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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES XXV

W. Blake, Jr.

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The present date list, GSC XXV, is the fourteenth 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 XXV

Abstract

This list presents 180 radiocarbon age determinations made by the Radiocarbon Dating Laboratory. They are on 171 geological samples from various areas as follows: Newfoundland (22); Nova Scotia (9); Quebec (8); Ontario (20); Manitoba (1); Alberta (24); British Columbia (38); Yukon Territory (4); Northwest Territories, mainland (15); Northwest Territories, Arctic Archipelago (37); Svalbard (2). Tables 1 and 2 summarize details of background and standard for the 2 L and 5 L counters during the period from November 7, 1984 to September 10, 1985; 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 180 datations effectuées sur 171 échantillons géologiques par le Laboratoire de datation au radiocarbone. Ces échantillons proviennent des régions suivantes: Ile de Terre-Neuve (22); Nouvelle-Ecosse (9); Québec (8); Ontario (20); Manitoba (1); Alberta (24); Colombie-Britannique (38); Yukon (4); Territoires du Nord-Ouest, continent (15); Territoires du Nord-Ouest, archipel Arctique (37); Svalbard (2). Tableaux 1 et 2 résument les valeurs de mouvement propre et de l'étalonnage des compteurs 2 L et 5 L, pour la période allant du 7 novembre 1984 au 10 septembre 1985; 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 présente le nombre de préparations de gaz pour le mouvement propre et pour l'étalonnage utilisées pour le comptage.

INTRODUCTION[1]

During the period from November 1984 through August 1985, both the 2 L counter (Dyck and Fyles, 1962) and the 5 L counter (Dyck et al., 1965) were operated for the entire 10 months. The 2 L counter was operated at 2 atmospheres (atm) throughout the year. The 5 L counter was operated at 1 atmosphere throughout the year.

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). For a recent review of laboratory operations the reader is referred to Lowdon (1985).

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 standard, and the error in the half-life of ^{14}C (Lowdon and Blake, 1973). Finite dates are based on the 2σ criterion (95.5% probability) and 'infinite' dates on the 4σ criterion (99.9% probability).

Table 1. Monthly average count for background during the period November 7, 1984 to September 10, 1985

Month	2 L Counter (2 atm) cpm*	5 L Counter (1 atm) cpm*
November 1984	1.159 ± 0.023	2.253 ± 0.030
December	1.130 ± 0.022	2.274 ± 0.031
January 1985	1.143 ± 0.018	2.270 ± 0.025
February	1.138 ± 0.018	2.284 ± 0.025
March	1.112 ± 0.020	2.247 ± 0.025
April	1.195 ± 0.034	2.317 ± 0.051
May	1.160 ± 0.018	2.237 ± 0.031
June	1.153 ± 0.018	2.191 ± 0.025
July	1.181 ± 0.028	2.301 ± 0.055
August	1.128 ± 0.032	2.233 ± 0.047

* cpm = counts per minute

Table 2. Monthly average count (N_0)* for oxalic acid standard during the period November 7, 1984 to September 10, 1985

Month	2 L Counter (2 atm) cpm	5 L Counter (1 atm) cpm
November 1984	17.985 ± 0.098	27.736 ± 0.183
December	17.978 ± 0.098	27.725 ± 0.267
January 1985	18.227 ± 0.101	27.764 ± 0.125
February	18.066 ± 0.185	27.707 ± 0.119
March	18.145 ± 0.165	27.986 ± 0.169
April	17.943 ± 0.162	27.951 ± 0.126
May	18.024 ± 0.098	27.762 ± 0.171
June	18.004 ± 0.100	27.723 ± 0.126
July	18.201 ± 0.099	27.554 ± 0.130
August	18.091 ± 0.097	27.970 ± 0.197

* N_0 = 0.95 of the net counting rate of the NBS oxalic acid standard

[1] Data for the tables in the introduction were compiled by R.N. McNeely, Laboratory Supervisor since November 1981. The introduction follows the style developed by J.A. Lowdon. 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	5 L	Standard 2 L	5 L
November 1984	4	4	3	3
December	3	3	3	3
January 1985	4	4	3	3
February	4	4	3	3
March	4	4	3	3
April	4	4	3	3
May	4	4	3	3
June	4	4	3	3
July	4	4	3	3
August	5	4	3	3

Table 4. Number of monthly background and standard gas preparations used during the report period

Month	Background 2 L	5 L	Standard 2 L	5 L
November 1984	3	3	2	2
December	2	2	2	2
January 1985	4	4	2	2
February	3	2	2	2
March	2	2	2	2
April	3	3	2	2
May	3	2	2	2
June	2	3	1	2
July	2	2	2	2
August	2	2	2	2

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.

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

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: H. Zalasky, Canadian Forestry Service, Edmonton, and R.J. Mott, L.D. Farley-Gill, and H. Jetté (wood); N.F. Alley, formerly Ministry of the Environment, Province of British Columbia, Victoria, K.D. Bennett, University of Cambridge, Cambridge, England (formerly Scarborough College, West Hill), A. Dyer, Memorial University of Newfoundland, St. John's, M-A. Geurts, Université d'Ottawa, Ottawa, H. Hyvärinen, University of Helsinki, Helsinki, Finland, G.M. MacDonald, McMaster University, Hamilton (formerly Scarborough College, West Hill), and P.J.H. Richard, Université de Montréal, Montréal (pollen); J.P. Smol, Queen's University, Kingston (diatoms and chrysophytes); J.V. Matthews, Jr. (plant macrofossils and fossil arthropods); A.W.H. Damman, University of Connecticut, Storrs, Connecticut (vascular plants and mosses); L. Ovenden, formerly Scarborough College, West Hill (mosses); J.M. Topping and M.F.I. Smith, National Museum of Natural Sciences, Ottawa, J.S. Bleakney, Acadia University, Wolfville, C.G. Rodrigues, University of Windsor, Windsor (molluscs); and M.C. Wilson, University of Calgary, Calgary (vertebrates).

G. Mizerovsky, formerly GSC, carried out a number of elevation measurements on a stereotope plotting instrument. A.C. Roberts, Mineralogy Section, made the X-ray diffraction determinations on shell samples. R.J. Richardson, J.A. Snider, J.E. Dale, and K.E. Rolko assisted in the processing and examination of samples prior to their submission to the laboratory. K.E. Rolko helped with the compilation of this report.

GEOLOGICAL SAMPLES

Eastern Canada

Newfoundland

Compass Pond Series

A series of samples was extracted from a 620 cm-long core from "Compass Pond" (unofficial name), a small headwater pond on Route 410, 12.5 km north of the town of Baie Verte, north-central Newfoundland (50°02'03"N, 56°11'47"W), at an elevation of approximately 236 m. The core (#II), obtained from a water depth of 2.14 m near the lake's centre, consisted of 440 cm of dark brown gyttja overlying 107 cm of clay-gyttja and a basal 73 cm of clay: dark grey, silty and thixotropic near the top of the unit grading into a light grey stiff clay near the base. Collected June 22, 1984 by A. Dyer and J.B. Macpherson[1].

Dating was performed in order to provide terrestrial evidence of the timing of deglaciation of northern Baie Verte Peninsula or, alternatively, to indicate Late Wisconsinan ice-free conditions in that area; to calculate sedimentation rates for pollen influx; and to interpolate dates of significant vegetational events.

GSC-3910. Compass Pond II, 95-100 cm — 2050 ± 90, $\delta^{13}C = -25.5‰$

Gyttja (sample M.P.II (95-100 cm); 59.2 g wet) from 95 to 100 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 two 1-day counts in the 2 L counter.

GSC-3906. Compass Pond II, 195-200 cm — 3050 ± 140, $\delta^{13}C = -26.8‰$

Gyttja (sample M.P. II (195-200 cm); 40.3 g wet) from 195 to 200 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 two 1-day counts in the 2 L counter.

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

GSC-3903. Compass Pond II, 295-300 cm — 4690 ± 160‰

Gyttja (sample M.P.II (295-300 cm); 41.9 g wet) from 295 to 300 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 two 1-day counts in the 2 L counter. No $^{13}C/^{12}C$ ratio is available for this sample, as the excess CO_2 was lost.

GSC-3902. Compass Pond II, 395-400 cm — 6280 ± 120, $\delta^{13}C = -25.1‰$

Gyttja (sample M.P.II (395-400 cm); 53.3 g wet) from 395 to 400 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.

GSC-3992. Compass Pond II, 435-440 cm — 8310 ± 140, $\delta^{13}C = -25.2‰$

Gyttja (sample M.P.II (435-440 cm); 58.2 g wet) from 435 to 440 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.

GSC-3898. Compass Pond II, 495-500 cm — 9950 ± 150, $\delta^{13}C = -21.0‰$

Clay-gyttja (sample M.P.II (495-500 cm); 65.1 g wet) from 495 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.

GSC-3891. Compass Pond II, 540-545 cm — 11 700 ± 180, $\delta^{13}C = -17.4‰$

Basal clay-gyttja (sample M.P.II (540-545 cm); 69.8 g wet) from 540 to 545 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 (A. Dyer): GSC-3891 is a minimum date for deglaciation of the site and corresponds with the date of 11 800 ± 200 BP (GSC-3957; J.B. Macpherson, unpublished data) from the basal organic lake sediment of the King's Point site in southeastern Baie Verte Peninsula. The date is also in accordance with dated marine material ranging from 11 400 to 11 900 BP (GSC-3687, -2318, -2134, and -1505, all in GSC XXIII, 1983, p. 5-6) in the Notre Dame Bay area. This interpretation is supported by pollen analysis. The dated material lies at the junction of two pollen zones: the lower zone, in the mineral sediment, comprises a grass-herb tundra assemblage and the upper zone comprises a shrub-sedge tundra assemblage (with peaks of Cyperaceae (23.8%), **Myrica** (10.5%), **Salix** (7.9%), and an increase in **Betula** from 20.6% at the base to 54.3% at the top of the zone). The evidence strongly suggests that the northern Baie Verte Peninsula lay within the Late Wisconsinan ice limit, contrary to Grant's (1977) hypothesis that the area lay beyond the limit (cf. also Prest, 1984).

The other dates in the series provide control for the arrival dates of boreal forest tree species. The initial rise in **Picea** pollen percentages (to 21.3%) and concentrations (to 23 000 grains/cm^3) indicate that spruce had arrived by 9300 BP, 1000 years later than at the King's Point site (GSC-4003, 10 300 ± 170 BP; J.B. Macpherson, unpublished data), approximately 60 km to the south. In addition, discriminant analysis (cf. Birks and Peglar, 1980) performed on spruce grains suggests that both **P. glauca** and **P. mariana** invaded the existing shrub tundra. The northward migration of spruce was possibly hindered by stagnant ice in lowland areas; Small Scrape Pond, 15 km to the southeast and at an elevation of approximately 122 m, was deglaciated by ca. 10 400 BP (see GSC-3966, this list).

The immigration of **Abies balsamea** occurred approximately one hundred years after the arrival of spruce. Its peak and subsequent decline closely mirror the early maximum of **Alnus** at ca. 8400 to 7400 BP. By ca. 8000 BP, **P. glauca** declined in favour of **P. mariana** and, at about this time, a second, larger peak in **Betula** is registered, representing the presence of **B. papyrifera**. To a certain degree, this sequence parallels that found by Lamb (1980, 1984) and Engstrom and Hanssen (1985) in southeastern Labrador although the events occurred earlier in the northern Baie Verte Peninsula.

Total pollen influx (excluding aquatics and pteridophytes) was highest between ca. 6200 and 2000 BP ranging from 4.5 to 15.1 x 10^3 grains/cm^2/year ($\bar{x}$ is 9.6 x 10^3 grains/cm^2/year). After 2000 BP, total pollen influx decreased to an average of 3 x 10^3 grains/cm^2/year. Further work on vegetational events and Holocene climatic interpretation is in progress. (A. Dyer, Palynological investigations of the Late Quaternary vegetational history of the Baie Verte Peninsula, north-central Newfoundland; unpublished M.Sc. thesis, Department of Geography, Memorial University of Newfoundland, St. John's, in preparation).

Small Scrape Pond Series

Duplicate cores were retrieved from "Small Scrape Pond" (unofficial name), a headwater pond draining into Scrape Pond, approximately 4 km southwest of the village of Ming's Bight, Baie Verte Peninsula, north-central Newfoundland (49°56'59"N, 56°05'17"W), at an elevation of approximately 122 m. Collected June 21, 1984 by A. Dyer and J.B. Macpherson, Memorial University of Newfoundland, St. John's, Newfoundland.

GSC-3937. Small Scrape Pond I, 315-320 cm — 9510 ± 160, $\delta^{13}C = -22.5‰$

Clay-gyttja (sample 2T.I.P.-I (315-320 cm); 62.5 g wet) from 315 to 320 cm below the sediment/water interface. The 320 cm-long core (#I), obtained from a water depth of 4.86 m, consisted of 295 cm of dark brown gyttja grading into clay-gyttja of unknown 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-3966. Small Scrape Pond II, 282-287 cm — 10 400 ± 160, $\delta^{13}C = -21.7‰$

Basal clay-gyttja (sample 2T.I.P.-II (282-287 cm); 57.7 g wet) from 282 to 287 cm below the sediment/water interface. The core (#II), obtained from a water depth of 4.9 m, consisted of 265 cm of dark brown gyttja overlying 22 cm of dark olive grey clay-gyttja and 9 cm of light greenish grey clay. 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 (A. Dyer): GSC-3966 is a minimum date for deglaciation of the site. The date is 1300 years younger than the minimum date for deglaciation of the Compass Pond site (this list), 15 km to the northwest and approximately 114 m higher in elevation, and suggests downwasting of the ice in northern Baie Verte Peninsula. This contrasts with evidence from other terrestrial sites (GSC-3608, -3647, and -3634; all in GSC XXIII, 1983, p. 4-5) that indicates a pattern of ice recession towards the interior of north-central Newfoundland. Pollen analysis of GSC-3966 reveals that the dated material occurs at the transition from a sedge-herb tundra assemblage, in the immediately underlying inorganic material, into a shrub-tundra assemblage.

GSC-3998. Port Saunders 9000 ± 80
$\delta^{13}C = +0.8‰$

Marine pelecypod shells (sample 80-GS-44; 47.8 g; **Mytilus edulis;** identified by D.R. Grant) from a borrow pit on the flank of an interlobate moraine 1.2 km northeast of the wharf in Port Saunders, Newfoundland (50°39.00'N, 57°17.38'W), at an elevation of 34 m above high tide level. Collected July 16, 1980 by D.R. Grant.

Comment (D.R. Grant): The shells were intact in life position and part of a large mass interpreted as a "mussel bank" which was covered by 4 m of coarse marine offlap gravel. Initially the date was intended to provide a minimum age for separation of Labradorean and Newfoundland ice domains along the Doctors interlobate moraine (Grant, in press) which is estimated at more than 12 000 years. The date is nonetheless valuable as one of the few indications of intermediate relative sea levels during the postglacial regression from a 142 m local marine limit (Grant, in press). Specifically, it helps define a sea level recovery that is transitional between the continuous emergence postulated for areas to the north (Grant, 1972) and the emergence/submergence pattern for areas to the south (e.g., Brookes et al., 1985).

Comment (W. Blake, Jr.): The sample submitted to the laboratory comprised 6 intact right valves and 11 fragments, plus 6 intact left valves and 5 fragments. All shell material was well preserved; although the exterior surfaces were chalky, the internal lustre and nacreous layer were intact on all shells. The largest valve measured 4.0 x 2.0 cm. Date is based on one 3-day count in the 5 L counter.

GSC-4006. Parsons Pond Hill 10 200 ± 100
$\delta^{13}C = +0.7‰$

Marine pelecypod shells (sample 72-GS-404; 48.0 g; **Mytilus edulis;** identified by D.R. Grant) from a borrow pit in a raised beach on the east side of the highway along the west flank of Parsons Pond Hill, 3.9 km south-southwest of the bridge in Parsons Pond village, Newfoundland (49°59.76'N, 57°43.50'W), at an elevation of 51 m above high tide level. Collected July 6, 1972 by D.R. Grant

Comment (D.R. Grant): The sample was part of a large mass of intact shells in life position interpreted as a "mussel bank". The gravel body is a mantle on the flank of a major recessional end moraine constructed by a spatulate piedmont tidewater glacier that issued from Long Range Mountains (Grant, in press). The date thus gives a minimum age for ice retreat from the coastal lowlands. The beach lies well below the local marine limit of 106 m (Grant, in press), and thus gives an important intermediate datum for postglacial regression. Relative sea level probably descended below its present level before 6000 BP and has since recovered (cf. GSC-4026, 7690 ± 90 BP; this list) a result which is in harmony with Brookes and Stevens (1985). Moreover, the elevation of the bulky littoral body seems to correspond to the interpolated position of the Bay of Islands Surface – a stillstand or transgression linked to the Ten Mile Readvance which occurred just after 10 900 BP (Grant, in press).

