerr Creek Series

Prominent terraces extend for 13 km upstream from the mouth of Forrest Kerr Creek, British Columbia. Near the mouth, alluvium blankets Holocene lavas up to 315 m elevation or 60 m above present river level; at 5.75 km upstream, alluvium forms a terrace with a top at 310 m; at 6.8 km, the terrace top is at 320 m; and at 10.9 km, the terrace top stands at 350 m. Beyond 13.3 km upstream, Forrest Kerr Creek flows through a rock-walled canyon. At the confluence of Forrest Kerr Creek and Iskut River, and for 20 km downstream, Holocene basalt floors Iskut valley. A 780 m-high basalt cone lies 4.2 km southeast of the confluence and is the vent for much of the Holocene basalt on the valley floor. About 1.5 km south of the cone, burnt humus beneath basalt tephra yielded a radiocarbon age of 8780 ± 150 BP (SFU-161; Brown et al., 1982). The following two radiocarbon dates from wood buried in terraces along the Forrest Kerr provide a minimum age for a phase of Holocene volcanism younger than 8780 ± 150 years.

GSC-3567. Forrest Kerr Creek (I) 3540 ± 70
$\delta^{13}C = -27.7‰$

Wood (sample B82-2-C14; 12.5 g; **Salix** sp. (willow); unpublished GSC Wood Identification Report No. 82-53 by R.J. Mott) from a branch in a cutbank on the right bank of Forrest Kerr Creek, 6.8 km north of the confluence of Iskut River and Forrest Kerr Creek (56°48'07"N, 130°38'38"W), at an elevation of 310 m. The cutbank in a 10 m-high terrace exposes a 1 m thickness of grey to black clay overlain by sand and gravel. The dated branch lies 3 m above the top of the clay. Collected 1982 by R.L. Brown, Geotex Consultants Limited, Vancouver; submitted by P.B. Read of the same organization.

GSC-3589. Forrest Kerr Creek (II) 2610 ± 70
$\delta^{13}C = -25.1‰$

Wood (sample J82-1-C14; 12.0 g; **Abies** sp. (western fir); unpublished GSC Wood Identification Report No. 83-9 by R.J. Mott) from one of several logs and branches projecting from the right bank of Forrest Kerr Creek, 10.9 km north of the confluence of Iskut River and Forrest Kerr Creek (56°54'07"N, 130°35'16"W), at an elevation of 335 m. The cutbank in a 7 m-high terrace exposes 2 m of varicoloured clay and silt containing the dated material which grades upward into reddish brown silt and overlying boulder gravel. Collected 1982 by J.M. Journeay, Geotex Consultants Limited; submitted by P.B. Read.

Comment (P.B. Read): The dated terrace fill probably results from damming, and subsequent ponding and deposition, of fluviatile and lacustrine sediments upstream of the blockage. Wood buried in terraces in three different localities yielded radiocarbon ages which become younger in the upstream direction where the terraces are higher. At 5.75 km upstream from the Holocene lava exposed at the mouth of Forrest Kerr Creek and at 300 m elevation, a 1 m-thick clay horizon contains leaves, branches, and bark dated at 3930 ± 80 BP (SFU-268, Brown et al., 1983). At 6.8 km from the lava and at 310 m, wood that is 3 m above a clay horizon yielded an age of 3540 ± 70 years (GSC-3567). At 10.9 km from the lava and at 350 m elevation, wood is 2610 ± 70 years old (GSC-3589). The radiometric ages record a short history of deposition from 3930 ± 80 to 2610 ± 70 years as a result of damming of Forrest Kerr Creek by Holocene lavas. The minimum age of the Holocene lavas is at least 3930 ± 80 years; the age may lie in the range 4000 to 5000 years but is not likely as old as 8780 ± 150 years (SFU-161). Petrological data indicate at least two phases of Holocene volcanism, and this preliminary radiometric data suggest that the two may be of differing ages, with one at 8780 ± 150 years (SFU-161) and another in the range of 4000 to 5000 years. Further studies are in progress.

Comment (W. Blake, Jr.): The wood used for GSC-3567 was 37 cm long, 5.5 x 3.5 cm in maximum cross-section. All the outside wood was cut off. On oven drying the sample weight decreased from 35.5 to 13.4 g. For GSC-3589 the single piece of wood used was 43.0 cm long, 3.5 cm maximum diameter (tapered at both ends), and the stubs of branches were all <2 cm long. On oven drying the sample weight decreased from 40.2 to 19.7 g. Each date is based on two 1-day counts in the 5 L counter.

GSC-2450. Charters River Site >54 000

Wood (sample CR Site #1; 44.1 g; "features resemble those of **Tsuga heterophylla** (western hemlock) and **Abies** sp. (western fir)", unpublished GSC Wood Identification Report No. 77-4 by L.D. Farley-Gill) from an 8 m-high road exposure of interbedded sand, silt, and clay, at the Charters River Site, 3 km north of Milnes Landing, southwestern Vancouver Island, British Columbia (48°25'N, 123°42'W), at an elevation of 53 m. Collected 1976 by D.E. Howes, N.F. Alley, J.M. Ryder, and B. Thomson; collectors were then with Geology Section, Resource Inventory Division, Ministry of the Environment, Province of British Columbia, Victoria.

Comment (D.E. Howes): The interbedded sand, silt, and clay are thought to represent floodplain deposits. They underlie a till (?) that, in turn, is overlain by loose sand and gravel. These beds are tentatively correlated to the Cowichan Head Formation (Armstrong and Clague, 1977) of the Olympia nonglacial interval. The floodplain deposits have been sampled by N.F. Alley for pollen analysis.

Comment (W. Blake, Jr.): The damp piece of wood submitted was 24 x 8 x 5 cm. Oven drying reduced its weight from 480 g (with adhering mud) to 220 g. The sample was hard and brittle, and had a lignitized appearance. The sample was prepared in two batches and two determinations were made:

One 1-day count in the 5 L counter at 1 atmosphere. The CO_2 used for this determination was derived from preparation of first batch of wood (22.3 g).	>40 000
One 5-day count in the 5 L counter at 4 atmospheres. The CO_2 used for this determination was derived from the first batch plus the preparation of an additional 21.8 g.	>54 000

Hesquiat Harbour Series

GSC-2940. Hesquiat Harbour (I) 1740 ± 60

A single marine pelecypod shell (sample Hesquiat Site 12; 25.5 g; **Saxidomus gigantea**, identified by W. Blake Jr.) from beach sand overlying cultural deposits in a sea-carved cave, 1.3 km southwest of Boat Basin, Vancouver Island, British Columbia (49°28'20"N, 125°26'40"W), at an elevation of 5.9 m. Collected July 1979 by D.E. Howes.

Comment (D.E. Howes): The cave was probably used by Indians shortly after it became elevated above high tide. Following initial occupation, however, the cave was subject to occasional marine incursion, possibly during catastrophic storms or as a result of tsunamis. Thus, the beach sands with shells probably were deposited when the cave floor was 1 to 2 m above the then high water line, that is 2 to 3 m above present high tide level. Emergence of 2 to 3 m in 1700 years or less for the west side of Vancouver Island is indicated by this date (Clague et al., 1982).

Comment (W. Blake, Jr.): The sample used was a single left valve, measuring 7.0 x 5.9 cm. The clean aragonitic shell was chalky inside and out, lustre was lacking, and there was some pitting on the exterior surface. Because of the sample size, only the outer 10 per cent was removed by HCl leach. Date is based on one 3-day count in the 2 L counter.

GSC-2976. Hesquiat Harbour (II) 13 000 ± 110

Wood (sample Hesquiat Site 14-5; 11.6 g; **Pinus** cf. **P. contorta**; unpublished GSC Wood Identification Report No. 79-56 by L.D. Farley-Gill) from a river escarpment in 3 m-thick glaciomarine silt 1 km southwest of Boat Basin on the west coast of Vancouver Island, British Columbia (49°28'30"N, 125°26'30"W), at an elevation of 25 m. Collected September 1979 by D.E. Howes.

Comment (D.E. Howes): The ^{14}C date obtained from these marine silts is the first one from the west coast of Vancouver Island to document that deglaciation of Fraser Glaciation ice had commenced prior to 13 000 years ago. Relative sea level at this time was at least >25 m. Maximum sea level at Hesquiat Harbour is approximately 32 to 34 m above present sea level (Howes, 1981a; Clague et al., 1982).

Comment (W. Blake, Jr.): The largest piece among several 'lumps' of contorted wood measured 6 x 4.5 cm (maximum diameter). On oven drying the weight decreased from 56.2 to 18.6 g. Adhering silt was scraped off. Date is based on one 3-day count in the 5 L counter.

GSC-2972. Hesquiat Harbour (III) >38 000

Wood (sample HES-1; 11.8 g; **Abies** sp.; unpublished GSC Wood Identification Report No. 79-62 by L.D. Farley-Gill) from glaciolacustrine silt exposed in an escarpment on Escalante River, 4.48 km due east of Escalante Point, British Columbia (49°32'10"N, 126°30'40"W) at an elevation of 173 m. The silts are approximately 25 m thick and are overlain by Vashon till of Fraser Glaciation that, in turn, rests below ice contact sands and gravels. Pollen analysis of the dated wood bed suggests that the climate was cooler and/or moister than present, possibly subalpine (N.F. Alley, personal communication, 1980). Another piece of wood from the same site has been ^{14}C dated at 29 580 ± 895 BP (WSU-2017; unpublished). Collected October 1979 by D.E. Howes.

Comment (D.E. Howes): The silts are thought to represent sediments formed in a marginal ice-dammed lake. An ice dam origin is supported by the pollen analysis and the topographic location and distribution of the silts on the Estevan Coastal Plain. The most feasible mechanism for creating a lake in this topographic situation is by damming Escalante River to the west by ice.

The precise age of the silts is not known; however, they are thought to represent sediments deposited during the advance of Fraser ice. Both dated pieces of wood are considered to represent old wood that has been reworked and redeposited during the period of lake infilling. Stratigraphic evidence from north-central Vancouver Island provides some support that both these dates are older than the age of sediments (Howes, 1981b). Parts of upper Nimpkish River valley were ice free at 25 200 ± 330 BP (GSC-2594; GSC XXI, 1981, p. 9), even though the area is adjacent to the source area of Vancouver Island ice. Considering these facts, it is difficult to conceive that ice would be present on the central-west coast (Escalante River area), 50 km west of this ice source, 29 000 years ago. Thus, it is postulated that the silts were not deposited until some time after 25 000 years ago.

Comment (W. Blake, Jr.): The sample had a maximum length of 12.5 cm and measured 12 x 8 cm in cross-section. On oven drying the weight decreased from 632.5 to 272.8 g. Date is based on one 3-day count in the 5 L counter.

GSC-2620. Northern Vancouver Island >36 000

Wood (sample PM-13; 11.8 g, **Abies** sp.; unpublished GSC Wood Identification Report No. 78-1 by R.J. Mott) from a roadside exposure of glaciomarine silt, 8 to 9 m thick, 1.2 km east of Nimpkish River on the northeastern coast of Vancouver Island, British Columbia (50°33'44"N, 126°59'W), at an elevation of 27 m. Marine shells present in the silts include **Clinocardium nuttalli** Conrad, cf **Yoldia** sp., and **Nuculana** sp. (identified by M.F.I. Smith, National Museum of Natural Sciences, Ottawa). Collected 1977 by D.E. Howes and J. Jungen.

Comment (D.E. Howes): Locally the glaciomarine silt overlies a till (identified in well records) and is overlain by till deposited during the Fraser Glaciation (Howes, 1983). Other ^{14}C dates obtained from wood collected in the same silt from nearby sites are >38 000 BP (I-9772) and 25 700 ± 500 BP (WSU-2018; both in Howes, 1983). The latter date is considered to be unreliable due to the strong possibility of contamination by modern carbon from groundwater. The glaciomarine silt and the lower till have been tentatively correlated to Fyles' (1963) Dashwood drift and Howes' (1981b) Muchalat River drift on Vancouver Island. They are thought to have been deposited during the transition from glacial to nonglacial conditions at the close of the Semiahmoo Glaciation on Vancouver Island (Howes, 1983).

Comment (W. Blake, Jr.): This single fragment of 'old-appearing' wood measured 14 x 4 x 2 cm. After adhering sand and clay were removed in a sonic bath using distilled water, examination showed it to be "somewhat compressed and lignified" (unpublished GSC Wood Identification Report No. 78-1 by R.J. Mott). Date is based on one 3-day count in the 5 L counter.

Northern Canada, Mainland

Yukon Territory

'Howard's Pass' Series

Peat from within an approximately 1 m-thick blanket bog at an elevation of 1600 m in 'Howard's Pass' on the Yukon side of the Yukon/Northwest Territories boundary (62°28'N, 129°12'W), 180 km northeast of Ross River, Yukon Territory and 37 km northwest of Tungsten, Northwest Territories.