Comment (W. Blake, Jr.): This sample was more fragmented than the shells making up GSC-3998 (this list). GSC-4006 contained only two intact right valves plus one intact left valve. The largest valve measured 5.0 x 2.7 cm. The shells, though fragile, were well preserved with intact nacreous layer and internal lustre. Date is based on one 3-day count in the 5 L counter.

St. Paul's Series

A blanket of shell-bearing marine sediments overlying till and covered by surface peat is exposed in a sea cliff on the Gulf of St. Lawrence shore 2.1 km west of the highway bridge at St. Paul's village, Newfoundland (49°51.26'N, 57°49.70'W). Collected July 8, 1984 by D.R. Grant.

GSC-4026. St. Paul's (I) 7690 ± 90
$\delta^{13}C = -30.4‰$

Peat (sample 84-GS-21; 65.0 g; largely **Sphagnum;** identified by D.R. Grant) at an elevation of 5.4 m above high tide level. The dated sample was the basal centimetre of a 1 m-thick blanket bog covering marine sediment.

GSC-4060. St. Paul's (II) 9320 ± 100
$\delta^{13}C = +0.3‰$

Marine pelecypod shells (sample 84-GS-19; 47.5 g; **Mytilus edulis;** identified by D.R. Grant) intact in life position as a "mussel bank" at an elevation of 5.2 m above high tide level, in the uppermost part of a marine sand layer overlying basal till.

GSC-4048. St. Paul's (III) 9550 ± 100
$\delta^{13}C = +0.8‰$

Marine pelecypod shells (sample 84-GS-27; 38.0 g; **Mya truncata uddevalensis;** identified by D.R. Grant) at an elevation of 4 m above high tide level. The shells were extracted from a lenticular body of grey stony plastic clay-silt with brownish oxidation at the top, containing also **Chlamys islandicus, Lithothamnion** spp. and **Balanus** spp., enclosed in a well stratified sublittoral(?) sand containing **Mesodesma arctatum**, with a layer of **Mytilus edulis** at the top.

Comment (D.R. Grant): This is the same site, or very near the site, where 'a compact grey till-like layer' had **Mesodesma arctatum** which dated 9230 ± 140 BP (GSC-1630) that Brookes (in GSC XIII, 1973, p. 8) interpreted as ice-rafted sediment. This series of dates was done to test the glacial origin of the clay layer, and to define relative sea level history. The two dates on the marine sand blanket (GSC-4048 and -4060) are close and in reasonable agreement. Together with GSC-4026, they require that relative sea level had fallen below 5 m elevation between approximately 7700 and 9200 BP – a result in accordance with Brookes and Stevens (1985). Hence water depth was too shallow to allow icebergs to deposit stony mud. To explain the intercalation of a thin small mass of partly weathered older offshore mud in younger sublittoral sand at shallow depths, it is suggested that partly emergent deepwater mud became frozen to the base of shorefast ice, then was released when the floe stranded elsewhere on the sandy bottom.

Comment (W. Blake, Jr.): The entire damp sample (350 g) comprising GSC-4026 was air dried, then 65.0 g of dry peat (flattish lumps up to 1 cm in thickness) was selected for dating. Following the NaOH leach, the sample showed no reaction with HCl. For GSC-4048 one whole **Mya truncata** valve (4.0 x 3.5 cm) plus seven fragments (the largest measured 5.9 x 3.5 cm) were used. All shells were 1 to 3 mm thick (thicker at the hinges), and no periostracum was present on the exterior, which was chalky in places. For GSC-4060 the largest whole valve of **Mytilus edulis** (only a few were still intact) measured 3.5 x 1.7 cm. The shells (all <1 mm thick) were fragile but well preserved. Each date is based on two 1-day counts in the 5 L counter.

Stephenville Crossing Series (A)

Four samples of **Sphagnum** peat were extracted from a single core obtained with a Russian peat sampler from a raised bog on glaciomarine deltaic deposits of Harry's River, 1.6 km north of Stephenville Crossing, Newfoundland (48°31'16"N, 58°26'42"W). The present vegetation of the bog, whose surface is at an elevation of 22.1 m, is dominated by **Kalmia angustifolium** and **Sphagnum fuscum**. Mineral soil occurs at 430 cm below the bog surface and approximately 17.8 m a.s.l. Collected August 1980 by A.W.H. Damman, University of Connecticut, Storrs, Connecticut.

GSC-3253. Stephenville Crossing, 97-100 cm — 2040 ± 80

Sphagnum peat (sample I-1; 2.5 g dry) from 97 to 100 cm below the bog surface. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3291. Stephenville Crossing, 197-203 cm — 3130 ± 110

Sphagnum peat (sample I-2; 21.2 g) from 197 to 203 cm below the bog surface. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3299. Stephenville Crossing, 297-303 cm — 4350 ± 90

Sphagnum peat (sample I-3; 20.0 g) from 297 to 303 cm below the bog surface. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3342. Stephenville Crossing, 424-430 cm — 6210 ± 130

Sphagnum peat (sample I-4; 25.2 g) from 424 to 430 cm below the bog surface. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Comment (A.W.H. Damman): Tree stumps and trunks at the mineral soil surface show that these bogs developed by paludification of forests growing on these gravelly deposits. Thus, the terrace surface was above sea level for an unknown time before bog formation started. The age of the basal peat indicates that peat bogs were present on these deposits by 6210 ± 130 BP (GSC-3342).

Net accumulation rates, based on depth of present peat, were much lower during the last 2000 years than before. It took approximately 2040 years to develop the upper 98.5 cm (0.48 mm/year) whereas the peat from 98.5 to 200 cm formed in 1090 years (0.93 mm/year). Since the bulk density of the peat at 1 to 2 m is about 1.4x that of the upper 1 m and decomposition losses are not considered in this estimate, the actual accumulation rate from about 3000 to 2000 BP is at least 3x that during the last 2000 years. This decrease in accumulation rate is probably due to the bog surface reaching the maximum elevation of the water mound that can be maintained in the peat under the present climatic conditions (Damman, in press). The pretreatment of all four samples included a cold NaOH leach.

Stephenville Crossing Series (B)

Peat and wood from the basal peat horizon of a raised **Sphagnum** bog (plateau bog) exposed in an active gravel pit, west of the Vocational School, Stephenville Crossing, Newfoundland (48°30'53"N, 58°26'47"W). Elevation of the bog surface is 16.8 m and peat depth at the sampling site is 125-130 cm. Collected August 1980 by A.W.H. Damman.

GSC-3275. Stephenville Crossing (I) — 1620 ± 50

Sphagnum peat (sample 6; 14.5 g dry).

GSC-3269. Stephenville Crossing (II) — 1850 ± 40

Wood (sample 7; 10.0 g; **Picea** sp., unpublished GSC Wood Identification Report No. 81-17 by R.J. Mott).

Comment (A.W.H. Damman): The younger ages in the basal peat layer of this site, compared to 6210 ± 130 BP (GSC-3342) in the basal peat of other parts of the same bog, indicate that the marginal part of the bog was paludified much more recently.

Comment (W. Blake, Jr.): GSC-3275, which contained some twigs and wood fragments, decreased in weight from 90.8 to 14.5 g during overnight drying in an electric oven. GSC-3269, also dried in the oven, decreased in weight from 13.5 to 10.0 g. The pretreatment of GSC-3275 included a cold NaOH leach. Each date is based on one 3-day count in the 5 L counter.

GSC-3345. Stephenville Crossing — 4450 ± 110

Peat (sample 1-5; 14.2 g dry) from a raised bog on glaciomarine deltaic deposits of Harry's River, collected with a Russian peat sampler in the southwestern part of the bog complex north of Stephenville Crossing (48°31'10"N, 58°27'03"W). Sample collected at 397 to 406 cm below the bog surface (elevation 21.2 m) of **Gaylussacia baccata-Kalmia angustifolia-Sphagnum fuscum** vegetation. Mineral soil in core occurs at 430 cm; very woody peat below 406 cm. Collected August 1980 by A.W.H. Damman.

Comment (A.W.H. Damman): This sample is about the same age as peat at 3 m (GSC-3299, 4350 ± 90 BP), and 1760 years younger than the basal peat (GSC-3342, 6210 ± 130 BP; both in this list), in another core from the same raised bog.

Paludification of the marginal peat of the deltaic terrace at a later date than the central parts probably accounts for the younger age of the peat in the present core. The site of this core was located about 175 m from the southwestern margin, whereas GSC-3299 and -3342 are from a core collected more than 500 m from the nearest margin of the raised bog. Pretreatment included a cold NaOH leach. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3433. Cow Head — 8250 ± 320, $\delta^{13}C = +1.0‰$

Three paired pelecypod valves (sample 81-2; 6.6 g; **Hiatella arctica**; identified by I.A. Brookes) from borings in Cambro-Ordovician carbonate breccia at Cow Head, Newfoundland (49°55'N, 57°48'W), at an elevation of 3 to 6 m. The bored rock surface is overlain by an irregular thickness of poorly sorted gravel beneath a beach-ridged marine terrace at 8 m a.s.l. Collected July 1981 by I.A. Brookes, York University, Toronto.

Comment (I.A. Brookes): Demise of bivalves is attributed to surf erosion and/or gravel deposition related to a sea level at 8 m which is thus dated at ca. 8300 BP. GSC-1763 (8340 ± 150 BP, elevation 4 m) and GSC-1762 (8650 ± 140 BP, elevation 8 m; both in GSC XVII, 1977, p. 3) relate more or less closely to this sea level plane which is warped up to the northeast along this coast (Brookes and Stevens, 1985).

Comment (W. Blake, Jr.): All shells, although whole, were misshapen. The largest measured 2.0 x 1.2 cm. All holes bored in shells were less than 1 mm in diameter.

No periostracum was preserved but the shells retained some internal lustre. Because of the small sample size, only the outer 5% of shell material 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

GSC-4018. Cape George >37 000
$\delta^{13}C = +0.1‰$

Fragments of marine pelecypod shells (sample 84-GS-01; 92.0 g; mainly **Mercenaria mercenaria;** identified by D.R. Grant) at an elevation of 20 to 27 m above high tide level, contained in a reddish brown silty till exposed in a cliff on Gulf of St. Lawrence shore 2.4 km northwest of Cape George and 0.1 km west of the mouth of School Brook, Nova Scotia (45°53.09'N, 61°55.31'W). Collected June 27, 1984 by D.R. Grant. Two determinations were made:

GSC-4018. Outer fraction 35 600 ± 990
$\delta^{13}C = -0.1‰$

Outer fraction of shells (10 to 60%) after outermost 10% was removed by HCl leach. Date is based on one 3-day count in the 5 L counter.

GSC-4018. Inner fraction >37 000
$\delta^{13}C = +0.1‰$

Inner fraction of shells (60 to 100%). Date is based on one 4-day count in the 5 L counter.

Comment (D.R. Grant): Of the eighteen fragments used, the largest was 6 cm and the thickest 7 mm. All had internal lustre, but the exterior was chalky, glacially striated, with some iron and manganese stain. Enclosing till rests on an emergent intertidal rock platform 4 to 6 m above present tide level, with associated gravel and sand. The littoral beds are assigned to the highest sea level stand of the last interglaciation (Grant, 1980). Date is considered minimal, rather than intra-Wisconsinan. Hence the shells were probably derived from previously weathered interglacial (i.e. Sangamonian) marine sediments and were incorporated into till of the first glacial advance over the area, evidently from north and west judging from lithology. Compares with GSC-1639 (>34 000 BP), -1408 (32 100 ± 900 BP; both in GSC XXIV, 1984, p. 4-5) from nearby Cape Breton Island.

GSC-2598. Minas Basin 3750 ± 60
$\delta^{13}C = -1.2‰$

A single oyster valve (sample PC-4/77; 54.4 g; **Crassostrea virginica;** identified by W. Blake, Jr.) from mud in a tidal flat exposure, located 2.4 km north of Evangeline Beach, Minas Basin, Nova Scotia (45°09.3'N, 64°19'W), at Extreme Low Tide Level, 14.6 m below HTL. Collected July 1977 by students of J.S. Bleakney, Acadia University, Wolfville, Nova Scotia; submitted by V.K. Prest.

Comment (W. Blake, Jr.): See comment for Minas Basin Series, next in this list. Very strong winds at a time of low tide had stripped away a layer of mud and exposed an ancient oyster bed. Many valves were still paired and in growth position. This valve was 16 cm long, 10 cm wide, and up to 1.1 cm thick. A transverse section was sawed out for dating. No pitting, encrustations, or chalkiness was evident; interior was slightly lustrous. Adhering mud was scraped off. Both the outer shell and the inner nacreous layer were composed of calcite plus a trace of quartz and dolomite (X-ray diffraction). Date is based on two 1-day counts in the 5 L counter.

Minas Basin Series

Shell and wood samples were collected from mud in the freshly exposed erosion bank of an intertidal creek, located 2.28 km north of the east end of Long Island, Evangeline Beach, Nova Scotia (45°09.5'N, 64°18'W). All samples were in situ. Elevations in relation to mean sea level (MSL) were determined by surveying. All samples were approximately 13 m below highest high water level (HHWL).

GSC-3105. Minas Basin (I) 4470 ± 60
$\delta^{13}C = -24.4‰$

Wood from a tree trunk (sample SB-15-5-80 (A); 11.4 g; **Tsuga canadensis;** unpublished GSC Wood Identification Report No. 80-18 by L.D. Farley-Gill), at 5.5 m below mean sea level (MSL). Collected May 1980 by J.S. Bleakney.

GSC-3435. Minas Bay (II) 4220 ± 70
$\delta^{13}C = -26.0‰$

Wood from a tree trunk (sample SB-15-5-80 (B); 11.8 g; **Pinus strobus;** unpublished GSC Wood Identification Report No. 80-18 by L.D. Farley-Gill), at 5.5 m below MSL. Collected May 1980 by J.S. Bleakney.

GSC-3040. Minas Basin (III) 3800 ± 80
$\delta^{13}C = -1.1‰$

Paired valves of ribbed mussel shells (sample SB-9.9.79 (A); 27.7 g; **Geukensia demissa;** identified by J.S. Bleakney), at 5.7 m below MSL. Collected September 1979 by J.S. Bleakney.

GSC-3043. Minas Basin (IV) 3700 ± 60
$\delta^{13}C = -1.2‰$

Pieces from a single oyster shell (sample SB-9.9.79 (B); 46.4 g; **Crassostrea virginica;** identified by J.S. Bleakney), at 5.7 m below MSL. Collected September 1979 by J.S. Bleakney.

Comment (J.S. Bleakney): The forest area is but 0.2 to 0.3 m above the in situ ribbed mussels and oyster bed, and apparently became submerged about 600 years prior to the development of the subtidal oyster bed, which in turn was entombed intact by increasing turbidity and sedimentation. The extinction of oysters in Minas Basin was probably the result of evolution of megatidal cycles at that time. The present location at 1.5 to 2.0 m above lowest low water level (LLWL) of this original subtidal oyster bed is the first evidence that low water levels in Minas Basin have recently descended, even though sea levels generally have been progressively rising (Bleakney and Davis, 1983).

Comment (W. Blake, Jr.): In addition to the GSC age determinations, a third individual oyster has been dated at 3615 ± 100 BP (DAL-296) and a second lot of ribbed mussels gave an age of 3310 ± 125 BP (DAL-362; both dates in Bleakney and Davis, 1983). The single huge oyster used for GSC-3043 was 19.3 cm long, 11.0 cm wide, and up to 1.0 cm in thickness. Pieces of the shell were cut out using a diamond saw and tap water as a lubricant. X-ray diffraction shows that both the outer blue shell and the inner white shell are composed of calcite, siderite, and rhodochrosite series (<20%). On the exterior of this shell, near the hinge are the remains of a mussel (**Geukensia demissa**) to which the oyster was attached. The sample used for GSC-3040 comprised eight right valves and nine left valves; all the valves were in intact pairs at the time of collection (J.S. Bleakney, personal communication, 1980). The periostracum was intact on all valves; the largest valves measured 6.4 x 2.6 cm, the smallest was 4.2 x 1.8 cm. Adhering clay was scraped off. X-ray diffraction showed that the outer shell was aragonite and calcite (<20%), whereas the inner nacreous layer was aragonite.

GSC-3040 was mixed with dead gas for counting. Each of the four dates is based on two 1-day counts in the 5 L counter.

Leak Lake Series

Leak Lake is situated at the edge of the outwash deposit at Parrsboro, Nova Scotia (45°26.2'N, 64°21'W), at an elevation of approximately 42 m. Four Livingstone cores (Leak Lake 2, 3, 4, and 5), taken in approximately 13 m of water, contain the lower part of the Holocene gyttja (green-brown) and penetrate well into red silts and clays (1 to 2 m), barren of organic material, interpreted as glacial sediment. The four cores are identical in Holocene sediment stratigraphy and samples from similar stratigraphic positions in cores Leak Lake 2 and Leak Lake 3 were combined to yield date GSC-2728. Likewise, samples from cores Leak Lake 4 and Leak Lake 5 (the only core containing the entire Holocene interval) were combined to yield date GSC-2880. All of the samples come from the base of the gyttja and were dated in hopes of giving a minimum age for the outwash at Parrsboro. Leak Lake 2, 3, and 4 collected July 1978, Leak Lake 5 collected December 1978 by D.M. Wightman, then Dalhousie University, Halifax, Nova Scotia; now Alberta Geological Survey, Edmonton, Alberta.