GSC-3428. Howard's Pass (I) 7580 ± 110
$\delta^{13}C = -27.6‰$

Partly decomposed and mineralized peat (sample 1051-XYHP-8103; 26.8 g dry) from 18 to 22 cm below the surface in a hand-dug trench.

Comment (L.E. Jackson, Jr.) The date is a minimum for the initiation of blanket bog growth in this area. The moss has been partly replaced by calcite and smithsonite which have been precipitated from spring waters which flow through the bog. The shallowness of the sample, coupled with only a 2000 year difference with GSC-3532 (this series), suggests that this date may be excessively old.

Comment (I.R. Jonasson): The ^{14}C age is likely too old, probably due to inorganic CO_3 contamination. The trench was re-dug in July 1982 and resampled for basal peaty material which is quite fibrous, fetid, and black.

GSC-3532. Howard's Pass (II) 9610 ± 100
$\delta^{13}C = -31.6‰$

Basal peat (sample 1051-XYHP-8201; 30.0 g dry) obtained from 100 to 110 cm depth in the same trench as GSC-3428. The sampled horizon directly overlies bedrock.

Comment (L.E. Jackson, Jr.) This date agrees well with other dates from this area which indicate that blanket bogs began to grow in the headwaters of the Pelly, Nahanni, and Natla rivers by approximately 8500 to 9500 years ago, i.e. GSC-3097 (8630 ± 160 BP) and GSC-3333 (9400 ± 130 BP; both in GSC XXII, 1982, p. 17; MacDonald, 1983) and GSC-3198 (8800 ± 90 BP, this list). The date also provides a maximum age for the initiation of the mineralization of the peat. This mineralized bog, in which the buried moss strata have undergone cell by cell replacement, forming zincian calcite, smithsonite, and hemimorphite, is unique among Holocene ore deposits (Jonasson et al., 1983).

Comment (W. Blake, Jr.): The thinly matted peat utilized for GSC-3428 was unusual because of its very light colour (5Y 6/3 - pale olive on the Munsell scale). Because of the presence of carbonates, this sample required treatment for a month with four additions of HCl. A strong smell of H_2S was noted, expecially at the start of the laboratory treatment; this was presumably due to the presence of sulphur as wurtzite (ZnS), and X-ray analysis showed 5.45 per cent sulphur and 15.3 per cent organic carbon for this sample. Because of the difficulties encountered with the first sample, GSC-3532 was pretreated by the submitter with 50 per cent HCl for six days to remove wurtzite and carbonate (<2 per cent); it was then oven dried at 120°C. This sample showed no reaction with HCl (approximately 6 per cent) in the Radiocarbon Dating Laboratory, but it was characterized by a strong odour (not H_2S). GSC-3428 is based on two 1-day counts in the 2 L counter; GSC-3532 is based on two 1-day counts in the 5 L counter.

Northwest Territories

'Sleet Lake' Series

Lake sediment was collected from a small (<1 ha) tundra pond, unofficially named 'Sleet Lake' (69°15'N, 133°36'W), 10.5 km southeast of Kittigazuit, Tuktoyaktuk Peninsula, Northwest Territories. The pond, whose surface was at an elevation of 40 m, was cored on July 29, 1980 using a Livingstone sampler from a raft. The water depth was a little over 5 m and 394 cm of gyttja was recovered. The compact nature of the sediment prevented further collection of sediment from the raft. Collected by R.W. Spear and D. LaHaie, both then at Scarborough College, Toronto; the former is now at Department of Ecology and Behavioral Biology, University of Minnesota, Minneapolis, Minnesota.

GSC-3330. Sleet Lake (P1), 60-68 cm 1970 ± 60
$\delta^{13}C = -30.5‰$

Lake sediment (sample SL-196; 23.4 g) from 60 to 68 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on one 2-day count in the 2 L counter.

GSC-3323. Sleet Lake (P2), 113-120 cm — 5270 ± 80; $\delta^{13}C = -28.7‰$

Lake sediment (sample SL-197; 67.3 g) from 113 to 120 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 2 L counter.

GSC-3311. Sleet Lake (P3), 193-200 cm — 6210 ± 60; $\delta^{13}C = -28.8‰$

Lake sediment (sample SL-198; 53.5 g) from 193 to 200 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 5 L counter.

GSC-3307. Sleet Lake (P4), 302.5-310 cm — 10 400 ± 110; $\delta^{13}C = -27.9‰$

Lake sediment (sample SL-199; 82.6 g) from 302.5 to 310 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

GSC-3302. Sleet Lake (P5), 382.5-390 cm — 12 500 ± 110; $\delta^{13}C = -27.7‰$

Lake sediment (sample SL-200; 142.5 g) from 382.5 to 390 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on one 4-day count in the 2 L counter.

Comment (R.W. Spear): This series of dates provides radiometric age control for sediment accumulation at Sleet Lake. It allows pollen influx to be calculated which gives detailed data on the vegetation history of the region, especially treeline fluctuations. From 12 500 to 10 500 BP dwarf birch tundra grew around the site. By 10 500 BP white spruce had arrived in the region. Its populations built up rapidly and by approximately 9000 BP reached a maximum, as indicated by high pollen influx. Black spruce became abundant in the region by 7200 BP and treeline still stood at least as far north as Sleet Lake, 70 km north of its modern limit; cf. GSC-3239 (6620 ± 70 BP, on spruce wood in the same area; Spear, 1983, and this list). The decline in spruce pollen influx indicates that treeline began to retreat southward by 5500 BP and that the modern vegetation zonation was established by 4000 BP (Ritchie and Spear, 1982; Ritchie et al., 1983).

GSC-3344. Hummocky Lake (P6) — 9030 ± 80; $\delta^{13}C = -29.0‰$

Basal lake sediment (sample HL-201 (387-395 cm); 73.3 g) was collected from a small tundra pond, informally named 'Hummocky Lake' (68°50'N, 133°31'W), 8 km southeast of Parsons Lake, Mackenzie Delta region, Northwest Territories. Four metres of gyttja were recovered from the center of the pond, elevation 40 m, which was more than 5 m deep. Collected July 1980 by R.W. Spear and D. LaHaie from a raft using a Livingstone sampler.

Comment (R.W. Spear): This date provides a minimum age for the formation of the pond. The pollen profile from Hummocky Lake has the two upper zones, spruce and alder, of the three standard zones, birch, spruce, and alder, recognized in the region. The date is from the spruce zone, a period when the boreal forest extended far north of its present limit. Macrofossil evidence in the form of spruce needles, found at 361 cm, confirms the presence of spruce in close proximity to Hummocky Lake by the early Holocene. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 5 L counter.