GSC-2728.	Leak Lake (2, 3)	12 900 ± 160 $\delta^{13}C$ = -30.2‰

Gyttja (sample Leak 2:1 (82.5-87.5) and 3:2 (105.5-110.5); 140 g wet). 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-2880.	Leak Lake (4, 5)	15 900 ± 1200 $\delta^{13}C$ = -28.3‰

Gyttja (sample Leak (2) Core 5:5B (445-450) and Core 4:2 (93-98); 133 g wet). NaOH leach was omitted from sample pretreatment. Sample was mixed with dead gas for counting. Date is based on three 1-day counts in the 2 L counter.

Comment (D.M. Wightman): The pollen sequences and sediment stratigraphy of the gyttja in four cores taken in Leak Lake (Leak Lake 2, 3, 4 and 5) are essentially identical (Wightman, 1980) and bear striking similarities to the pollen profile and sediment stratigraphy of cores taken from Basswood Road Lake in New Brunswick (Mott, 1975). As such, the chronology of the Basswood Road Lake sequence can be used to assess the reliability of the Leak Lake radiocarbon dates (R.J. Mott, personal communication). The sample for date GSC-2728 occurs approximately at the boundary between pollen zones 9 and 8 (Mott, 1975) and as this boundary was dated at 12 600 ± 270 BP (GSC-1067, GSC XV, 1975, p. 9) at Basswood Road Lake, the date of 12 900 ± 160 BP appears to be quite good. The sample for date GSC-2880 comes from pollen zone 9 (tundra type vegetation) at the base of the core but only about 7 cm of gyttja separate this sample from the sample used for date GSC-2728. However, date GSC-2880 appears to be spuriously old (15 900 ± 1200 BP). Thus there is a distinct possibility that contamination by 'old' carbon, derived from nearby Carboniferous rocks, has affected the ages of both GSC-2880 and -2728. A similar date of 16 500 ± 370 BP (GSC-1063, GSC XV, 1975, p. 9) was obtained from Little Lake in New Brunswick and Mott (1975) felt that this date was also too old. Two other dates (DAL-313, -314; Wightman, 1980) from the Leak Lake cores add further credibility problems. A sample from cores Leak Lake 2 (87.5-99.5 cm) and Leak Lake 3 (110.5-122.5 cm) should have given a date slightly older than 12 900 ± 160 BP (GSC-2728) but instead yielded an age of 9580 ± 310 BP (DAL-313). A sample from a stratigraphically higher position in the cores (Leak Lake 2, 29-41 cm; Leak Lake 3, 44-56 cm) was dated at 9715 ± 200 BP (DAL-314). It is felt that the Leak Lake dates are too variable to be regarded as reliable.

Quebec

Lac à Léonard Series

A series of samples was extracted from a 550 cm-long core from Lac à Léonard, 2 km south of Mont St-Pierre, Gaspé, Quebec (49°12'30"N, 65°48'45"W), at an elevation of 17 m. All measurements were made from the sediment-water interface. The water depth at the coring site was 50 cm. Collected June 13, 1979 by P. Richard and A. Larouche, Département de Géographie, Université de Montréal, Montréal, Québec, using Hiller, Russian and Livingstone corers.

GSC-3037.	Lac à Léonard, 90-100 cm	3100 ± 60 $\delta^{13}C$ = -30.4‰

Telmatic peat (sample LEO 90-100; 24.6 g dry). Date is based on two 1-day counts in the 5 L counter.

GSC-3046.	Lac à Léonard, 185-200 cm	4920 ± 60

Mixed gyttja and telmatic peat (sample LEO 185-200; 11.6 g dry). Date is based on two 1-day counts in the 5 L counter.

GSC-3214.	Lac à Léonard, 390-400 cm	7160 ± 110 $\delta^{13}C$ = -28.1‰

Gyttja (sample LEO 390-400; 13.3 g dry). 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-3217.	Lac à Léonard, 440-450 cm	7860 ± 120 $\delta^{13}C$ = -28.6‰

Gyttja (sample LEO 440-450; 9.7 g dry). 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-3210.	Lac à Léonard, 485-500 cm	8970 ± 140 $\delta^{13}C$ = -29.3‰

Gyttja (sample LEO 485-500; 16.8 g dry). 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 (P. Richard): Five events are fixed by the dates, according to Labelle and Richard (1984): 1) the beginning of the accumulation of organic sediment in the basin (GSC-3210; 8970 ± 140 BP), 2) the immigration of **Abies balsamea** into the region and the maximum pollen representation of **Alnus crispa** (GSC-3217; 7860 ± 120 BP), 3) the end of the **Alnus crispa** phase (GSC-3214; 7160 ± 110 BP), 4) the immigration of **Acer saccharum** and **Ulmus americana**, and 5) a decrease in the pollen concentration and an increase of Cyperaceae pollen corresponding to an increase in paludification of the lake (GSC-3037; 3100 ± 60 BP).

GSC-3741.	Rivière-Beaudette North	11 100 ± 100 $\delta^{13}C$ = -2.2‰

Marine pelecypod shells (sample RAB-82-44; 34.8 g; **Mya arenaria**; identified by S.H. Richard) from a grey, medium grained sand unit lying above a thin (approximately 6 to 10 cm), highly fossiliferous, stony marine sandy mud unit, and forming the bottomset beds of an ice marginal outwash delta. This sand unit is about 4 m below ground level and is overlain by a unit of well developed foreset deltaic sand beds capped by another unit of topset pebbly sand beds. Exposure of this glaciomarine ice proximal deposit is in an active sand and gravel borrow pit, 2.4 km northwest of the village of Rivière-Beaudette, Soulanges County, Quebec (45°14'50"N, 74°21'10"W), at an elevation of approximately 56 m. Collected October 6, 1982 by S.H. Richard.

Comment (S.H. Richard): The marine shells dated were found articulated and upright, in growth position. The underlying unit contains upright, articulated valves of the cold water species **Mya truncata.** These two units are overlain by a sandy deltaic unit 3 to 4 m thick containing disarticulated, single valves of the species **Mya arenaria** and **Macoma balthica** lying with their convex sides upwards, parallel to the dip along the bedding planes of the foreset and topset beds. The intertonguing of marine mud and ice proximal deltaic sand beds suggests that the sequence of sediments making up the northern segment of the Rivière-Beaudette ridge is a glaciomarine unit deposited in an ice contact deltaic marine environment at the margin of an ice lobe grounded in the Champlain Sea (Richard, 1976, 1977, 1982a,b). GSC-3741 provides an age for the time of deposition of the bottomset marine sand bed as a sediment flow or density current deposit before its burial by the prograding foreset sand beds during the building of the delta by the meltwater issuing from the ice margin.

GSC-3741 is the oldest radiometric determination obtained for specimens of **Mya arenaria** from the central part of the Champlain Sea basin in the Montreal area. It extends the known stratigraphic range of this species by more than two hundred years. The stratigraphic position where these marine shells were found, inside an ice marginal outwash delta, shows that when the last ice lobe deployed by the Laurentide Ice Sheet across the Ottawa-St. Lawrence Lowland reached its eastern limit of advance at Rivière-Beaudette, the first penetration of **Mya arenaria** into the western Champlain Sea basin had already occurred. It also shows that the two geological events overlapped each other and were partly synchronous (GSC-3475, 10 500 ± 100 BP; GSC XXII, 1982, p. 5).

Comment (W. Blake, Jr.): Most shells in this sample were fragmented; the largest fragments measured 5.7 x 3.0 cm. Some pieces were iron stained, but some had internal lustre also. All fragments were <1 mm thick. No periostracum remained. Only the outer 10% of shell material was removed by HCl leach. Date is based on one 3-day count in the 5 L counter.

Rivière-Beaudette South Series

Two shell samples from a grey, pebbly, stony marine clay unit, approximately 4 m in thickness, lying above a mostly unfossiliferous unit of ice contact submarine outwash gravels and sands forming the core of the Rivière-Beaudette ridge near its southern end. Exposure of this proximal glacial marine pebbly clay unit is in a sand and gravel borrow pit (Leroux Pit) 2.0 km south of the village of Rivière-Beaudette, Soulanges County, Quebec (42°12'35"N, 79°19'25"W). Collected July 1981 by C.G. Rodrigues, University of Windsor, Windsor, Ontario, and S.H. Richard.

GSC-3809. Rivière-Beaudette South (I) — 10 900 ± 100; $\delta^{13}C = -2.7‰$

Marine pelecypod shells (sample RAB-81-13; 38.0 g; **Mya arenaria** and **Mya** sp.; identified by S.H. Richard and W. Blake, Jr.) from the upper part of the marine clay unit, at an elevation of approximately 58 m.

Comment (S.H. Richard): The marine shells dated were found articulated and upright, in growth position. This unit was also found to contain upright, articulated valves of the cold water species **Mya truncata.** GSC-3809 is the second radiocarbon age determination obtained on shells from a stratigraphic section exposed in the southern part of the Rivière-Beaudette ridge. The first date (11 000 ± 90 BP, GSC-3702; this list) came from a level characterized by a **Balanus hameri** macrofaunal association at the base of the fossiliferous unit. GSC-3809 comes from a level some 3 m higher up in the section near the top of the overlying **Hiatella arctica** association zone. This level is characterized by the first appearance in this association, as an accompanying species, of shells of **Mya arenaria** and by a reduced salinity, cold water **Elphidium clavatum** dominant foraminiferal assemblage (sample no. 3D in Rodrigues and Richard, 1983). GSC-3809, together with GSC-3702, provides an age range for the time of deposition, during the construction of the submarine fan lobe, of the stony marine clay unit forming the western side of the Rivière-Beaudette ridge.

Comment (W. Blake, Jr.): All identifiable fragments of **Mya truncata** were excluded from the dated sample, but some small pieces may have remained. The largest **Mya arenaria** valve measured 4.2 x 2.7 cm. All shells were <1 mm thick except at the hinge. The shells were chalky, exhibited little internal lustre, and had no pitting or encrustations. Only the outer 10% of shell was removed by HCl leach. Date is based on one 3-day count in the 5 L counter.

GSC-3702. Rivière-Beaudette South (II) — 11 000 ± 90; $\delta^{13}C = 1.4‰$

Barnacle shells (sample RAB-81-14; 48.5 g; **Balanus hameri**; identified by C.G. Rodrigues and S.H. Richard) from the base of the marine clay unit, about 4 m below ground level, at an elevation of approximately 56 m.

Comment (S.H. Richard): GSC-3702 is the first radiocarbon age measurement obtained for plates of the stenohaline, deepwater barnacle **Balanus hameri** from the western Champlain Sea basin. The radiocarbon dated marine clay bed is believed to have originated as fine suspended sediment (rock flour) supplied to the marine environment in relatively deep water (>15 m) by meltwater issuing from the ice margin. The occurrence of thin strata of well rounded to angular pebbles and stones at various levels in the clay unit is the result of fluctuating discharge of water and sediment. This lithostratigraphy suggests that the sequence of sediments making up the Rivière-Beaudette ridge is a glaciomarine unit deposited in an ice contact subaqueous outwash fan near the margin of an ice lobe grounded in the Champlain Sea (Richard, 1977, 1982b). GSC-3702 dates the beginning of deposition of the stony marine clay unit forming parts of the western side of the Rivière-Beaudette ridge. If the interpretation of the origin of the ridge is correct, the presence of an ice lobe at Rivière-Beaudette ca. 11 000 years BP provides strong evidence for a readvance across Ottawa Valley into the western Champlain Sea basin between approximately 11 100 and 11 000 BP (Richard, 1975; GSC XXIII, 1983, p. 11).

Comment (W. Blake, Jr.): The shells comprising the sample were brushed clean of adhering sediment. Some fragments exhibited iron staining. The largest piece measured 5.3 x 1.9 cm. Date is based on one 3-day count in the 5 L counter.

Ontario

Nutt Lake Series

A series of lake sediment samples from a 720 cm-long core taken in 780 cm of water at Nutt Lake, Watt township, Muskoka District, Ontario (45°13'N, 79°27'W), at an elevation of 305 m. Collected February 1984 by K.D. Bennett, L.C. Cwynar, K.A. Hadden, and J.C. Ritchie, University of Toronto, Toronto, using a modified Livingstone piston corer.

GSC-3920. Nutt Lake, 51-57 cm — 1080 ± 90, $\delta^{13}C = -28.9‰$

Organic mud (sample Core C 13, 831-837 cm; 102.6 g wet) from 51 to 57 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3913. Nutt Lake, 105-111 cm — 2060 ± 70, $\delta^{13}C = -29.5‰$

Organic mud (sample Core B 8, 885-891 cm; 84.9 g wet) from 105 to 111 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3911. Nutt Lake, 155-161 cm — 2820 ± 80, $\delta^{13}C = -29.8‰$

Organic mud (sample Core B 8, 935-941 cm; 75.6 g wet) from 155 to 161 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3909. Nutt Lake, 213-219 cm — 3730 ± 80, $\delta^{13}C = -30.6‰$

Organic mud (sample Core B 9, 993-999 cm; 89.0 g wet) from 213 to 219 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3869. Nutt Lake, 278-284 cm — 4460 ± 80, $\delta^{13}C = -28.6‰$

Organic mud (sample Core B 10, 1058-1064 cm; 95.4 g wet) from 278 to 284 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3877. Nutt Lake, 321-327 cm — 5640 ± 80, $\delta^{13}C = -27.6‰$

Organic mud (sample Core B 10, 1101-1107 cm; 97.9 g wet) from 321 to 327 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3874. Nutt Lake, 375-381 cm — 6690 ± 100, $\delta^{13}C = -27.1‰$

Organic mud (sample Core B 11, 1155-1161 cm; 90.4 g wet) from 375 to 381 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3867. Nutt Lake, 429-435 cm — 8180 ± 100, $\delta^{13}C = -27.0‰$

Organic mud (sample Core B 11, 1209-1215 cm; 88.9 g wet) from 429 to 435 cm below the mud/water interface. Date is based on one 3-day count in the 2 L counter.

GSC-3923. Nutt Lake, 483-489 cm — 9140 ± 100, $\delta^{13}C = -26.5‰$

Organic mud (sample Core B 12, 1263-1269 cm; 97.6 g wet) from 483 to 489 cm below the mud/water interface. Date is based on one 3-day count in the 2 L counter.

GSC-3846. Nutt Lake, 522-528 cm — 9850 ± 130, $\delta^{13}C = -29.5‰$

Organic mud (sample Core B 12, 1302-1308 cm; 103.4 g wet) from 522 to 528 cm below the mud/water interface. Date is based on one 4-day count in the 2 L counter.

Comments (K.D. Bennett): Nutt Lake has been studied as one of a series of sites through southern Ontario from near Lake Erie to 46°30'N latitude to investigate the rates of spread and population expansion of the main forest tree taxa during postglacial time. The radiocarbon dates show that the rate of sedimentation in Nutt Lake has been constant (18.7 years/cm) throughout postglacial time, establishing this as an excellent site for such a study. There are no published pollen influx diagrams from the Canadian Shield in southern Ontario; the dated pollen percentage, concentration, and influx diagrams from Nutt Lake add significantly to knowledge of the postglacial vegetation history of the area. When examined in conjunction with the other sites in this study, it will contribute to an understanding of the mechanisms of spread and population expansion of forest trees in southern Ontario. NaOH leach was omitted from the pretreatment of all samples.

'Hams Lake' Series

A series of lake sediment samples from a 600 cm-long core taken in 850 cm of water at "Hams Lake" (informal name), 4 km north-northwest of Paris, South Dumfries Township, Brant County, Ontario (43°14'N, 80°25'W), at an elevation of 282 m. Collected February 1984 by K.D. Bennett, P. Julig, J.H. McAndrews, and J.C. Ritchie using a modified Livingstone piston corer; submitted by K.D. Bennett, now at the University of Cambridge, Cambridge, England.

GSC-3968. Hams Lake, 26-32 cm — 330 ± 80, $\delta^{13}C = -31.2‰$

Organic mud (sample Core C11 (876-882 cm); 90.5 g wet) from 26 to 32 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-4072. Hams Lake, 85-91 cm — 1420 ± 80, $\delta^{13}C = -29.2‰$

Organic mud (sample Core C12 (935-941 cm); 56.4 g wet) from 85 to 91 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-4065. Hams Lake, 141-147 cm — 2590 ± 80, $\delta^{13}C = -30.4‰$

Organic mud (sample Core C12 (991-997 cm); 81.0 g wet) from 141 to 147 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-4008. Hams Lake, 200-206 cm — 3240 ± 80, $\delta^{13}C = -31.8‰$

Organic mud (sample Core A2 (1050-1056 cm); 82.6 g wet) from 200 to 206 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-4047. Hams Lake, 259-265 cm — 4200 ± 80, $\delta^{13}C = -29.4‰$

Organic mud (sample Core A3 (1109-1115 cm); 82.8 g wet) from 259 to 265 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3943. Hams Lake, 318-324 cm — 5830 ± 130, $\delta^{13}C = -33.7‰$

Organic mud (sample Core A3 (1168-1174 cm); 90.2 g wet) from 318 to 324 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3953. Hams Lake, 377-383 cm — 7400 ± 120, $\delta^{13}C = -31.0‰$

Organic mud (sample A4 (1227-1233 cm); 94.5 g wet) from 377 to 383 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3925. Hams Lake, 436-442 cm — 8560 ± 140; $\delta^{13}C = -28.0‰$

Organic mud (sample A4 (1286-1292 cm); 90.1 g wet) from 436 to 442 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-4034. Hams Lake, 495-501 cm — 9080 ± 130; $\delta^{13}C = -28.0‰$

Organic mud (sample Core A5 (1345-1351 cm); 86.2 g wet) from 495 to 501 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3956. Hams Lake, 551-557 cm — 10 300 ± 150; $\delta^{13}C = -29.2‰$

Organic mud (sample Core A6 (1401-1407 cm); 83.2 g wet) from 551 to 557 cm below the mud/water interface. Date is based on two 1-day counts in the 2 L counter.

Comment (K.D. Bennett): Hams Lake has been studied as one of a series of sites through southern Ontario, north from near Lake Erie to latitude 46°30'N, in order to investigate the rates of spread and population expansion of the main forest tree taxa during postglacial time. The dates show that the rate of sedimentation in Hams Lake has been constant (19.0 years/cm) throughout the postglacial, establishing this as an excellent site for such a study. Together with those from Nutt Lake (this list), the dated pollen percentage, concentration, and influx diagrams from Hams Lake add significantly to knowledge of the postglacial vegetation history of the area. When examined in conjunction with the other sites in this study, it will make a major contribution to our understanding of the mechanisms of spread and population expansion of forest trees in eastern North America. NaOH leach was omitted from the pretreatment of all samples. All samples except GSC-3968 and -4047 were mixed with dead gas for counting.

Western Canada

Manitoba

GSC-3988. Fletcher Lake Section A — 3430 ± 60; $\delta^{13}C = -27.1‰$

Peat (sample CFL-A-322-320; 16.5 g dry) from the base of a 324 cm-high peat face on the west shore of Fletcher Lake, Manitoba (58°09'45"N, 93°50'15"W), at an elevation of 162 m. The dated sample, comprising **Sphagnum** moss plus Ericales and **Picea** sp. fragments (identified by G.M. MacDonald), was from 320 to 324 cm depth. Collected June 1984 by R. Bellows, York University, Toronto, Ontario, and A. Silis, McMaster University, Hamilton, Ontario; submitted by G.M. MacDonald, McMaster University.

Comment (G.M. MacDonald): Dating was carried out to determine if the section would contain a complete postglacial record of vegetation development at the site. The 3430 BP date suggests that further analysis is unwarranted. Date is based on two 1-day counts in the 5 L counter.

Alberta

GSC-3780. Athabasca Delta — 240 ± 60; $\delta^{13}C = -26.3‰$

Wood (sample DGS-83-2; 23.6 g dry; **Picea** sp.; unpublished GSC Wood Identification Report No. 84-4 by R.J. Mott) in silty mud on the left bank of Embarras Channel, 200 km north of Fort McMurray, Alberta (58°28'N, 111°28'W), at an elevation of 213 m. Sample was buried 280 cm below the surface of an active levee of the Embarras channel on the upper delta plain of the modern Holocene Athabasca River Delta. Collected July 1983 by D.G. Smith, University of Calgary, Calgary, Alberta.

Comment (D.G. Smith): The date does not agree with the ages of vertical buried tree stumps which are 200 plus years old and which are buried 60 cm (root collar depth). The estimated age was 600 years.

Comment (W. Blake, Jr.): This fractured and split sample was air dried (weight decreased from 456.0 g wet to 219.9 g damp; then after oven drying it weighed 149.7 g). All adhering mud was cut off. Date is based on one 1-day count in the 5 L counter.

GSC-2674. Fork Lake — >36 000

Wood (sample R77-SR20-30.8 m; 8.8 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 78-18 by L.D. Farley-Gill) from 30.8 m depth in an unoxidized till unit in a dry auger test hole (R77-SR20, Sand River map sheet (73L/5)). The site is 2.4 km northeast of the southwest corner of Fork Lake, 2.7 km south of Rich Lake, Alberta in SE ¼, LSD 1, sec. 25, tp. 63, rge. 11, W 4th mer. (54°28.3'N, 111°31'W), at an elevation of approximately 556.6 m (estimated from topographic map with a 25 foot contour interval). The sampled unit is overlain by a 2 m-thick sand and silt layer which is in turn overlain by a second till. The unoxidized till from which the sample was derived is underlain by a 2 m-thick interbedded till and sand layer. Collected August 1977 by C. Lutzak and submitted by M.M. Fenton, both of the Alberta Research Council, Edmonton, Alberta.

Comment (M.M. Fenton): This date is the first obtained on a subtill unit from this part of Alberta. The sample is from Unit 1 of the Marie Creek Formation which was deposited during the Ardmore glaciation (L.D. Andriashek and M.M. Fenton, Quaternary stratigraphy and surficial geology, Sand River map sheet 73L, in preparation). The Marie Creek Formation is overlain by the Vilna Member (till) of the Grand Centre Formation and is likely (at least) Early Wisconsinan.

Comment (W. Blake, Jr.): The wood fragments which comprised this sample were somewhat twisted, and the wood broke apart along the annual rings. The largest flat piece is 7.5 cm long and has a maximum width of 3 cm. The maximum thickness, if the wood is all from one piece, was 1 to 2 cm. Some silt was adhering to the dry sample when it was received, but this was removed. Sample was mixed with dead gas for counting. Date is based on one 4-day count in the 5 L counter.

GSC-3751. Battle River — >27 000; $\delta^{13}C = -23.5‰$

A single piece of wood (sample NPW-1-1983; 2.6 g dry; **Picea** or **Larix**, probably **Larix** sp.; unpublished GSC Wood Identification Report 83-32 by R.J. Mott) from diamicton 1.5 m above Cretaceous bedrock, in a gravel pit on the west side of Battle River, 14 km east and 5 km south of Wetaskiwin, Alberta (52°55'30"N, 113°11'W), at an elevation of 735 m. The wood was approximately 40 cm within the enclosing wet and unoxidized diamicton (exposed when the pit was excavated in March 1983). Collected June 1983 by J.J. Kulig, University of Alberta, Edmonton, Alberta.

Comment (J.J. Kulig): The unit sampled contains sand laminae and dropstones which have been interpreted as one of the initial phases of infilling of a proglacial lake. It was hoped that the date would provide an indication of which glaciation (Early or Late Wisconsinan) the sediments related to. However the 'greater than' date does not permit this (Kulig, 1985).

Comment (W. Blake, Jr.): The damp sample (5.5 g) was air dried and all adhering clay and silt were removed. The piece of wood measured 6 cm long and 1.5 x 1.0 cm in cross-section. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3620. Bowhay Lake 5290 ± 80
$\delta^{13}C = -27.1‰$

Organic lake sediment (sample CMA 2; 76.2 g wet) taken at 60 to 65 cm below the sediment-water interface of a small unnamed muskeg lake 2.5 km northeast of Bowhay Lake, Alberta (59°58'N, 113°34'W), at an elevation of 300 m. The sample was obtained using a modified Livingstone corer. Collected April 20, 1981 by R.W. Spear, then Scarborough College, University of Toronto, now University of Minnesota, Minneapolis, Minnesota, and J.C. Ritchie, Scarborough College, University of Toronto, West Hill, Ontario.

Comment (G.M. MacDonald): The fossil pollen spectra from this sediment sample is similar to the modern pollen spectra of this region (MacDonald, 1984a). This suggests that the vegetation in this part of northern Alberta was similar to modern conditions by 5290 BP. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 2 L counter.

GSC-3065. Aquitaine Pit 10 200 ± 280
$\delta^{13}C = -23.1‰$

Bone (sample OS-79-48-11; 438 g; cranium of female **Bison** sp., identified by M.C. Wilson) from a building excavation at the southwest corner of 4th Avenue and 5th Street S.W., downtown Calgary, Alberta, on a terrace 0.8 km south of and 5 m above the Bow River (51°02'55"N, 114°04'25"W), at an elevation of 1045 m. The specimen which had been shattered by a bulldozer, was recovered from crossbedded fine sandy gravels referred to as the late Pleistocene Bighill Creek Formation (Stalker, 1968; Jackson et al., 1982; Wilson, 1983); it lay some 3 m below street level. The rostrum of the skull remained intact in situ and its delicate nature suggests only limited transport. The estimated age, 11 000 to 11 500 BP, was based on previous dates for the same unit: 11 370 ± 170 BP (GSC-613; GSC VI, 1967, p. 15), 11 300 ± 290 BP (RL-757; Wilson and Churcher, 1978), 11 100 ± 160 BP (GSC-989, GSC IX, 1970, p. 68), and 10 760 ± 160 BP (GSC-612, GSC VI, 1967, p. 14), all on bone. Collected September 1978 by M.C. Wilson, University of Calgary, Calgary, Alberta; submitted by A.MacS. Stalker.

Comment (M.C. Wilson): Date GSC-3065 is slightly more recent than the other dates from the Bighill Creek Formation, but it is within reasonable bounds (see Jackson et al., 1982; Wilson, 1983). Gravel units equivalent to the Bighill Creek Formation seem to be slightly younger in northern Alberta than in the south but range overall from about 11 500 to 9500 BP (Wilson and Churcher, 1984).

Comment (W. Blake, Jr.): The sample was washed in a sonic bath with distilled water to remove adhering mud and sand, then dried in an electric oven. The NaOH leach was omitted because of the small sample size. Sample was mixed with dead gas for counting. Date is based on one 4-day count in the 2 L counter.

Wild Spear Lake Series

Lake sediment was collected from a small (approximately 16 ha) muskeg lake, unofficially named "Wild Spear Lake". The lake is located in the Caribou Mountains approximately 60 km north of Jean d'Or, Alberta (59°15'N, 114°09'W), at an elevation of 825 m. The lake was cored from the ice with a modified Livingstone piston corer. The water depth was approximately 2.5 m and a 332 cm-long core of limnic sediment was recovered. Coring ceased when an impenetrable clay-pebble diamict was encountered. Collected April 24, 1981 by J.C. Ritchie and R.W. Spear.

GSC-3619. Wild Spear Lake, 18-25 cm 1850 ± 60
$\delta^{13}C = -27.5‰$

Organic lake sediment (sample CMB 4; 63.6 g wet) 18 to 25 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 5 L counter.

GSC-3612. Wild Spear Lake, 66-70 cm 5630 ± 70
$\delta^{13}C = -27.6‰$

Organic lake sediment (sample CMB 3; 65.1 g wet) from 66 to 70 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 5 L counter.

GSC-3358. Wild Spear Lake, 93-95 cm 7870 ± 90
$\delta^{13}C = -25.5‰$

Crumbly organic lake sediment (sample CMB 1; 53.9 g wet) from 93.5 to 95.5 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 5 L counter.

GSC-3313. Wild Spear Lake, 255-268 cm 10 200 ± 490
$\delta^{13}C = -29.0‰$

Moss (sample CMB+CMC; 1.7 g dry; **Drepanocladus** sp., identified by L. Ovenden, Scarborough College, University of Toronto, West Hill, Ontario) taken from a distinctive layer present at a depth of 255 to 268 cm from the sediment/water interface in two adjacent cores. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Comment (G.M. MacDonald): The series of dates provides radiometric age control for sediment accumulation at Wild Spear Lake and chronological control for a fossil pollen record which was obtained from the lake sediments. GSC-3313 also provides a minimum deglaciation date for the Caribou Mountains region of north-central Alberta. The fossil pollen record indicates that the initial postglacial vegetation of the region was dominated by herbs, shrubs, and poplar. Spruce expanded into the region at approximately 8700 BP. Alder and pine arrived in the area at approximately 8000 and 6000 BP respectively. The vegetation of the region appears to have remained stable and similar to the modern conditions from approximately 6000 BP to the present (MacDonald, 1984a,b,c).

Sunwapta Pass Series

Wood samples from streambank sections in Sunwapta Pass, Jasper National Park, Alberta (52°13'N, 117°12'W). Collected July 1981 by B.H. Luckman, University of Western Ontario, London, Ontario.

GSC-3336. Sunwapta Pass (I) 1800 ± 60
$\delta^{13}C = -24.3‰$

Tree or branch section (sample SP81-1L2; 11.7 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 81-28 by L.D. Farley-Gill) from 10 to 15 cm above the peat/grey clay contact in a 1.2 m-thick peat unit exposed in a slumped streambank section in Sunwapta Pass, at an elevation of approximately 1975 m.

Comment (B.H. Luckman): This tree was dug out of a slumped section in Bog 3 (Luckman et al., 1979; Bog 4 in Beaudoin, 1984, Fig. 2.5) downstream of the Wilcox Creek alluvial fan. The age determination indicates that this was not, as had been hoped, a log sample of Hypsithermal age and no further analyses were carried out on this sample (Luckman, 1982).

Comment (W. Blake, Jr.): The sample submitted was a cross-sectional piece from a log; the original weight (damp) was 115.8 g. The sample was air dried. Date is based on two 1-day counts in the 5 L counter.

GSC-3356. Sunwapta Pass (II) 5190 ± 60
$\delta^{13}C = -23.0‰$

Wood (sample SP81-3L; 11.6 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 81-29 by L.D. Farley-Gill) from a log 85 cm long in peat exposed at the base (clay/gravel contact) of a streambank section in Sunwapta Pass, at an elevation of approximately 1970 m.

Comment (B.H. Luckman): This log was recovered about 50 m upstream from sections SP9 and SP12 in Bog 2 in Sunwapta Pass (Luckman et al., 1979; Beaudoin, 1984). The apparent stratigraphic position of the log was below a clay and peat section containing two tephras. Dated wood from a similar stratigraphic position 50 to 70 m downstream at the same site yielded dates of 7700 ± 110 BP (BGS-450) and 8100 ± 100 BP (GSC-2589, GSC XIX, 1979, p. 17). The radiocarbon date indicates that this log must have been reworked and was not in its true stratigraphic position as the tephra above it is Mazama (Beaudoin, 1984; Luckman et al., 1979).

The sample is only a partial cross-section of the trunk, contains 60 to 80 rings, and is about 10 cm thick (across the rings). Ring curvature in the sample indicates a tree of 30 to 50 cm diameter and thus is the largest tree so far recovered from the Sunwapta Pass bogs. There are few trees (none of this size) in the immediate vicinity of the site today. The tree was either growing at the site or moved to it by snow avalanches from the upper part of the adjacent alluvial fan and incorporated into the peat bog. Correlation with samples from the Maligne Pass site (GSC-3147, this list) suggests that the tree dates from the later phases of the Hypsithermal. This correlation is supported by the large size and complacent ring pattern as compared to present trees in this area.

Comment (W. Blake, Jr.): Wood was received wet; upon drying in an electric oven, the weight decreased from 45.7 to 16.8 g. Date is based on one 3-day count in the 5 L counter.

GSC-3147. Maligne Pass 5290 ± 70
$\delta^{13}C = -22.9‰$

Wood (sample MP1; 11.3 g; **Abies** sp.; unpublished GSC Wood Identification Report No. 80-34 by L.D. Farley-Gill) cut from a log approximately 4 m long and 15 cm in diameter recovered from a shallow, peat enclosed pond in Maligne Pass, Jasper National Park, Alberta (52°49'N, 117°25'W). Sample was immersed in peat and organic mud under approximately 50 cm of water at a bog site about 50 m vertically above and several hundred metres horizontally from the present treeline. Collected August 1980 by B.H. Luckman, University of Western Ontario, London, Ontario.

Comment (B.H. Luckman): This is one of two trees recovered from this bog, the other one dating at 5920 ± 100 BP (BGS-566). These trees document a period of higher-than-present timberline associated with the Hypsithermal. The dates and pollen evidence from other sites suggest that these trees probably represent the final stages of the Hypsithermal and were preserved by subsequent development of the bog at this site (Kearney and Luckman, 1983).

Comment (W. Blake, Jr.): The wet sample was dried in an electric oven. Weight of the outer piece decreased from 51.6 to 11.9 g; weight of the inner piece decreased from 30.3 to 8.7 g. The sample utilized for dating comprised the inner piece plus the inner half of the outer piece (it split easily along growth rings). Date is based on two 1-day counts in the 5 L counter.