'Twin Tamarack' Lake Series

A series of pond sediment samples from a 466 cm-long core taken in Twin Tamarack Lake (informal designation) in the Campbell-Dolomite Uplands, Northwest Territories, (68°18'N, 133°25'W), at 25 m; water depth, 2.45 m. The site is located 10 km east-southeast of Inuvik. Collected April 1980 by R.W. Spear and L.C. Cwynar with a modified Livingstone piston corer; submitted by J.C. Ritchie.

GSC-3394. Twin Tamarack 2-6 cm — 440 ± 60; $\delta^{13}C = -32.4‰$

Organic mud (sample T.T.6; 10.0 g dry) from 2 to 6 cm below the mud/water interface. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 2 L counter.

GSC-3377. Twin Tamarack, 67-73 cm — 3640 ± 90; $\delta^{13}C = -31.1‰$

Organic mud (sample T.T.1; 11.0 g dry) from 67 to 73 cm below the mud/water interface. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 2 L counter.

GSC-3384. Twin Tamarack, 119-126 cm — 5830 ± 90; $\delta^{13}C = -24.3‰$

Organic mud (sample T.T.2; 13.5 g dry) from 119 to 126 cm below the mud/water interface. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

GSC-3347. Twin Tamarack, 163-172 cm — 7810 ± 100; $\delta^{13}C = -24.9‰$

Organic mud (sample T.T.3; 11.8 g dry) from 163 to 172 cm below the mud/water interface. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

GSC-3346. Twin Tamarack, 296-304 cm — 11 600 ± 140; $\delta^{13}C = -26.2‰$

Organic silt and clay (sample T.T.4; 84 g) from 296 to 304 cm below the mud/water interface. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 2 L counter.

GSC-3387. Twin Tamarack, 320-330 cm — 13 100 ± 150; $\delta^{13}C = -26.0‰$

Organic silt and clay (sample T.T.5; 141.5 g dry) from 320 to 330 cm below the mud/water interface. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on two 3-day counts in the 2 L counter.

Comment (J.C. Ritchie): The pollen data from the site have extended the record for this region back to roughly 14 000 BP, which correlates closely with the suggested chronology of deglaciation (Rampton and Bouchard, 1975). It also extends the reconstructed vegetation record back by roughly 2000 years from an earlier investigation (Ritchie, 1977). The TT pollen percentage and influx data are significant in several respects: a) the increase in influx to maximal values at approximately 10 000 BP, composed primarily of **Betula**, **Populus**, and **Juniperus**, has been interpreted, along with data from other sites in the northwest, as support for the early Holocene Milankovitch thermal maximum (Ritchie et al., 1983); b) the detailed pollen influx curves for the main taxa have been interpreted in terms of a period, between approximately 11 000 and 6000 BP, of relative vegetation instability, involving processes of differential plant migration, interspecific competition, and response to environmental change (Ritchie, in press); and c) the data further refine knowledge of the chronology of the **Picea** rise, **Alnus** rise, and the **Myrica** peak, three useful stratigraphic markers in the northwest.

Comment (W. Blake, Jr.): The two basal samples, GSC-3346 and -3387, showed very strong reaction with HCl. According to the submitter, GSC-3387 included marl, and GSC-3346 contained tube-shaped calcareous remains mixed in with the silt and clay.

'Black Ice' Lake Series

Lake sediment was collected from a small tundra pond. Black Ice Lake (unofficial name), Northwest Territories (69°25'N, 132°10'W), 35 km east of the town of Tuktoyaktuk and 2 km west of Eskimo Lakes, at an elevation of 40 m. Nearly 4 m of gyttja and organic clay was recovered from 11 m of water using a Livingstone sampler from the ice. Gravel prevented further penetration of the sediments. Collected May 10, 1980 by L.C. Cwynar, then Scarborough College, Toronto, now Department of Botany, University of Toronto, Toronto; and R.W. Spear.

GSC-3341. Black Ice Lake (P7), 283-290 cm — 5020 ± 60, $\delta^{13}C = -30.6‰$

Lake mud (sample BIL-203; 42.6 g) from 283 to 290 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count in the 5 L counter.

GSC-3335. Black Ice Lake (P8), 382.5-391 cm — 6550 ± 90, $\delta^{13}C = -27.8‰$

Organic clay and gravel (sample BIL-202; 170.6 g) from 382.5 to 391 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

Comment (R.W. Spear): These dates provide a minimum age for the formation of the pond and enable a rough sediment accumulation rate to be calculated for the site. The accumulation of sediment at Black Ice Lake postdates the arrival of alder in the region. Hence, the pollen stratigraphy consists of only the uppermost of the regional pollen zones, the alder zone. High percentages of pollen and macrofossils, needles, and seed wings of spruce between the levels of the radiocarbon-dated samples indicate that spruce forests were continuous in the region during the mid-Holocene (cf. Ritchie et al., 1983).

Eskimo Lake Series

Wood samples from partially buried spruce logs were collected on a collapsed bank near a lake shore. The site (69°27'N, 132°10'W), at an elevation of 20 m, lies 35 km east of the town of Tuktoyaktuk within 2 km of the northeastern edge of Eskimo Lakes, Northwest Territories. One snag was located in a shallow depression filled with peat. The 50 cm above-ground portion was cut off and brought back to the laboratory for analysis. The other log was located 1 m from the first and was partially buried by peat. Collected July 1980 by R.W. Spear and D. LaHaie.

GSC-3239. Eskimo Lakes (P9) — 6620 ± 70, $\delta^{13}C = -25.0‰$

Wood (sample OL-30; 11.4 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 81-10, by L.D. Farley-Gill) from a snag exposed above ground. Date is based on two 1-day counts in the 5 L counter.

GSC-3243. Eskimo Lakes (P10) — 6370 ± 70, $\delta^{13}C = -25.2‰$

Wood (sample OL-31; 11.7 g; **Picea** sp.; unpublished GSC Wood Identification Report as above) from a log buried in peaty soil. Date is based on two 1-day counts in the 5 L counter.

Comment (R.W. Spear): These dates provide evidence that treeline stood at least 50 km beyond its modern limit in mid-Holocene time. The above-ground portion of the snag had a diameter of 12 cm and 120 large growth rings. It must have grown under as favorable climatic conditions as those found in the boreal forest near Inuvik today (Spear, 1983).

GSC-3198. Nahanni River — 8800 ± 90, $\delta^{13}C = -27.4‰$

Peat (sample JJ-39-1; 10.5 g dry) from the base of a blanket bog in a natural exposure 20 m above the west bank of South Nahanni River, Northwest Territories (62°25'N, 128°27'W), at an elevation of approximately 690 m. The collection site is 50 km north-northwest of Tungsten, Northwest Territories. Collected July 1980 by L.E. Jackson, Jr.