Watchtower Basin Series

Two wood samples from a shallow peat enclosed pond in the Watchtower Basin, Jasper National Park, Alberta (52°50'N, 117°50'W), at an elevation of 2153 m. Both samples were recovered from the bed (approximately 0.5 to 0.7 m below the water surface) of a small pond located on a bedrock ridge. The pond is more than 100 m vertically above present treeline which is 0.5 to 1.0 km downvalley. Collected August 1980 by B.H. Luckman.

GSC-3195. Watchtower Basin (I) 8790 ± 80
$\delta^{13}C = -23.9‰$

Wood (sample number W3; 10.2 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 80-35 by L.D. Farley-Gill) from a log approximately 50 cm long and 8 cm diameter.

GSC-3226. Watchtower Basin (II) 7910 ± 70
$\delta^{13}C = -25.0‰$

Wood (sample W2; 11.6 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 80-35 by L.D. Farley-Gill) from a log fragment, 30 cm long and approximately 2 cm thick (across rings).

Comment (B.H. Luckman): Both samples are from the same site as GSC-2615 (8080 ± 90 BP, GSC XIX, 1979, p. 19). All three samples document a period of higher-than-present timberline in the earliest part of the Hypsithermal in this area. GSC-3195 comes from a very complacent tree growing under favourable conditions (mean ring width 1.32 mm, 31 rings) and is the oldest macrofossil evidence for higher timberlines yet reported from Jasper National Park. (It is also the oldest post-Wisconsinan tree date.) It indicates that spruce had migrated to this site and was growing above its present vertical range under favourable conditions by 8790 BP (Kearney and Luckman, 1983).

GSC-3226 had more than 60 narrow rings (average 0.33 mm wide). The ring curvature suggests these are the outer rings from a very old, large tree, more than 40 cm in diameter which could have been 250 to 500 years old at death. The inferred dimensions and site of GSC-3226 (the nearest present tree is stunted krummholz perhaps 30 cm high and 5 cm maximum diameter) indicate conditions were much more favourable for tree-growth at this site ca. 7900 to 8200 BP than at present.

Comment (W. Blake, Jr.): Both samples were received wet. Upon oven drying wood W2 decreased in weight from 145.0 to 28.0 g; wood W3 from 150.5 to 24.4 g. For GSC-3195 only the outer part (<20 annual rings) was used for dating. For GSC-3226 about the outer half (∽1 cm in thickness and an estimated maximum of 30 to 40 rings) was used. Each date is based on one 3-day count in the 5 L counter.

GSC-3885. Pocahontas 11 900 ± 120

Freshwater gastropod shells (sample 83-28-3; 16.0 g; tentatively identified as **Stagnicola proxima** by J.M. Topping, National Museum of Natural Sciences, Ottawa) recovered from glaciolacustrine silts and clays on a bench 80 m above the present level of Athabasca River, 1 km southeast of

Pocahontas along the Miette Hotsprings road (off Highway 16), Jasper National Park, Alberta (53°13'N, 117°55'W), at an elevation of 1080 m. The fossiliferous unit was 2.8 m thick at the top of the section and was underlain by 1.3 m of sorted gravels and 4.3 m of glacial diamicton. Collected August 1983 by V.M. Levson, University of Alberta, Edmonton, Alberta.

Comment (V.M. Levson): The shells were located on a high bench, the top of which represents the level of the valley before significant postglacial dissection occurred. The lake containing the shells probably existed shortly after retreat of ice from the area. These shells thus provide a minimum date for the deglaciation of lower Athabasca River valley in Jasper National Park (Levson and Rutter, 1985).

Comment (W. Blake, Jr.): A $^{13}C/^{12}C$ ratio of -7.8‰ was determined for this sample, but the date is reported in uncorrected form because of the uncertainty as to how freshwater shells should be corrected. Because of the small sample size, only the outer 10% of shell material was removed by HCl leach. Sample was mixed with dead gas for counting. Date is based on one 4-day count in the 2 L counter.

GSC-3792. Jasper — 29 100 ± 560; $\delta^{13}C$ = -24.4‰

Wood (sample 1983-2-3; 11.9 g; **Larix lyallii**; identified by H. Zalasky, Canadian Forestry Service, Edmonton, Alberta) from a sand and gravel supply pit 0.5 km west of Jasper townsite, Alberta (52°53'N, 118°06'W), at an elevation of 1120 m. The wood was collected at a depth of 20 m below the surface of a dry bed of fluvial sands and gravels. One fragment was collected within the same unit but at a depth of 18 m. The sands and gravels were unconformably overlain by up to 4 m of glacial till. Collected in June and November 1983 and January 1984 by V.M. Levson, University of Alberta, Edmonton, Alberta.

Comment (V.M. Levson and N.W. Rutter): This date is one of the few sub-till dates obtained in the Canadian Rockies. It indicates that at ca. 29 000 BP a fluvial environment existed in the vicinity of the dated section. The presence of till, overlying the dated sands and gravels, suggests that ice extended downvalley at least as far as Jasper townsite after approximately 29 000 BP, most likely in the Late Wisconsinan (Levson and Rutter, 1985).

Comment (W. Blake, Jr.): Most of the original material (collected in 1983) was from a single bed approximately 50 cm long, 10 cm wide, and a few centimetres in thickness. A few fragments were recovered from the enclosing sand and gravel. NaOH leach was omitted from sample pretreatment. Date is based on one 3-day count plus one 1-day count in the 5 L counter.

Yesterday Lake Series

Lake sediment was collected from a small (approximately 10 ha) muskeg lake, unofficially named "Yesterday Lake". The lake is located in the Clear Hills approximately 20 km northwest of the town of Clear Prairie, Alberta (56°46'N, 119°29'W), at an elevation of 1050 m. The lake sediment was cored from the ice using a modified Livingstone piston corer. The water depth was 2 m and a 250 cm-long sediment core was recovered. Coring ceased when an impenetrable pebbly-clay diamict was encountered. Collected April 13, 1982 by G.M. MacDonald and R.W. Spear, then of Scarborough College, University of Toronto, West Hill, Ontario; MacDonald is now at McMaster University, Hamilton, Ontario and Spear is at the University of Minnesota, Minneapolis, Minnesota.

GSC-3676. Yesterday Lake, 60-65 cm — 6370 ± 90; $\delta^{13}C$ = -24.0‰

Organic lake sediment (sample 82-S1a-C; 67.3 g wet) from 60 to 65 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-3505. Yesterday Lake, 104-110 cm — 9260 ± 130; $\delta^{13}C$ = -22.6‰

Organic lake sediment (sample 82-S1a-B; 74.6 g wet) from 104 to 110 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 two 1-day counts in the 2 L counter.

GSC-3544. Yesterday Lake, 150-157 cm — 10 000 ± 150; $\delta^{13}C$ = -26.5‰

Organic lake sediment (sample 82-S1a-A; 133.7 g wet) from 150 to 157 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 two 1-day counts in the 2 L counter.

Comment (G.M. MacDonald): This series of dates provides radiometric age control for sediment accumulation at Yesterday Lake and chronological control for a fossil pollen record obtained from the lake sediments. GSC-3544 also provides a minimum deglaciation date for the Clear Hills region of west-central Alberta. The fossil pollen record is extremely similar to the more completely analyzed Lone Fox Lake pollen record (this list). The comparison of the pollen stratigraphy of Yesterday Lake and Lone Fox Lake cores is reported in detail in MacDonald (1984a).

Comment (W. Blake, Jr.): GSC-3544 showed no reaction with HCl, although this date was obtained on an organic-rich zone at 150 to 157 cm, which underlies a distinct marl zone.

Lone Fox Lake Series

Lake sediment was collected from a small (approximately 5 ha) muskeg pond, unofficially named "Lone Fox Lake", located in the Clear Hills approximately 20 km northwest of the town of Clear Prairie, Alberta (56°43'N, 119°43'W), at an elevation of 1100 m. The lake sediment was cored from the ice using a modified Livingstone piston corer. The water depth was 3 m and a 411 cm-long core of limnic sediment was recovered. Coring ceased when an impenetrable pebbly-clay diamict was encountered. Collected April 14, 1982 by G.M. MacDonald and R.W. Spear.

GSC-3643. Lone Fox Lake, 50-55 cm — 1960 ± 60; $\delta^{13}C$ = -31.9‰

Organic lake sediment (sample 82-S2-F; 56.3 g wet) from 50 to 55 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-3669. Lone Fox Lake, 100-105 cm — 3960 ± 90; $\delta^{13}C$ = -31.3‰

Organic lake sediment (sample 82-S2-E; 52.0 g wet) from 100 to 105 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-3630. Lone Fox Lake, 200-205 cm — 6890 ± 90; $\delta^{13}C = -30.0‰$

Organic lake sediment (sample 82-S2-D; 64.2 g wet) from 200 to 205 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-3675. Lone Fox Lake, 300-305 cm — 8810 ± 110; $\delta^{13}C = -26.8‰$

Organic lake sediment (sample 82-S2-C; 54.8 g wet) from 300 to 305 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-3482. Lone Fox Lake, 342-348 cm — 9990 ± 100; $\delta^{13}C = -30.5‰$

Organic lake sediment (sample 82-S2-B; 73.8 g) from 342 to 348 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-3520. Lone Fox Lake, 360-365 cm — 10 700 ± 140; $\delta^{13}C = -27.4‰$

Organic lacustrine silts (sample 82-S2-A; 107.7 g) from 360 to 365 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 (G.M. MacDonald): This series of dates provides radiometric age control for sediment accumulation at Lone Fox Lake and chronological control for a fossil pollen record which was obtained from the lake sediments. GSC-3520 also provides a minimum deglaciation date for the Clear Hills region of west-central Alberta. The fossil pollen record indicates that the Clear Hills region was occupied by a herb-shrub-poplar dominated vegetation from 10 700 BP until 9900 BP when spruce expanded into the region. Pine subsequently expanded into the Clear Hills at approximately 8000 BP. The vegetation of the region appears to have remained stable and similar to modern conditions from approximately 7000 BP to the present (MacDonald, 1984a,b,c).

British Columbia

Johnsen Pond Series

Lake sediment was collected from a small (approximately 1 ha) pond, locally known as "Johnsen Pond". The pond is located 1.5 km north of Moyie Lake, British Columbia (49°23'N, 115°50'W), at an elevation of 1000 m. The lake was cored from the ice surface using a modified Livingstone piston corer. The water depth was 4.5 m and a 7 m-long sediment core was recovered. Collected April 18, 1985 by G.M. MacDonald, McMaster University, Hamilton, Ontario, and K.D. Bennett, Scarborough College, University of Toronto, West Hill, Ontario.

GSC-4083. Johnsen Pond (B), 590-597 cm — 7850 ± 90; $\delta^{13}C = -27.0‰$

Organic lake sediment (sample 85-S13-B; 62.1 g wet) from 590 to 597 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-4073. Johnsen Pond (F), 640-646 cm — 8890 ± 110; $\delta^{13}C = -31.7‰$

Organic lake sediment (sample 85-S13-F; 65.5 g wet) from 640 to 646 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.

GSC-4064. Johnsen Pond (A), 715-724 cm — 8480 ± 180; $\delta^{13}C = -29.9‰$

Organic lake sediment (sample 85-S13-A; 124.7 g wet) from 715 to 724 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 (G.M. MacDonald): The apparent inversion of dates GSC-4064 and GSC-4073 suggests that significant sediment mixing has taken place in the lake basin and that further dating of the sediment core is unwarranted.

GSC-3824. Radium Hot Springs — 2130 ± 100; $\delta^{13}C = -25.9‰$

Wood (sample 83-1; 3.0 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 84-9 by R.J. Mott) from a borehole (rotary drilled) at the south abutment of the CP Rail bridge over Columbia River, 2 km north-northwest of Radium Hot Springs, British Columbia (50°38.0'N, 116°05.6'W), at an elevation of approximately 782 m. The dated sample was collected from a detrital, organic-rich bed at a depth of 15.3 m below the surface. This bed is overlain and underlain by interbedded gravel, sand, and silt which are part of an alluvial fan deposited by Sinclair Creek, a tributary of Columbia River. Drilling was discontinued in these materials at a depth of 35 m. Collected December 1983 by D.F. VanDine, Thurber Consultants, Victoria; submitted by J.J. Clague.

Comment (J.J. Clague): GSC-3824 provides information on the rate of growth of the Sinclair Creek fan in the southern Rocky Mountain Trench. About 15 m of sediment has accumulated at the site over the last 2000 to 2200 radiocarbon years. Thus, there has been significant aggradation of the fan surface in the recent geologic past. The fan sediments, in part, may have accumulated in a lake on the floor of the Rocky Mountain Trench; if so, this lake has since been completely filled with sediment.

Comment (W. Blake, Jr.): The wet sample as received weighed 20.5 g. It was air dried and as much of the adhering mud as possible was scraped off. The largest fragment was 1.5 cm long, 5 mm in diameter (two pieces fitted together). Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-1990. Upper Meadow Creek — 6450 ± 70

Basal peat (sample SA-31; 68.5 g) 5.75 m below the surface of a peat bog developed in a meltwater channel which originates in a terminal moraine complex, in upper Meadow Creek, 3.2 km south of Harbour Lake, British Columbia (51°31'N, 119°10'W), at an elevation of 885 m. Two tephras occur above the sample, the oldest (at 4.25 m depth) being St. Helens Y (ca. 3200 BP). Collected August 1973 by N.F. Alley with a Hiller peat corer.

Comment (N.F. Alley): The date provides a minimum age for the advance of a glacier westwards out of the Monashee Mountains, which led to the deposition of the moraine and the subsequent erosion of the meltwater channel.

Comment (W. Blake, Jr.): See Duford and Osborn (1978, 1980) and Alley (1980) for a discussion of moraine chronology and correlation in this area. The sample decreased in weight from 226 to 68.5 g upon drying in an electric oven. NaOH leach omitted from sample pretreatment. Date is based on one 3-day count in the 5 L counter.

GSC-2043. Stevens Lake 9060 ± 170

Basal organic-rich silt (sample SA33; 50.5 g dry) from 4.35 m below the surface of a peat bog on the western fringe of Stevens Lake, 9.6 km north-northeast of Battle Mountain, Wells Gray Provincial Park, British Columbia (52°00'N, 119°48'W), at an elevation of 1525 m. The peat encloses a small lake on hummocky moraine and an esker-kame complex surrounding Stevens Lake on the plateau north of Battle Mountain. Collected August 1973 by N.F. Alley using a Hiller peat corer.

Comment (N.F. Alley): The date provides a minimum age for deglaciation of the southern Cariboo Mountains and a maximum age for younger moraines occurring along valley bottoms adjacent to the western flank of Battle Mountain.

Comment (W. Blake, Jr.): The dated material, which contained a significant amount of silt, decreased in weight from 207.0 to 50.5 g upon oven drying. 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-1988. Harp Mountain 9160 ± 80

Basal silty peat (sample SA-30; 34.0 g dry) from 4.25 m below the surface of a subalpine bog, 2.4 km west of Harp Mountain, British Columbia (51°26'N, 119°51'W), at an elevation of 1680 m. The bog encloses a small lake in a rock hollow. Three tephras occur above the sample, the oldest (at 2.55 m depth) being Mazama (ca. 6600 BP). Collected August 1973 by N.F. Alley with a Hiller peat corer.

Comment (N.F. Alley): The date provides chronological control for the base of a pollen diagram constructed for this site and is a minimum age for deglaciation of the southern end of the Cariboo Mountains at this elevation (cf. GSC-1457; 10 000 ± 140 BP; deglaciation date based on basal peat in the Rocky Mountain Trench near Donald; GSC XVI, 1976, p. 9).

Comment (W. Blake, Jr.): Upon drying in an electric oven, the sample weight decreased from 178.0 to 34.0 g. Because of the small sample size (and significant silt content), the NaOH leach was omitted from the sample pretreatment. Date is based on one 3-day count in the 5 L counter.

Johnson Lake Series

Basal peat and marl from a bog 4.8 km west of Johnson Lake, British Columbia (51°10'N, 119°52'W), at an elevation of approximately 1098 m. Two tephras occur above the samples, the oldest (at 3.75 m depth) is probably Mazama (ca. 6600 BP). Collected August 1973 by N.F. Alley with a Hiller peat corer.

GSC-2025. Johnson Lake (I) 9440 ± 80

Basal marl (sample SA32; 209 g wet) 6.5 m below the surface of the peat bog.

GSC-2025-2. Johnson Lake (II) 8800 ± 80

Peat fragments (sample SA32; 19.7 g) separated from the basal marl.

Comment (N.F. Alley): Date GSC-2025 provides a minimum age for the deglaciation of the Shuswap Highland. The difference in age between GSC-2025 and GSC-2025-2 is not readily explicable in terms of in situ contamination, for other dates on similar mixed materials in the same age range show close agreement: see GSC-1994 (10 100 ± 80 BP) and GSC-1994-2 (9840 ± 130 BP); GSC-2036 (10 100 ± 90 BP) and GSC-2036-2 (10 000 ± 140 BP; all in this list). In the case of GSC-2025-2, fluid peat may have leaked down the edges of the core barrel from younger horizons above, thus contaminating the sample. The correct age probably lies around 9200 BP.