Comment (L.E. Jackson, Jr.) This date provides a minimum age for deglaciation of South Nahanni valley and also for the initiation of blanket bog formation in this area. The date is in conformity with other dates from this region taken from stratigraphically analogous settings, i.e. GSC-3097 (8640 ± 160 BP) and GSC-3333 (9400 ± 130 BP; both in GSC XXII, 1982, p. 17; MacDonald, 1983) and GSC-3532 (9610 ± 100 BP, this list).

Comment (W. Blake, Jr.): A check of the 0.18 to 0.425 mm fraction showed that it consisted mainly of moss fragments, most of which were probably **Sphagnum**. Mosses also dominated the >0.425 mm fraction; other plant macrofossils and insects were extremely rare (unpublished GSC Plant Macrofossil Report No. 81-1 by J.V. Matthews, Jr.). Date is based on two 1-day counts in the 5 L counter.

GSC-3663. Richardson River — 10 300 ± 240, $\delta^{13}C = -3.6‰$

Marine pelecypod shells (sample AM-82-12; 9.6 g; **Macoma calcarea**, identified by W. Blake, Jr. and J.E. Dale) from a gravelly sand raised beach on the south side of Richardson River, 21 km west of Cox Lake, Northwest Territories (67°52'N, 117°10'W), at an elevation of 120 m. Collected August 1982 by A. Mercier, Université d'Ottawa, Ottawa; submitted by D.A. St-Onge.

Comment (D.A. St-Onge): Many of the shells were paired at the time of collection. The date is a minimum age for the postglacial marine transgression which reached 170 m a.s.l. in this area (St-Onge and Bruneau, 1982). The date overlaps with I (GSC)-25, 10 530 ± 260 BP (Isotopes I, 1961, p. 51-52), a shell sample collected at an elevation of 74 m along the coast of Coronation Gulf 120 km to the north.

Comment (W. Blake, Jr.): This age determination is of considerable importance because of the high elevation at which the shells were collected. Shells that were encrusted or exhibited marked translucence were excluded. The largest valve measured 2.3 x 1.9 cm. Most valves, especially the smaller ones, were characterized by partially intact periostracum. Few valves retained internal lustre. Because of the small sample size, only the outer 10 per cent was removed by HCl leach. Date is based on two 1-day counts in the 2 L counter.

Coppermine River Series (II)

Wood, peat, and marine shells collected from various site in Coppermine River valley.

GSC-3135. Coppermine River Valley (I) 4370 ± 60

Part of a log (sample DS-80-24; 11.65 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 80-33 by L.D. Farley-Gill) at the 7.5 m level in an 11 m-high bank on the east side of Coppermine River, 9.5 km downstream (straight line) from the mouth of White Sandy River, Northwest Territories (66°14'30"N, 114°20'15"W), at an elevation of 280 ± 10 m. The sample contained approximately 50 annual rings. Collected August 12, 1980 by D.A. St-Onge, then Université d'Ottawa, Ottawa.

Comment (D.A. St-Onge): The wood is contained in a crossbedded sequence of alluvial sand and fine gravel which marks a period of aggradation by Coppermine River. It has not yet been possible to determine the cause of this event. Date is based on one 2-day count in the 5 L counter.

GSC-3205. Coppermine River Valley (II) 7980 ± 140

Twigs (sample DS-80-29; 2.5 g dry; **Salix** sp.; unpublished GSC Wood Identification Report No. 80-29 by R.J. Mott) accumulated in a trough in crossbedded coarse sand at 26.5 m above present river level. This unit is part of a 32 m-high exposure of silty sand rhythmites (22 m) overlain by alluvial sands (10 m) on the east side of Coppermine River 17.5 km downstream (in a straight line) from the mouth of White Sandy River, Northwest Territories (66°16'15"N, 114°20'30"W), at an elevation of 300 ± 10 m. Collected August 14, 1980 by D.A. St-Onge.

Comment (D.A. St-Onge): The twigs were found in a trough downstream from a ripple in alluvial sand overlying glacial Lake Coppermine rhythmites. The alluvial sand is part of a terrace at 300 m a.s.l. which may mark a pause in downcutting by Coppermine River from the 365 m a.s.l. maximum elevation of glacial Lake Coppermine (St-Onge et al., 1981). Other lines of evidence suggest that the lake no longer existed by 10 300 ± 240 BP (GSC-3663, this list).

Comment (W. Blake, Jr.): The sample used for dating comprised 21 twigs, up to 15 cm long, and with maximum diameter of 5 mm; several still had part or all of the bark attached. Other twigs present were **Betula** sp. and a third group were so gnarled and poorly preserved that it was impossible to differentiate between **Salix** sp. and **Populus** sp. (unpublished GSC Wood Identification Report No. 80-29 by R.J. Mott). Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3463. Coppermine River Valley (III) 7530 ± 140

Wood (sample COP II b.11; 4.1 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 82-22 by R.J. Mott) from within a 4 m-thick organic fill in channelled alluvial sands near the top of a 31 m-high section on the north side of Quicksand Creek 2.2 km south of its mouth in Coppermine River, Northwest Territories (66°49'30"N, 116°21'W), at an elevation of approximately 325 m. Collected July 16, 1980 by D.A. St-Onge, M-A. Geurts, and F. Guay, all then with Université d'Ottawa, Ottawa.

Comment (D.A. St-Onge): Wood at the base of this sequence was dated at 8400 ± 80 BP (GSC-2959) and the peat at the top at 3210 ± 60 BP (GSC-2998; both in GSC XX, 1980, p. 15). This date from unit 6e (St-Onge, 1980, Fig. 3, p. 1313) marks the transition phase in vegetation from shrub tundra to forest tundra.

Comment (W. Blake, Jr.): A single piece of wood was used for dating. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3393. Coppermine River Valley (IV) 4470 ± 70

Peat (sample DS-81-21; 53.2 g) from the west bank of a small stream which has cut through pond deposits in postglacial deltaic and beach sands, overlying marine silt, 2.8 km south of Escape Rapids in Coppermine River valley, Northwest Territories (67°35'32"N, 115°27'42"W), at an elevation of approximately 140 m (from the 1:50 000 contour map). Collected July 24, 1981 by D.A. St-Onge.

Comment (D.A. St-Onge): The relatively young age in comparison to GSC-3327 (9820 ± 90, this series) indicates that the infilling of this pond by organic debris long postdates retreat of the postglacial sea. Date is based on two 1-day counts in the 5 L counter.