Comment (W. Blake, Jr.): The wet marl sample was given no pretreatment but was placed in the shell apparatus and treated with H_3PO_4 to recover the CO_2. Because of the small size of the peat component, which remained in the shell apparatus after the marl was dissolved, the NaOH leach was omitted. GSC-2025-2 was given a further treatment with HCl, plus the usual distilled water rinses. GSC-2025 is based on one 3-day count in the 5 L counter; GSC-2025-2 is based on one 4-day count in the 5 L counter.

Mount Fadear Plateau Series

Basal peat and marl from 4 m below the surface of a bog 8 km west-northwest of Agate (Skaam) Bay, Adams Lake, British Columbia (51°06'N, 119°54'W), at an elevation of 1100 m. Three tephras occur above the sampled unit, the oldest tephra (at 2.75 m depth) being Mazama (ca. 6600 BP). The basal marl is underlain by blue silty clay. Collected August 1973 by N.F. Alley with a Hiller peat corer.

GSC-1994. Mount Fadear Plateau (I) 10 100 ± 80
$\delta^{13}C = +1.0‰$

Basal marl (sample SA-29; 115.5 g wet).

GSC-1994-2. Mount Fadear Plateau (II) 9840 ± 130
$\delta^{13}C = -28.6‰$

Fragments of peat (sample SA-29; 8.9 g) extracted from the marl.

Comment (N.F. Alley): Date GSC-1994 provides a minimum age for the deglaciation of the Mount Fadear Plateau, situated between North Thompson River and Adams Lake. Date GSC-1994-2, on the peat fragments, shows good agreement with the enclosing marl.

Comment (W. Blake, Jr.): The agreement between the two dates is closer than for the Granite Mountain Series (Alley, 1980; GSC XXI, 1981, p. 7). The wet marl sample was given no pretreatment but was placed in the shell apparatus and treated with H_3PO_4 to recover the CO_2. Because of the small size of the peat component, which remained in the shell apparatus after the marl was dissolved, the NaOH leach was omitted. GSC-1994-2 was given a further treatment with HCl, plus the usual distilled water rinses. GSC-1994 is based on one 3-day count in the 5 L counter. GSC-1994-2 was mixed with dead gas for counting; the date is based on two 1-day counts in the 2 L counter.

GSC-3944. Falls Creek 7560 ± 110
$\delta^{13}C = -28.1‰$

A well compacted peat sample (CH-84-53-04; 53.0 g dry) from a 3 to 7 cm-thick layer exposed under a lava flow along the east bank of Falls Creek, east of the south end of Clearwater Lake in Wells Gray Provincial Park, British Columbia (52°10'N, 120°10'W), at an elevation of 710 m. The peat layer is underlain by at least 50 cm of clean fluvial sands and is overlain by 10 cm of intercalated silts and clay upon which the 5 m-thick lava flow rested. See Campbell (1963), Hickson and Souther (1984), and Hickson (Late Cenozoic volcanic history of the Clearwater-Wells Gray area, British Columbia, Canada; thesis in preparation) for further details of the volcanic activity. Collected August 1984 by C.J. Hickson and P. Metcalfe, both at University of British Columbia, Vancouver.

Comment (C.J. Hickson, P. Metcalfe): GSC-3944 provides a date on a postglacial lava flow that occupies a meltwater channel and shows some quench features. The presence of tree casts precludes a synglacial origin for the flow but the peripheral quench features are enigmatic. It is possible that flows earlier in the sequence dammed Falls Creek, backing up water into which later flow lobes moved. It is also possible that the eruption occurred in winter, and the flow was quenched against a thick cover of snow and ice which accumulated in the valley. Meltwater from the ice would have been dammed by ice farther downstream. This date is the first reported for the four postglacial volcanic centres in the Wells Gray area.

Comment (W. Blake, Jr.): The sample was a well compacted peat. As received in the laboratory it comprised pieces up to 8 cm in diameter and 1.5 cm in thickness. Date is based on two 1-day counts in the 5 L counter.

GSC-1992. Opax Mountain 8740 ± 90

Basal peat (sample ONE 3; 27.5 g dry) 540 cm below the surface of a bog in the northeast part of Opax Mountain plateau, British Columbia (50°51'N, 120°30'W), at an elevation of 1370 m. The bog had developed in a glacially scoured rock hollow. Collected August 1973 by N.F. Alley with a Hiller peat corer.

Comments (N.F. Alley): The date fixes the age of the lowest level in a pollen profile. The pollen assemblage at this level consists of 61% tree pollen, 12% shrubs, and 27% herbs. Arboreal pollen comprises 31% **Pinus contorta**, 9% **P. monticola**, 5% **P. ponderosa**, 5% **Picea**, 7% **Alnus**, and 1% or less each of **Abies**, **Pseudotsuga**, **Populus**, **Tsuga heterophylla**, **Betula**, and **Myrica**. The date is also a minimum age for the deglaciation of this part of the interior plateau. Mazama tephra occurs above the sample at 395 cm depth.

Comment (W. Blake, Jr.): During drying in an electric oven the weight of the peat decreased from 140.5 to 27.5 g. NaOH leach was omitted from sample pretreatment. Date is based on two 1-day counts in the 5 L counter.

Snowshoe Lake Series

Lake sediment was collected from a small (approximately 8 ha) muskeg lake, unofficially designated "Snowshoe Lake". The lake is located in the Milligan Hills, approximately 60 km east of Beatton River, British Columbia (57°27'N, 120°40'W), at an elevation of approximately 900 m. The lake sediment was cored from the ice using a modified Livingstone piston corer. The water depth was 2.0 m and a 411 cm-long sediment core was recovered. Coring ceased when an impenetrable pebbly clay diamict was encountered. Collected April 10, 1983 by G.M. MacDonald and R.W. Spear.

GSC-3762. Snowshoe Lake (E), 96-100 cm — 3490 ± 70, $\delta^{13}C = -24.6‰$

Organic lake sediment (sample 83-S10-E; 83 g wet) from 96 to 100 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-3724. Snowshoe Lake (D), 206-210 cm — 6130 ± 90, $\delta^{13}C = -24.3‰$

Organic lake sediment (sample 83-S10-D; 70.4 g wet) from 206 to 210 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-3718. Snowshoe Lake (C), 280-284 cm — 8150 ± 100, $\delta^{13}C = -25.4‰$

Organic lake sediment (sample 83-S10-C; 66.4 g wet) from 280 to 284 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-3708. Snowshoe Lake (B), 347-352 cm — 9550 ± 100, $\delta^{13}C = -25.7‰$

Organic lake sediment (sample 83-S10-B; 79.0 g wet) from 347 to 352 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-3704. Snowshoe Lake (A), 373-377 cm — 10 400 ± 140, $\delta^{13}C = -27.6‰$

Organic lake sediment (sample 83-S10-A; 69.3 g wet) from 373 to 377 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 two 1-day counts in the 2 L counter.

Comment (G.M. MacDonald): The series of dates provides radiometric age control for a fossil pollen record which was obtained from the lake sediments. GSC-3704 also provides a minimum deglaciation date for the Milligan Hills region of British Columbia. The fossil pollen record from Snowshoe Lake is similar to the more completely analyzed Lone Fox Lake, Alberta pollen (this list). The comparison between the Snowshoe Lake and Lone Fox Lake pollen records is presented in detail in MacDonald (1984a).

GSC-3961. Chilliwack River 4270 ± 60

Wood (sample CH7/1; 11.8 g dry; **Abies** sp., unpublished GSC Wood Identification Report No. 84-47 by R.J. Mott) removed from a log exposed in the face of a terrace on the south side of Chilliwack River valley, British Columbia (49°04'45"N, 121°45'40"W), at an elevation of 175 m. The sample represents the outer 4 cm of a 40 cm-diameter log, embedded nearly horizontally, and exposed two to three months. Collected October 1984 by I. Saunders, Simon Fraser University, Burnaby, British Columbia.

Comment (I. Saunders): The 40 m-high terrace is adjacent to the present-day Chilliwack River. The sampled log is 5 m below this surface. The terrace has a longitudinal extent of 3 km, with no other correlative terraces either up- or down-valley. The sample is derived from a massive matrix-supported diamict unit which accounts for most of the terrace's composition. In a few places, a thin unit of deformed glaciolacustrine clay underlies the diamict. Although the local stratigraphy suggests a morainal origin for the diamict, GSC-3961 indicated that it is probably a rapid mass movement deposit from mid-Holocene times; there were no valley glaciers at this site at 4270 BP. Contemporary slope failures and debris flow activity in this locality attest to the continuing instability of unconsolidated sediments in the valley. Further discussion of this site, and others in the area, is presented by Saunders (1985).

Comment (W. Blake, Jr.): Only the largest piece (28 cm long, 4 x 2 cm in cross-section) of the submitted sample was used. All the outside wood (dark weathered) plus adhering silt was cut off. Date is based on one 3-day count in the 5 L counter.

GSC-3918. Tyee Lake 7510 ± 80

Peat (sample CIA-84-127; 102.6 g wet) collected from the walls of a pit that was dug at the base of a small excavation, 3 km east of Tyee Lake and 28 km north-northeast of Williams Lake, British Columbia (52°22.3'N, 122°01.4'W), at an elevation of approximately 909 m. The excavation and pit are located on the flank of a hill bordering the floodplain of a small unnamed stream. Sediments exposed in the excavation face and pit walls include, from top to bottom: 215 cm of peat with lenses of sandy gravel near the base; 100 cm of calcareous mud containing freshwater molluscs; 15 cm of peat; and more than 45 cm of glaciofluvial (?) sand and gravel. The dated sample was collected from the lower peat unit, 3-5 cm above the base of the organic sequence. Collected June 1984 by J.J. Clague and F.A. Noone.

Comment (J.J. Clague): The organic sediments accumulated, in part, in a small lake or pond and, in part, in a bog or marsh fringing such a pond. The depression in which the organic sediments accumulated was formed at the end of the Fraser Glaciation about 10 000 to 11 000 BP. GSC-3918 indicates that organic sedimentation began at this locality about 7500 BP or shortly before. The reason for the absence of earlier Holocene organic sediments is unknown, although the climate may have been too warm and/or dry to support a bog or pond at this site immediately after the Fraser Glaciation. Some time during the late Holocene, the basin in which the organic sediments accumulated was breached and incised by the stream that presently flows past the site.

The dated sample contains a variety of plant macrofossils (unpublished GSC Plant Macrofossil Report No. 84-29 by J.V. Matthews, Jr.) and fossil arthropods (unpublished GSC Fossil Arthropod Report No. 84-29 by J.V. Matthews, Jr.). Reporting on the plant macrofossils, Matthews commented: "The plant fossils represent taxa that occur at present around and in small ponds in central B.C. Because of the presence of two species of **Chenopodium**, it is possible that some of the shoreline or adjacent sites were scantily vegetated. Conspicuously absent are conifer needles and any evidence of alder or willow..." Regarding the fossil insect fauna, Matthews stated: "Insect fossils are not as abundant as plant macrofossils; consequently the list is much less informative. It does include a bark beetle of the genus **Polygraphus**, members of which feed on conifers. Thus even though conifer seeds or needles were not seen, coniferous trees were probably growing in the region. Many of the fossils represent taxa that presently occur in central B.C. in and around small lakes and ponds." Also present in the dated peat sample are molluscs, including **Gyraulus parvus** (Say), **Valvata sincera sincera** Say, **Physella** sp., and Pisidiidae (identified by M.F.I. Smith, National Museum of Natural Sciences, Ottawa).

Comment (W. Blake, Jr.): The especially marl-rich portion of the peat was excluded from the sample submitted to the laboratory. Following the usual NaOH pretreatment applied to peats, the sample showed a slight reaction with HCl. Date is based on one 3-day count in the 5 L counter.

Lac Ciel Blanc Series

Lake sediment was collected from a small (approximately 17 ha) muskeg lake unofficially named "Lac Ciel Blanc". The lake is located on the Estho Escarpment approximately 1 km north of Trail Lake, British Columbia (59°31'N, 122°11'W), at an elevation of 650 m. The lake sediment was cored from the ice using a modified Livingstone piston corer. The water depth was 2 m and a 440 cm-long core of limnic sediment was recovered. Coring ceased when an impenetrable pebbly-clay diamict was encountered. Collected April 9, 1983 by G.M. MacDonald and R.W. Spear.

GSC-3791. Lac Ciel Blanc (D), 96-100 cm — 4090 ± 100, $\delta^{13}C = -26.4‰$

Organic lake sediment (sample 82-S8-D; 79.8 g wet) from 96 to 100 cm below the sediment/water interface. NaOH leach was omitted from sample pretreatment. Date is based on three 1-day counts in the 2 L counter.

GSC-3786. Lac Ciel Blanc (C), 248-252 cm — 7400 ± 120, $\delta^{13}C = -24.3‰$

Organic lake sediment (sample 83-S8-C; 55.6 g wet) from 248 to 252 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 two 1-day counts in the 2 L counter.

GSC-3778. Lac Ciel Blanc (B), 298-302 cm — 8750 ± 120, $\delta^{13}C = -21.8‰$

Organic lake sediment (sample 83-S8-B; 61.8 g wet) from 298 to 302 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 two 1-day counts in the 2 L counter.

GSC-3755. Lac Ciel Blanc (A), 346-350 cm — 9350 ± 150, $\delta^{13}C = -24.2‰$

Organic lake sediment (sample 83-S8-A; 53.0 g wet) from 346 to 350 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.

GSC-3749. Lac Ciel Blanc (X), 370-373 cm — 9910 ± 120, $\delta^{13}C = -28.3‰$

Marly gyttja (sample 83-S8-X; 89.9 g wet) sample of highly organic, marly gyttja, taken from the same depth level of two adjacent cores (I and II) at 370 to 373 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 two 1-day counts in the 2 L counter.

Comment (G.M. MacDonald): This series of dates provides radiometric age control on the rate of sediment accumulation at Lac Ciel Blanc, and chronological control for a fossil pollen record which was obtained from the lake sediments. GSC-3749 also provides a minimum deglaciation date for the Estho Escarpment region of British Columbia. The fossil pollen evidence indicates that this portion of British Columbia was occupied by a sage-grass-willow vegetation until approximately 10 000 BP. Shrub birch and poplar became important in the vegetation at approximately 10 000 BP and spruce appeared in the region at approximately 9700 BP. Pine appeared in the region between 7000 and 5000 BP. From 5000 BP to the present the vegetation appears to have remained stable and similar to the modern muskeg-dominated vegetation of the region (MacDonald, 1984a).

Ste. Marie Lake Series

Wood and other plant detritus from a trench excavated across a peat bog, 3.5 km southwest of Ste. Marie Lake and 33 km southeast of Prince George, British Columbia (53°42.8'N, 122°22.9'W), at an elevation of 950 m. The trench exposes up to 2.7 m of peat overlying about 30 cm of organic-rich mud, and, at the base, fluvial or glaciofluvial pebble-cobble gravel. A thin discontinuous layer of sand and gravel occurs 20 to 30 cm above the base of the organic sequence. The two dated samples were collected from the basal organic-rich mud directly above the pebble-cobble gravel. Collected June 1983 by J.J. Clague.

GSC-3694. Ste. Marie Lake (I) 7770 ± 80
$\delta^{13}C = -26.3‰$

Wood (sample CIA-83-19-4; 11.0 g; **Picea** or **Larix** sp.; unpublished GSC Wood Identification Report No. 83-33 by R.J. Mott). Date is based on one 3-day count in the 5 L counter.

GSC-3764. Ste. Marie Lake (II) 7840 ± 80
$\delta^{13}C = -27.3‰$

Plant detritus (sample CIA-83-19-5; 24.0 g dry; stems, rhizomes, and possibly moss fragments, fungal sclerotia, charcoal; unpublished GSC Plant Macrofossil Report No. 83-52 by J.V. Matthews, Jr.). Date is based on two 1-day counts in the 5 L counter.

Comment (J.J. Clague): The two dates are statistically equivalent and indicate that organic sedimentation commenced in the bog ca. 8000 BP. The reason for the absence of older Holocene organic sediments at this site is unknown, although one possible explanation is that the climate was too dry for a bog to exist here during the early Holocene (see also GSC-3918, this list).

Comment (W. Blake, Jr.): The wood sample used for GSC-3694 comprised 15 twigs; maximum length 11 cm; maximum diameter 1 cm. The sample was air dried, its weight decreasing from 44.7 to 11.5 g. Two twigs were broken to use for identification. All twigs, some of which showed slight rounding at the ends, were scraped clean of adhering debris. For GSC-3764 the sample was washed and the portion retained for dating was <5 mesh but >80 mesh in size. On overnight drying in an electric oven the weight decreased from 137.8 to 24.0 g. Most included pebbles were picked out while the sample was still wet. The pretreatment of GSC-3764 included a cold NaOH leach.