GSC-3327. Coppermine River Valley (V) 9820 ± 90 $\delta^{13}C = -3.7‰$

Marine pelecypod shells (sample DS-81-25; 48.2 g; **Macoma calcarea**, identified by W. Blake, Jr.) from sand, 1.7 km southwest of Bloody Fall on Coppermine River, Northwest Territories (67°43'48"N, 115°25'34"W), at an elevation between 90 and 100 m.

Comment (D.A. St-Onge): The shells, mostly whole and some paired, were collected at the contact between marine silt and the overlying sand. The date is a minimum age for the postglacial marine transgression which reached 170 m a.s.l. in this area (St-Onge and Bruneau, 1982). Date is based on two 1-day counts in the 5 L counter.

Comment (W. Blake, Jr.): The large (maximum dimensions, 3.7 x 2.6 cm) clean shells were thin and fragile; the shell material was determined to be aragonite by X-ray diffraction.

GSC-3584. South Coronation Gulf Coast 9620 ± 130 $\delta^{13}C = +0.5‰$

Marine pelecypod shells (sample HB-82-1; 14.1 g; **Hiatella arctica**, identified by W. Blake, Jr.) from the south coast of Coronation Gulf, 17.5 km south of Gray's Bay and 13.2 km east of Anialik River, Northwest Territories (67°38'37"N, 110°51'50"W). The sample was collected in silty sand, part of an extensive surface of marine sediments at approximately 200 m a.s.l. Collected July 21, 1982 by H.C. Bruneau, Université d'Ottawa, Ottawa.

Comment (D.A. St-Onge): The sample is one of the highest found in the area (including Victoria Island). Geomorphology and stratigraphy indicate that is is near the limit of Holocene marine submergence. The age is within the same range as previous dates along this coast (Craig, 1960), the oldest being I(GSC)-17 (10 215 ± 220 BP; Isotopes I, 1961, p. 51) from Tree River valley, but it is younger than a recent date on shells in the Richardson River basin approximately 280 km to the west, 10 300 ± 240 BP (GSC-3663; this list). This indicates that the western part of Coronation Gulf was ice free several centuries before the eastern part of the gulf, and dates within Bathurst Inlet are all <9000 years (cf. Blake, 1963).

Comment (W. Blake, Jr.): Other species present (not used) were **Mya truncata, Macoma calcarea, Mytilus** sp. (probably **Mytilus edulis**), and **Balanus crenatus**; this is the oldest sample along the mainland coast in which **Mytilus** has been found (cf. Blake, 1973). The **Hiatella arctica** shells used for dating comprised both whole shells and fragments; the largest valve was 3.4 x 1.6 cm in size. Most valves exhibit good external ornamentation, no periostracum, and no good internal lustre. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

Kaminak Lake Mudboil Series

Fine terrestrial organic detritus under mudboils at the edge of the west arm of Kaminak Lake, Northwest Territories (62°17'N, 95°31'W), at an elevation of 69.5 m. Collected 1980 by P.A. Egginton.

GSC-3143. Kaminak Lake (I) 2510 ± 50

Organic detritus (sample EK-80-19; 197.6 g dry) at a depth of 50 cm, and continuous for a horizontal distance of at least 1 m.

GSC-3220. Kaminak Lake (II) 2920 ± 60

Organic detritus (sample EK 80-21; 462.8 g dry) at a depth of 35 to 40 cm and continuous for at least 1 m under a mudboil.

Comment (P.A. Egginton): The organics were buried by a downslope displacement of muds associated with mudboils. The presence of this buried organic layer and four others indicates that at least five mud surges have occurred at this elevation in the last 2500 to 3000 radiocarbon years.

Comment (W. Blake, Jr.): The organic carbon content of GSC-3143 was 7.1 per cent, but of GSC-3220, only 1.6 per cent, as determined on a Leco analyzer. NaOH leach was omitted from the pretreatment of both samples. GSC-3143 is based on one 3-day count in the 5 L counter; GSC-3220 is based on two 1-day counts in the 5 L counter.

Yandle-Kaminak Lake Sediment Series

Lake sediment cores were recovered from Yandle Lake (61°40'N, 96°33'W; area 1900 ha) and Kaminak Lake (62°17'30"N, 95°20'W; area 37 000 ha), District of Keewatin, Northwest Territories, in order to determine the time at which lacustrine conditions were initiated and the rates at which sedimentation occurred. Collected July 1976 by R.A. Klassen, with plastic core tubes pushed in while scuba diving.

GSC-2634. Yandle Lake 5080 ± 170
$\delta^{13}C = -25.5‰$

Organic lake sediment (samples 76YL 1005 and 76YL 2006; 18.5 g freeze-dried plus 32.1 g wet) from two cores (252 and 194 cm in length) collected within 20 m of one another in a central location in Yandle Lake. The 2 cm-long dated increments were from a 'gel' containing 2 to 4 per cent (by weight) organic matter (Shilts et al., 1976) at the base of the freshwater sediment, approximately 40 cm below the sediment/water interface, and overlying marine/estuarine silty clay (same stratigraphic position in both cores). Lake surface elevation approximately 110 m; water depth 6.1 m.

GSC-2696. Kaminak Lake (I) 1000 ± 120
$\delta^{13}C = -26.8‰$

Laminae of detrital organic matter in lake sediment (sample 77KC2304; 77.2 g wet) from 12 to 14 cm below the sediment/water interface in a 146 cm-long core. Lake surface elevation approximately 53 m; water depth approximately 25 m.

GSC-2688. Kaminak Lake (II) 2370 ± 120
$\delta^{13}C = -26.7‰$

Laminae of detrital organic matter in lake sediment (sample 77KC2316; 67.7 g wet) from 102 to 104 cm below the sediment/water interface in the same core from which GSC-2696 was extracted.

Comment (R.A. Klassen): "Based on these dates, estimates of annual accumulation rates vary between about 0.08 and 0.7 mm/year" (Klassen et al., 1983). The core from Yandle Lake has a diatom succession that shows the changeover from marine/brackish water conditions to freshwater (Edwards, 1978).

Comment (W. Blake, Jr.): The incursion of the sea into this region occurred close to 7000 years ago; cf. I (GSC)-8 (6975 ± 250 BP; Isotopes I, 1961, p. 50-51), a determination on marine pelecypod shells at an elevation of 65 m near Carr Lake, roughly midway between Yandle Lake and Kaminak Lake (limit of postglacial marine submergence approximately 170 m). NaOH leach was omitted from the pretreatment of all samples. Each sample was mixed with dead gas for counting. Each date is based on two 1-day counts in the 2 L counter.