GSC-3939. Big Slide 230 ± 80
$\delta^{13}C = -22.4‰$

A single piece of wood (sample CIA-84-190; 12.8 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 84-51 by R.J. Mott) from a bluff on the east side of Fraser River, 12 km north-northwest of Quesnel, British Columbia (53°05.1'N, 122°31.6'W), at an elevation of approximately 503 m. The sample was collected from a pocket of woody debris at the base of up to 20 m of colluvial silt and sand. The colluvium unconformably overlies a Pleistocene succession comprising, from top to bottom, lacustrine silt and sand, fluvial gravel, and older colluvium; this succession has a maximum thickness of about 40 m at the date locality. The dated colluvium is derived from the Pleistocene lacustrine unit; it was emplaced by slumping and flow of silt and sand from the valley wall directly to the east of the date site. Collected September 1984 by J.J. Clague.

Comment (J.J. Clague): GSC-3939 indicates that slope failures precursory to "Big Slide", a large active landslide in lacustrine sediments approximately 0.5 km to the southeast (Evans, 1982), occurred about 200 to 300 years ago. The dated colluvium is covered by undisturbed trees, some of which are at least 100 years old.

Comment (W. Blake, Jr.): Only the largest flat piece of wood, 24 cm long and 3.7 x 1.5 cm in cross-section, was used for dating. The sample was air dried in small pieces; its weight decreased from 13.1 to 12.8 g. Date is based on two 1-day counts in the 5 L counter.

GSC-3974. Albion 12 000 ± 110
$\delta^{13}C = -5.1‰$

Serpulid worm tubes (sample FAB-210S; 29.0 g) from a fossiliferous, stony, clayey silt unit in a gravel pit, 1.5 km east of Albion on Langley Indian Reserve, located on the north side of Fraser River, British Columbia (49°10'37"N, 122°31'50"W), at an elevation of 73 m. Collected October 1984 by J.E. Armstrong and J.J. Clague.

Comment (J.E. Armstrong): The unit sampled forms part of the Fort Langley Formation of Late Wisconsinan age (Armstrong et al., 1985). At the site the formation is 5 m thick and it overlies Vashon Drift. Both the Fort Langley Formation and the Vashon Drift are units of the Fraser Glaciation (Wisconsin). The date confirms the original stratigraphic correlation.

Comment (W. Blake, Jr.): The date is similar to two other recent determinations on serpulid worm tubes from coastal British Columbia (GSC-3782, 12 200 ± 120 BP; GSC-3726, 12 400 ± 160 BP; both in GSC XXIV, 1984, p. 14). Both of these earlier determinations also were characterized by more negative $^{13}C/^{12}C$ ratios than is usually the case with marine mollusc shells.

On receipt by the laboratory, the serpulid worm tubes were broken open and were washed repeatedly in distilled water over a one month period to remove clay and silt adhering inside. Date is based on one 3-day count in the 2 L counter.

Germansen Mountain Series

Peat samples from a bog 9.6 km south of Germansen Lake, British Columbia (55°35'N, 124°55'W), at an elevation of 1680 m. The bog is located between the middle moraine and the outer moraine in the lower part of a west-facing cirque. One other moraine and two fossil protalus ramparts or block streams of progressively younger age occur between the middle moraine and the cirque headwall. Collected August 1973 by N.F. Alley with a Hiller peat corer.

GSC-2171. Germansen Mountain (I) 6820 ± 70

Very coarse peat (sample OM1B; 9.9 g dry) 130 cm below the surface of the bog; overlain by finer peat and underlain by very coarse peat.

GSC-2159. Germansen Mountain (II) 8210 ± 80

Basal peat (sample OM1C; 9.6 g dry) 180 cm below the surface of the bog.

Comment (N.F. Alley): GSC-2159 fixes the age of the lowest level in the pollen profile. The date also provides a minimum age for the outer moraine and a maximum age for the middle moraine. The date suggests that the outer moraine correlates with an early Holocene advance recognized in parts of Alaska (Porter, 1971). GSC-2171 fixes the age level in the pollen profile and the time at which a change in peat sedimentation occurred. Near the edges of the bog, this change in the nature of the peat is also associated with accumulations of wood, including tree trunks and branches of coniferous and deciduous taxa. A date on the wood of 6890 ± 115 BP (I-8455, unpublished) shows close agreement with GSC-2171.

Comment (W. Blake, Jr.): The wet peat comprising GSC-2159 decreased in weight from 68.0 to 9.6 g during oven drying; GSC-2171 decreased in weight from 82.5 to 24.8 g. Each date is based on two 1-day counts in the 5 L counter.

Omineca River Series

Peat and marl from a valley bottom bog, 24 km west of Germansen Landing, British Columbia (55°47'N, 125°05'W), at an elevation of approximately 946 m. The bog formed in a small rock hollow within an area of drumlinized bedrock and till on valley side of Omineca River. Collected August 1973 by N.F. Alley with a Hiller peat corer.

GSC-2170. Omineca River (I) 6010 ± 140

Peat and peaty marl (sample OM3A; 22 g) 300 to 305 cm below the surface.

GSC-2036. Omineca River (II) 10 100 ± 90

Basal marl (sample OM3B; 262.2 g wet) from 5.6 to 5.7 m below the surface.

GSC-2036-2. Omineca River (III) 10 000 ± 140

Peat fragments separated from basal marl (sample OM3B; 38.0 g).

Comment (N.F. Alley): GSC-2036 provides a minimum age for the deglaciation of Omineca River valley – the major valley in the Omineca Mountains; it also fixes the age of the lowest level in a pollen profile. GSC-2036-2, the date on the peat fragments at the same depth in the core, shows exceptionally good agreement with the enclosing marl. GSC-2170 fixes the age of a level in the pollen profile as well as the change in sedimentation (marl below, peat above).

Comment (W. Blake, Jr.): The basal marl sample was placed in the shell apparatus with H_3PO_4 to recover the CO_2. The organic residue was neutralized, treated with HCl and distilled water rinses, and burned. The marl fraction in GSC-2171 was utilized; treatment was as described for GSC-2036. GSC-2036 was based on one 3-day count in the 5 L counter. Both GSC-2036-2 and GSC-2170 were mixed with dead gas for counting; each date is based on two 1-day counts in the 2 L counter.

GSC-3431. Machmell River 12 200 ± 140
$\delta^{13}C = -6.0‰$

Barnacles (sample Machmell River 1; 15.9 g) exposed in a roadcut along a logging road about 8.5 km upstream from the mouth of Machmell River at the head of Owikeno Lake, British Columbia (51°36.6'N, 126°33.4'W), at an elevation of approximately 95 m. The barnacles were found in growth position on a rock surface overlain successively by partially baked laminated silt, gravel, and columnar basalt. Collected June 1981 by H.W. Nasmith, then Thurber Consultants, Victoria; now retired; submitted by J.J. Clague.

Comment (J.J. Clague): GSC-3431 is significant for the following reasons: (1) It is a maximum date for the lava flow at the top of the section. This flow probably issued from the Silverthrone Mountain area, 35 km to the east-southeast. (2) Sea level was at least 95 m higher relative to the land than at present, and the sea extended inland to within 50 km of the crest of the Coast Mountains. (3) Lower Machmell River valley and, presumably, Rivers Inlet and Owikeno Lake were deglaciated prior to 12 200 BP. The glacier in Machmell valley had retreated to within 50 km of its source (ice fields at the crest of the Coast Mountains) before this date.

Data from other major valleys and fiords in the Coast Mountains (e.g., Terrace-Kitimat area, Howe Sound; Clague, 1980, 1981, 1985) suggest that deglaciation of these areas occurred between 11 000 and 10 000 BP. Thus, GSC-3431, collected only a few tens of kilometres from existing ice fields, seems too old. The barnacles may have incorporated "old" carbon prior to their death, in which case the value of 12 200 ± 140 BP is greater than the true age of the barnacles. Although there is no direct evidence for this, numerous fossil marine and freshwater shells have yielded anomalously old radiocarbon dates (see comment for Kitimat Series, this list).

Comment (W. Blake, Jr.): It should also be noted that the $^{13}C/^{12}C$ ratio is unusually negative for a marine organism, although serpulid worm tubes farther south along the British Columbia coast have given values of -3.7‰ (GSC-3782) and -3.2‰ (GSC-3726; both in GSC XXIV, 1984, p. 14) as well as -5.1‰ (GSC-3974, this list). A similar $^{13}C/^{12}C$ ratio to that reported here was obtained on freshwater bivalve shells (GSC-3114) near Rainy River, Ontario (GSC XXII, 1982, p. 7), and even more negative values for freshwater and brackish-water shells have been reported by Olsson and Osadebe (1974); cf. also a value of -7.8‰ (GSC-3885, this list) for freshwater gastropod shells from Jasper National Park. Because of the small sample size, only the outer 10% of shell material was removed by HCl leach. Sample was mixed with dead gas for counting. Date is based on one 4-day count plus one 2-day count in the 2 L counter.

Kitimat Series

Wood and shells from marine sediments exposed in a landslide scar on the west side of Kitimat Arm, 8 km south-southwest of Kitimat, British Columbia (53°59.1'N, 128°41.8'W). Both of the dated samples were collected from sandy silt at an elevation of 11.5 m (mean sea level datum). Collected October 1981 by A.S. Gottesfeld, Northwest Community College, Terrace, British Columbia.

GSC-3497. Kitimat (I) 9570 ± 120
$\delta^{13}C = -0.6‰$

A single right pelecypod valve (sample MC-2; 22.5 g; **Saxidomus giganteus**; identified by A.S. Gottesfeld). Because of the small sample size, only the outer 10% of shell material was removed by HCl leach. Date is based on one 3-day count in the 2 L counter.

GSC-3503. Kitimat (II) 8900 ± 100
$\delta^{13}C = -24.6‰$

Wood (sample MC-1; 11.9 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 82-34 by R.J. Mott). Date is based on one 3-day count in the 5 L counter.

Comment (J.J. Clague): In conjunction with other radiocarbon dates, GSC-3497 and GSC-3503 provide chronological control on the late Pleistocene-early Holocene fall in sea level in the Kitimat area (Clague, 1985; Clague et al., 1982). At about 8900 BP, sea level at Kitimat was at least 11 m higher relative to the land than at present. A date of 9300 ± 90 BP (GSC-2425; GSC XIX, 1979, p. 24) on coniferous wood from marine deltaic sediments exposed along Kitimat River, 13 km north of this site, indicate that at a slightly earlier date, sea level was about 35 m higher than today. The sea probably was near its present level by about 8000 to 8500 BP, judging by radiocarbon dates on low-elevation terrestrial and littoral deposits at McNeil River, 88 km west-northwest of Kitimat (GSC XIX, 1979, p. 24-25).

GSC-3497 and GSC-3503 were obtained on shell and wood from the same stratum. The shell date may be anomalously old due to the incorporation of "old" carbon by the mollusc prior to its death. This probably is a common phenomenon in marine (Robinson and Thompson, 1981) and freshwater (Clague, 1982) environments; where wood and shell from the same stratum have been dated by GSC and other labs, the shell in some cases is several hundred years older than the wood.

Comment (W. Blake, Jr.): The age of the shell sample, GSC-3497, comes closer to the age of the wood if a correction is made for the apparent age of sea water (cf. Robinson and Thompson, 1981). A summary of west coast age determinations on shell/charcoal and shell/wood pairs is provided by Taylor and Slota (1979).

Northern Canada, mainland

Yukon Territory

GSC-3297. Takhini Hot Spring 130 ± 160

Charcoal (sample E72-42C; 2.0 g dry) from a trench cut in the spring deposit of Takhini Hot Spring, Yukon Territory (60°52'41"N, 135°21'23"W), at an elevation of approximately 727 m. The sample was collected by digging into the sidewall of the trench to a depth of approximately 10 cm. The charcoal occurred just above a 10 to 15 cm-thick, light colored, fine grained gypsum layer, approximately 38 cm below the exposed top of the deposit of slightly moist, rusty colored travertine. Collected in July 1972 by R.O. van Everdingen, Inland Waters Directorate, Environment Canada, Calgary, Alberta.

Comment (R.O. van Everdingen): It was assumed that the charcoal would provide an approximate date for the change in spring-deposit chemistry and mineralogy and a lower limit for the rate of travertine deposition during formation of the upper portion of the deposit. The uncorrected age, however, suggests that the charcoal was derived from the surface of the deposit and embedded in the trench wall during recent excavation operations. Sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3901. Meadowhead Creek 10 300 ± 150

Organic detritus (sample HH84-12 (7.40-7.61 m); 6.7 g dry) in lake sediment collected using a permafrost coring kit, from the west side of a thermokarst lake in alpine tundra at the head of Meadowhead Creek, 10.4 km northwest of Kalzas Twins, Yukon Territory (63°19.6'N, 134°54.1'W), at an elevation of 1280 m. Perennially frozen peat 4.59 m thick overlies ice-rich clayey silt of unknown thickness in which organic content decreases downward. Dated sample is from 81 to 101 cm below the base of the peat. Approximately 250 g of sediment was washed on a screen with a 0.175 mm opening, yielding 6.7 g of organic material (dry weight). A sample from 101 to 119 cm below the base of the peat yielded insufficient material for dating. Identifiable arthropod and aquatic plant remains were all of forms living in the region today (unpublished GSC Fossil Arthropod Report No. 84-34 and unpublished GSC Plant Macrofossil Report No. 84-34 by J.V. Matthews, Jr. and L. Barton). Collected July 14, 1984 by O.L. Hughes, J.G. Fyles, C. Burn (Carleton University, Ottawa), and G. Ewing.

Comment (O.L. Hughes): The site is about 1 km inside a prominent moraine that marks the upper limit of the Cordilleran ice sheet against an isolated nunatak during the maximum of the Late Wisconsinan McConnell Glaciation (Hughes, 1983). The date is therefore minimum for retreat of the Cordilleran ice sheet from its maximum position. Because of the small sample size, the NaOH leach was omitted from the pretreatment. Sample was mixed with dead gas for counting. Date is based on one 4-day count in the 2 L counter.

Roop Lakes Series

Wood samples from an exposure in the bank of a thermokarst pond, 2.5 km north of the northernmost of the Roop Lakes and 68 km east-northeast of Mayo, Yukon Territory (63°51.5'N, 135°39.1'W), at an elevation of 715 m. The succession comprised, from the surface down: 12 cm of living moss and lichens, 46 cm of moss peat, 152 cm of sedge peat, and at least 91 cm of organic silt, which contained the lower wood sample. The organic silt extends to an unknown depth below the exposed face. Collected July 7, 1964 by O.L. Hughes; submitted November 28, 1983.

GSC-3887. Roop Lakes (I) 2870 ± 60

Wood (sample HH64-116-2; 12.8 g dry; **Picea** sp., unpublished GSC Wood Identification Report No. 84-7 by R.J. Mott) from the base of the sedge peat.

GSC-3796. Roop Lakes (II) 2900 ± 80

Twigs (sample HH64-116-1; 2.5 g dry; **Picea** sp., **Betula**? sp., **Populus**? sp.; unpublished GSC Wood Identification Report No. 83-50 by R.J. Mott) extracted from the organic silt 91 cm below the base of the sedge peat.

Comment (O.L. Hughes): GSC-3796 was intended to provide a minimum age for deglaciation of the area, but dates from elsewhere in central Yukon, including GSC-3901 (this list) indicate that the area was deglaciated much earlier. GSC-3887 was dated to support GSC-3796. The succession from sedge peat to moss peat is common in bogs of the region, but the age of the base of the peat is unusually young for peat totalling nearly 2 m in thickness.

Comment (W. Blake, Jr.): For GSC-3887 only the largest (12 cm long, 5 x 3 cm in cross-section) of four punky, poorly preserved wood pieces, all identified as spruce (see above) was used for dating. GSC-3796 was mixed with dead gas for counting. GSC-3887 is based on two 1-day counts in the 5 L counter; GSC-3796 is based on one 3-day count in the 2 L counter.

Northwest Territories

Ra Lake Series

Lake sediment was collected from a small (approximately 2 ha) muskeg pond, unofficially named "Ra Lake". The lake is located in the Franklin Mountains approximately 15 km east of the town of Norman Wells, Northwest Territories (65°14'N, 126°25'W), at an elevation of 330 m. The lake was cored from the ice using a modified Livingstone piston corer. The water depth was 2.6 m and a 256 cm-long sediment core was recovered. Coring ceased when an impenetrable pebbly-clay diamict was encountered. Collected April 20, 1982 by G.M. MacDonald and R.W. Spear.

GSC-3514. Ra Lake (B), 132-138 cm — 4530 ± 80, $\delta^{13}C = -26.6‰$

Organic lake sediment (sample 82-S6-B; 82.0 g wet) from 132 to 138 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.

GSC-3549. Ra Lake (A), 169-176 cm — 5510 ± 100, $\delta^{13}C = -24.1‰$

Organic lake sediment (sample 82-S6-A; 93.2 g wet) from 169 to 176 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 two 1-day counts in the 2 L counter.