Northern Canada, Arctic Archipelago

Banks Island

Thesiger Bay Series

GSC-3229. Thesiger Bay (I) 10 600 ± 130

Wood (sample DGH-2-80, 3.9 g dry; **Salix** sp.; unpublished GSC Wood Identification Report No. 80-42 by R.J. Mott) from a coastal cliff section on Thesiger Bay, 3.8 km south-southeast of Sachs Harbour, Banks Island, Northwest Territories (71°57'N, 125°14'W), at an elevation of 5.0 m. Collected 1980 by D.G. Harry and H.M. French, both then at University of Ottawa, Ottawa.

Comment (D.G. Harry): The dated material was collected from a thin (1 to 6 cm) horizon containing detrital willow roots and stems, overlain by 2.5 cm of medium sand and underlain by up to 4.0 m of silty sand. This locality lies at the western margin of the Sachs River lowlands outwash plain. Although outwash sands and gravels are sometimes exposed near sea level along this coastline, the materials observed at this locality appear to be of postglacial age. The presence of willow fragments demonstrates the establishment of a vegetation cover prior to accumulation of the sand unit. Moreover, the age determination suggests that at least the overlying sand unit well postdates the last glacial event on southern Banks Island (Vincent, 1983). The origin of the materials in this section is thus uncertain; their sedimentology suggests that they may represent reworked outwash sediments, deposited in a low-energy fluvial or lacustrine environment in early Holocene time. A number of small frost fissures and larger inactive ice wedges extend downwards into the silty sand from the organic horizon, which therefore marks a former ground surface (Harry, 1982; French et al., 1982). The date provides a minimum age for this surface and for the ice wedges developed within the silty sand.

Comment (W. Blake, Jr.): The date on this sample is one of the oldest yet obtained for Banks Island on terrestrial organic materials which were outside the limit of the Laurentide Ice Sheet in Late Wisconsinan time (Vincent, 1982); others are GSC-240 from the Masik River (10 660 ± 170 BP; GSC IV, 1965, p. 38-39) and GSC-2673 from near Shoran Lake (10 200 ± 130 BP; GSC XX, 1980, p. 19-20). Six twigs, up to 8.5 cm long, were used for the determination. Sample was mixed with dead gas for counting. Date is based on one 5-day count in the 2 L counter.

GSC-3216. Thesiger Bay (II) 6490 ± 60

Peat (sample DGH-1-80; 42.7 g dry; sedge and grass stem/rhizome fragments with a few moss fragments; identified by J.V. Matthews, Jr.) from the same site as GSC-3229, at an elevation of 6.5 m. Collected 1980 by D.G. Harry and H.M. French.

Comment (D.G. Harry): The dated sample was collected 1.4 m below ground surface, at the base of a 1.1 m-thick layer of frozen peat overlain by humiferous fine sand and underlain by medium sand. The date provides a maximum age for growth of the peat layer and for the thaw event which truncated an adjacent ice wedge at the same level (Harry, 1982; French et al., 1982). The peat sample contained achenes of **Carex stans** type and fragments of Coleoptera species identified by J.V. Matthews, Jr.; these include **Pterostichus (Cryobius)** sp., **Hydroporus** sp., and **Rhynchaenus (Isochnus)** sp. (unpublished GSC Fossil Arthropod Report No. 81-1). With reference to the **Rhynchaenus** fossil Matthews stated "The species appears to feed on Arctic willow. It is expected to occur at Sachs Harbour today, so at most the fossil suggests an Arctic environment similar to that of the present. The other fossils do not contradict this assumption."

Comment (W. Blake, Jr.): Part of this sample was screened through an 80 mesh sieve and then picked for plant macrofossils and fossil arthropods; 300 g of this material decreased in weight to 42.7 g upon oven drying. Date is based on one 3-day count in the 5 L counter.

GSC-3292. Thesiger Bay (III) 8560 ± 210

Twigs (sample DGH-3-80 (b); 2.4 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 80-42 by R.J. Mott) from a coastal permafrost section on Thesiger Bay, 4.0 km south-southeast of Sachs Harbour, Banks Island, Northwest Territories (71°57'N, 125°13'W), at an elevation of 2.0 m. Collected 1980 by D.G. Harry and H.M. French.

Comment (D.G. Harry): The dated wood is from the basal horizon of a 1.6 m-thick sequence of lacustrine sediments underlying a drained thermokarst lake basin. The date provides a maximum age for the inception of lake sedimentation at this site. At a second drained lake site, located 11.4 km to the southeast, wood collected from an identical geomorphic and stratigraphic setting has yielded a date of 8280 ± 140 BP (GSC-2246; GSC XX, 1980, p. 22; Vincent, 1983). The close agreement between these two dates suggests that regional thermokarst development on southern Banks Island may have been initiated approximately 8000 to 9000 years ago (Harry, 1982; Harry and French, 1983).

Comment (W. Blake, Jr.): Only the single largest twig (13 cm long and with a maximum diameter of 7 mm) in a collection of several small twigs (nearly all without bark) was used for dating. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

King William Island

GSC-3548. Gjoa Haven 2760 ± 120

Paired valves of marine pelecypod shells (sample 82-HTA-S10; 14.5 g; **Astarte** sp., identified by W. Blake, Jr.) from sand approximately 2 m below ground surface in Gjoa Haven, King William Island, Northwest Territories (68°37'35"N, 95°52'W), at an estimated elevation of 10 m. The shells were collected from a single, gently dipping horizon interpreted to be glaciofluvial sand, reworked by wave action, and exposed in a gully. Collected July 1982 by R.G. Hélie.

Comment (R.G. Hélie): It was hoped that this sample would give a minimum age for the glaciofluvial outwash composing most of the southeastern part of King William Island and produced by a calving ice front, approximately 9000 years ago. Unfortunately, the shells, though deeply imbedded in the sand, were deposited during the emergence of King William Island; therefore, this date represents the minimum sea level at the time.

Comment (W. Blake, Jr.): The sample used consisted of seven pairs, some fully intact at the time of receipt by the laboratory. The largest valve measured 3.3 x 2.4 cm. The shells were characterized by intact periostracum, internal lustre on a few, and no encrustations or external pitting. Because of the small sample size, only the outer 10 per cent was removed by HCl leach. Sample was mixed with dead gas for counting. Date is based on one 1-day count in the 2 L counter.

Ellesmere Island

Makinson Inlet Peat Series

Peat samples were collected from an exposure 8 km due east of the head of Makinson Inlet (north arm), Ellesmere Island, Northwest Territories (76°41.5'N, 81°37'W), at an elevation of approximately 400 m. The site is on the valley wall, where the peat appears to occupy a channel cut in the underlying Eureka Sound Formation. The peat is overlain by a unit composed mainly of large boulders (some >1 m in diameter); this unit may include till as well as coarse outwash.

GSC-140-2. Makinson Peat (I) >44 000

This moss peat (sample FG-61-162e; 94 g dry; **Calliergon giganteum;** unpublished GSC Bryological Report No. 258 by M. Kuc, 1973) is part of the original sample. Collected August, 1961 by J.G. Fyles; submitted 1973 by W. Blake, Jr. Date is based on one 4-day count in the 5 L counter.

GSC-2677. Makinson Peat (II) >52 000
$\delta^{13}C = -33.8‰$

Moss peat (sample BS-77-242; 115.0 g; **Calliergon giganteum;** unpublished Bryological Report JJ-163 (1978) by J.A.P. Janssens, then University of Alberta, Edmonton) from the uppermost 2 cm of the main peat unit. Collected July, 1977 by W. Blake, Jr. Date is based on one 5-day count in the 5 L counter at 4 atmospheres.

GSC-3607. Makinson Peat (III) >35 000
$\delta^{13}C = -27.3‰$

Peat or peaty soil (sample BS-77-243; 25.4 g dry; unpublished GSC Plant Macrofossil Report No. 83-11 by J.V. Matthews, Jr.) from a thin peaty band which is blacker than the main peat unit (cf. GSC-2677, this series) approximately 5 m below; this band, exposed in a small gully, was approximately 5 m below the ground surface. Collected 1977 by W. Blake, Jr. Date is based on one 3-day count in the 5 L counter.

GSC-3607-2. Makinson Peat (IV) >45 000

This is a separate determination on the same sample (BS-77-243; 106.0 g dry) used for GSC-3607, above. An entirely new preparation was used. Date is based on two 1-day counts plus one 3-day count in the 5 L counter at 4 atmospheres.

Comment (W. Blake, Jr.): The plant macrofossils and fossil arthropods in the peat used for GSC-2677 have been discussed by Matthews in Blake and Matthews (1979).

The peaty soil higher in the section was dated because it contained abundant seeds of **Arctostaphylos alpina-rubra** type (which had not been found in the underlying main peat unit) and their presence suggested the possibility of correlation with an **Arctostaphylos**-bearing deposit some 16 km to the north, on which a date of 31 100 ± 480 BP (GSC-3364; Blake, 1982b) had been obtained. GSC-3607 and -3607-2 show that all the organic deposits at this site east of the head of Makinson Inlet are >45 000 years old. The presence of the **Arctostaphylos** seeds suggests a warmer climate than at present, and with regard to the sample itself Matthews noted that "coal, amber or other contaminants that might compromise a dating attempt are not present" (unpublished GSC Plant Macrofossil Report No. 83-11). With regard to insects Matthews reported two species of Staphylinidae (rove beetles), **Holoboreaphilus nordenskioeld**, and **Stenus** sp., as well as a ground beetle, **Amara (Curtonotus)** sp., and a predaceous diving beetle, **Hydroporus** sp.. He stated: "Despite the small size of the insect assemblage, it suggests a warmer climate than at present. Carabid beetles are not known to occur on Ellesmere Island; therefore, even if the head identified as **Amara** does not represent that genus, it nevertheless indicates a northward range expansion for carabids. The northernmost record for **Holoboreaphilus** is southern and central Baffin Island, and this is probably true of the genus **Stenus** as well."

The pretreatment of samples GSC-2677, -3607, and -3607-2 included hot NaOH and HCl leaches for approximately one-half hour; in the case of GSC-140-2, the treatment with each reagent was extended to one hour.

GSC-3688. Split Lake 6260 ± 60
$\delta^{13}C = -23.8‰$

Wood (sample 83-BS-419; 13.0 g; **Larix** sp.; unpublished GSC Wood Identification Report No. 83-34 by R.J. Mott) from a large driftwood log (23 cm in diameter, 105 cm long, exposed part only) in marine mud approximately 2 km north of the northeastern corner of Split Lake (north half) and 13 km north of Makinson Inlet (north arm), Ellesmere Island, Northwest Territories (77°48.3'N, 81°47.5'W), at an elevation of approximately 47 m (altimeter determination). Collected 1983 by W. Blake, Jr.

Comment (W. Blake, Jr.): The date on this log shows that in mid Holocene time, or later, the sea extended well to the north of the present head of Makinson Inlet; cf. GSC-1972, 7330 ± 80 BP (GSC XVIII, 1978, p. 15; Blake, 1978). Sometime prior to 1040 ± 40 BP (GSC-2893; GSC XXI, 1981, p. 17; Blake, 1981) Split Lake Glacier advanced and dammed a lake in the part of the valley where this log was found. Date is based on one 4-day count in the 5 L counter.

GSC-3414. Glacier 7A-45 >43 000
$\delta^{13}C = -23.0‰$

Wood (sample BS-77-354; 11.4 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 77-47 by R.J. Mott) from among coarse bouldery till in front of Glacier 7A-45 (designation following the Glacier Atlas of Canada, Department of the Environment, Area 46427A, unpublished), approximately 16 km north of the head of Makinson Inlet (north arm), Ellesmere Island, Northwest Territories (77°49.8'N, 81°45'W), at an elevation of approximately 62 m. Collected August 1977 by W. Blake, Jr.

Comment (W. Blake, Jr.): R.J. Mott stated (unpublished GSC Wood Identification Report No. 77-47) that: "Wood is lignified to some extent and hard compared to fresh wood of the same genus. The early wood only is slightly compressed. This wood appears to be older than postglacial wood previously found in the Arctic but differs in appearance to Beaufort Formation wood and is not as lignified as Eureka Sound Formation wood. However, these possibilities cannot be excluded." The sample was dated to see if there was driftwood of mid-Wisconsinan age present in this valley, for finite ages in the 30 000 to 35 000 year-range had been obtained on willow twigs in lake sediments higher up on the valley side (Blake, 1982b). Also, the sea was known to have reached this far north in the valley in Holocene time; cf. GSC-1972, 7330 ± 80 BP (GSC XVIII, 1978, p. 15; Blake, 1978, 1981). The dated wood obviously belongs to an older generation of wood – perhaps interglacial (cf. GSC-3607-2; >45 000 BP, this list). Date is based on one 3-day count plus one 1-day count in the 5 L counter.

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