Comment (G.M. MacDonald): This series of dates provides broad radiometric control on sediment accumulation rates at Ra Lake and limited chronological control for a fossil pollen record obtained from the lake sediments. The Ra Lake pollen record is similar to the detailed pollen record obtained from nearby Lac Meleze (see below). A detailed comparison of the Ra Lake and Lac Meleze pollen records is provided in MacDonald (1984a).

Lac Meleze Series

Lake sediment was collected from a small (approximately 4 ha) muskeg pond, unofficially named "Lac Meleze". The lake is located in the Franklin Mountains approximately 30 km east of the town of Norman Wells, Northwest Territories (65°13'N, 126°07'W), at an elevation of 650 m. The lake was cored from the ice using a modified Livingstone piston corer. The water depth was 2.5 m and a 491 cm-long sediment core was recovered. Coring ceased when an impenetrable pebbly-clay diamict was encountered. Collected April 20, 1982 by G.M. MacDonald and R.W. Spear.

GSC-3637. Lac Meleze (F), 90-95 cm — 2220 ± 90, $\delta^{13}C = -24.2‰$

Organic lake sediment (sample 82-S7-F; 56.2 g wet) from 90 to 95 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 two 1-day counts in the 2 L counter.

GSC-3667. Lac Meleze (E), 190-195 cm — 3360 ± 150, $\delta^{13}C = -23.1‰$

Organic lake sediment (sample 82-S7-E; 51.3 g wet) from 190 to 195 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 two 1-day counts in the 2 L counter.

GSC-3651. Lac Meleze (D), 260-265 cm — 4390 ± 160, $\delta^{13}C = -25.9‰$

Organic lake sediment (sample 82-S7-D; 52.5 g wet) from 260 to 265 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 two 1-day counts in the 2 L counter.

GSC-3624. Lac Meleze (C), 345-350 cm — 5970 ± 160, $\delta^{13}C = -26.1‰$

Organic lake sediment (sample 82-S7-C; 59.5 g wet) from 345 to 350 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 two 1-day counts in the 2 L counter.

GSC-3496. Lac Meleze (B), 384-389 cm — 9240 ± 120, $\delta^{13}C = -26.9‰$

Organic lake sediment (sample 82-S7-B; 73.8 g wet) from 384 to 389 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.

GSC-3536. Lac Meleze (A), 434-439 cm — 11 000 ± 340, $\delta^{13}C = -27.5‰$

Organic lake sediment (sample 82-S7-A; 94.6 g wet) from 434 to 439 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 (G.M. MacDonald): The series of dates provides radiometric age control for sediment accumulation at Lac Meleze and chronological control for a fossil pollen record which was obtained from the lake sediment. GSC-3536 also provides a minimum deglaciation date for this part of the Franklin Mountains. The fossil pollen record indicates that the region was occupied by a sage-grass-willow dominated vegetation until 11 000 BP. The vegetation was dominated by shrub birch between 11 000 and 9000 BP. Spruce arrived in the region at approximately 9000 BP. The vegetation in the region has been stable and similar to the modern muskeg dominated condition since 6000 BP.

Lac Demain Series

Lake sediment was collected from a small (approximately 5 ha) muskeg pond, unofficially named "Lac Demain". The lake is located on the Horn Plateau, approximately 15 km southeast of Willow Lake, Northwest Territories (62°03'N, 118°42'W), at an elevation of 750 m. The lake was cored from the ice using a modified Livingstone piston corer. The water depth was 1.5 m and a 485 cm-long sediment core was recovered. Only the upper 220 cm contained significant organic material. Coring ceased when the underlying inorganic clays and pebbly diamict became impenetrable. Collected April 17, 1982 by G.M. MacDonald and R.W. Spear.

GSC-3639. Lac Demain (E), 45-50 cm — 2570 ± 70, $\delta^{13}C = -26.0‰$

Organic lake sediment (sample 82-S3-E; 56.5 g wet) from 45 to 50 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-3673. Lac Demain (D), 70-75 cm — 3380 ± 70, $\delta^{13}C = -24.7‰$

Organic lake sediment (sample 82-S3-D; 50.2 g wet) from 70 to 75 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-3628. Lac Demain (C), 100-105 cm — 6450 ± 90, $\delta^{13}C = -22.3‰$

Organic lake sediment (sample 82-S3-C; 64.4 g wet) from 100 to 105 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-3487. Lac Demain (B), 121-126 cm — 7620 ± 180; $\delta^{13}C = -20.9‰$

Organic lake sediment (sample 82-S3-B; 57.7 g wet) from 121 to 126 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 three 1-day counts in the 2 L counter.

GSC-3524. Lac Demain (A), 192-197 cm — 10 500 ± 200; $\delta^{13}C = -24.4‰$

Organic lake sediment (sample 82-S3-A; 78.2 g wet) from 192 to 197 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 2-day count in the 2 L counter.

Comment (G.M. MacDonald): This series of dates provides radiometric age control for sediment accumulation at Lac Demain and chronological control for a fossil pollen record which was obtained from the lake sediments. GSC-3524 also provides a minimum deglaciation date for the Horn Plateau. The fossil pollen record indicates that prior to 10 500 BP, the region was occupied by a sage-grass-willow dominated vegetation. Shrub birch was dominant in the region from approximately 10 500 BP to 8500 BP. Spruce appeared in the region at about 8500 BP. Pine arrived in the area at approximately 6000 BP. The vegetation of the Horn Plateau region appears to have remained stable and similar to the modern muskeg dominated condition from approximately 5000 BP to the present (MacDonald, 1984a,b,c).

GSC-3721. Coppermine River 3300 ± 70

Humic sand (sample BF-3; 62.5 g dry) from 105 to 110 cm below the surface of a section exposed in a small infilled channel along Coppermine River, Northwest Territories (67°45'42"N, 115°21'12"W), at an elevation of approximately 75 m. Collected July 1981 by M.-A. Geurts, Université d'Ottawa, Ottawa, and D.A. St-Onge.

Comment (M.-A. Geurts): This sample gives the age of the **Alnus** peak (20%) in a pollen diagram calculated on the sum of AP plus NAP. Prior to the interval dated by GSC-3721 **Alnus** represents less than 10% of the pollen sum. Date is based on two 1-day counts in the 2 L counter.

GSC-2042. MacQuoid Lake 6520 ± 70

Marine mollusc shells (sample BNA-73-185; 47.1 g; **Hiatella arctica**; identified by W. Blake, Jr.) from a hole dug in sand and gravel beach sediment, 26 km east-northeast of MacQuoid Lake, Northwest Territories (63°33'27"N, 94°04'15"W), at an elevation of 120 m. Collected July 29, 1973 by A.N. Boydell, then Geological Survey of Canada, now Environment Canada.

Comment (A.S. Dyke): The sample, which also contained abundant **Balanus balanus** as well as **Clinocardium ciliatium, Mya truncata,** and **Serripes groenlandicus** (all identified by W. Blake, Jr.), came from about 1 m below the surface of beach sediment at the bottom of a hole dug to the frost table. The date shows that sea level was at or above 120 m in the Baker Lake region of Keewatin about 6500 years ago, in agreement with a date of 6570 ± 140 BP on shells at 122 m at Duffy Lake (GSC-1016; GSC IX, 1970, p. 81). Two other dates from the Baker Lake vicinity also provide some control on middle Holocene sea level history: GSC-289, shells from beach sand at 126 m dated 6830 ± 170 BP and GSC-299, shells from the surface at 90 m dated 5480 ± 150 BP (both in GSC V, 1966, p. 23-24).

Comment (W. Blake, Jr.): The sample as received was enclosed in damp sand. After oven drying the shells were washed in distilled water to remove adhering sand and silt, and were then dried again in the oven. Probably a number of the **Hiatella arctica** valves represented pairs. The aragonitic shells had little pitting, encrustations, or chalkiness. Most of the sample used for dating consisted of intact valves or large fragments. Date is based on one 3-day count in the 5 L counter.

Northern Canada, Arctic Archipelago

Axel Heiberg Island

Mokka Fiord Series

Marine pelecypod shells collected from the surface of raised littoral deposits (silty gravel) on the southwest shore of the head of Mokka Fiord, Axel Heiberg Island, Northwest Territories (79°31'N; 87°27'W). Collected August 1961 by J.G. Fyles.

GSC-171. Mokka Fiord (I) 2420 ± 140

Shells (sample FG-61-186a; 63.2 g; **Astarte** sp., **Astarte borealis,** some **Mya truncata** and **Hiatella arctica;** identified by J.G. Fyles) from 1.5 m elevation. Date is based on two 1-day counts in the 2 L counter.

GSC-267. Mokka Fiord (II) 2900 ± 130

Shells (sample FG-61-186b; 47.0 g; **Astarte** sp.; identified by J.G. Fyles) from 3 m elevation. Date is based on two 1-day counts in the 2 L counter.

GSC-174. Mokka Fiord (III) 3130 ± 140

Shells (sample FG-61-186c; 74.5 g; **Astarte** sp.; identified by J.G. Fyles) from 5 to 6 m elevation. Date is based on one 3-day count in the 2 L counter.

GSC-273. Mokka Fiord (IV) 4830 ± 130

Shells (sample FG-61-186d; 41.4 g; **Astarte** sp.; identified by J.G. Fyles) from 14 to 15 m elevation. First reported by Blake (1970, Table VI). Date is based on one 3-day count in the 2 L counter.

GSC-274. Mokka Fiord (V) 4960 ± 130

Shells (sample FG-61-186e; 42.1 g; **Astarte** sp.; identified by J.G. Fyles) from 23 to 24 m elevation. First reported by Blake (1970, Table VI). Date is based on one 3-day count in the 2 L counter.

GSC-351. Mokka Fiord (VI) 6010 ± 140

Shells (sample FG-61-186f; 98.6 g; **Astarte borealis;** identified by J.G. Fyles) from 37 m elevation. First reported by Blake (1970, Table VI). Two determinations were made:

Outer fraction	5910 ± 140
Inner fraction	6010 ± 140

Each date is based on one 3-day count in the 2 L counter.

GSC-350. Mokka Fiord (VII) 7980 ± 150

Shells (sample FG-61-186g; 81.7 g; **Astarte** sp.; identified by J.G. Fyles) from 83 to 88 m elevation. First reported by Walcott (1972, Fig. 7). Two determinations were made:

Outer fraction	7860 ± 150
Inner fraction	7980 ± 150

Each date is based on two 1-day counts in the 2 L counter.

Comment (D.A. Hodgson): Marine limit for this location is not known, however the limit is >140 m at Blue Man Cape, 40 km to the northeast (see comment for Blacktop Creek series, Ellesmere Island, this list). The dates form part of an accordant emergence curve for northern Eureka Sound (Hodgson, 1985, Fig. 8), even though they are for surface samples for which the related sea level is unknown.

Comment (W. Blake, Jr.): For all but last two samples approximately the outer 20% of shell material was removed by HCl, i.e. the standard treatment for shells at the GSC. In the case of both GSC-350 and -351, 45% or more of shell material was removed prior to the sample being prepared in two fractions.

Nansen Sound Series

Shell and driftwood from two sites along the Nansen Sound coast of Axel Heiberg Island.

GSC-2044. Nansen Sound (I) 28 800 ± 1800

Marine pelecypod shell (sample HCA-73-28-6-7; 4.2 g; species unrecorded, probably a single valve) from the surface of littoral silt, at an elevation of 62 m, on the western shore of Nansen Sound, Axel Heiberg Island, Northwest Territories (81°01.5'N, 91°38'W). Collected June 28, 1973 by D.A. Hodgson.

Comment (D.A. Hodgson): The highest Holocene shells so far dated from northern Axel Heiberg Island were at 30 m elevation and were 8250 ± 140 years old (GSC-167; GSC IV, 1965, p. 42). All higher shell collections (see GSC-149; GSC III, 1964, p. 179) have provided older dates than GSC-2044, with the exception of GSC-432 from 64 to 70 m elevation which dated 14 180 ± 180 BP (GSC IX, 1970, p. 83). The numerous whole valves, some paired, that lie up and downslope from GSC-2044 do not appear to have been disturbed since deposition. Because of the small sample size, HCl 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-2003. Nansen Sound (II) 4470 ± 60
$\delta^{13}C = -23.8‰$

Driftwood (sample HCA-73-28-6-8; 11.5 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 73-60, by L.D. Farley-Gill) embedded in platy carbonate beach gravel, 12 m above high water, on the northwest shore of Nansen Sound, Axel Heiberg Island, Northwest Territories (81°05'N, 91°48'W). Collected June 18, 1973 by D.A. Hodgson. The dimensions of the embedded wood were not recorded.

Comment (D.A. Hodgson): The sample dates the 12 m or slightly higher (allowing for ice push) sea level. It shows that emergence of northern Axel Heiberg Island in the last 4500 years was about two thirds that of northern Eureka Sound (Hodgson, 1985, Fig. 8). The approximate date (4500 years) was first reported in Blake (1975). Date is based on two 1-day counts in the 5 L counter.

Ellesmere Island

GSC-2700. Bjorne Peninsula 30 100 ± 750
$\delta^{13}C = +1.9‰$

Marine pelecypod shells (sample HCA 74-14-7-1; 17.4 g; **Hiatella arctica**; identified by D.A. Hodgson) from the gravelly silt surface of a hilltop, 103 to 108 m elevation, 6 km west of Gunnars Island in Baumann Fiord; Ellesmere Island, Northwest Territories (77°29'N, 85°45'W). Collected July 14, 1974 by D.A. Hodgson.

Comment (D.A. Hodgson): This sample is from a lower elevation than GSC-840 (8590 ± 150 BP; Blake, 1970, Table VI; GSC XI, 1971, p. 315) collected at 107 m, 60 km to the southwest, and GSC-244 (8480 ± 140 BP, GSC IV, 1965, p. 43) collected at 116 m, 70 km to the north. Whether 'old' shells such as these come from glacially reworked deposits, or whether they are preserved in marine deposits lying beyond the limit of the last glaciation, is not known (Hodgson, 1985). Because of the small sample size, only the outer 10% of shell material was removed by HCl leach. Sample was mixed with dead gas for counting. Date is based on one 4-day count in the 2 L counter.

Comment (W. Blake, Jr.): The sample was cleaned in two batches, first by scraping and then in distilled water using a sonic bath. Encrusted shells and thicker whole shells were not used. The sample dated comprised six right valves, six left valves (not pairs), and 17 fragments; all were thin and clean. No periostracum was preserved and some shells exhibited chalkiness (external) as well as internal lustre. All fragments were <3 cm long, although some may have derived from larger valves. The smallest whole valve measured 2.2 x 1.1 cm.

GSC-2719. Starfish Bay 8710 ± 120
$\delta^{13}C = -1.7‰$

Whole marine pelecypod shells (sample HCA-78-28-7-6; 19.0 g; **Portlandia arctica**; identified by D.A. Hodgson) exposed in glaciomarine silt 3 km west of the head of Starfish Bay (north shore), Ellesmere Island, Northwest Territories (78°11'N, 84°08'W). The shells were in a 20 cm-thick zone at the base of 4 m of faintly rhythmically banded silt, at an elevation of 68 m. Collected July 28, 1978 by D.A. Hodgson.

Comment (D.A. Hodgson): The sample provides a minimum age for the 72 m relative sea level. Sea level at the time of shell deposition, however, was likely much higher because the shell zone is conformable with the underlying till; furthermore, kame deltas at the head of the fiord lie at 85 to 90 m elevation (Hodgson, 1985). Because of the small sample size, only the outer 10% of shell material 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.

Comment (W. Blake, Jr.): The sample was wet sieved to remove adhering silt, then washed in distilled water (some silt/clay still adhered). All valves (many were paired prior to collection) still retained the periostracum. The largest valve in this collection of aragonitic shells measured 1.8 x 1.2 cm.

Rock Basin Lake Series

Lake sediment samples from a lake, informally designated as 'Rock Basin Lake', which occupies a deep depression in a hill abutting the south side of Ekblaw Glacier at the head of Baird Inlet, Ellesmere Island, Northwest Territories (78°29.5'N, 76°46.8'W). The elevation of the lake surface is approximately 295 m, based on repeated determinations with a Wallace and Tiernan surveying altimeter. Cores were taken with a modified Livingstone sampler using the lake ice (101 cm-thick) as a coring platform; water depth 14.8 m. In Core 3, 56 cm long, basal sandy silt was overlain by 51 cm of laminated silty gyttja and fine detritus gyttja grading upwards into loose algal gyttja (Hyvärinen and Blake, 1981). Collected June 18, 1979 by W. Blake, Jr., H. Hyvärinen (University of Helsinki, Helsinki, Finland), R.J.H. Richardson (then GSC, now Alberta Geological Survey, Edmonton), and R.N. McNeely (then Water Quality Branch, Environment Canada, now GSC).

GSC-3192. Rock Basin Lake, 20-25 cm 4080 ± 210
$\delta^{13}C = -36.6‰$

Organic lake sediment (sample BS-79-47 (3: 20-25 cm); 4.2 g dry) from 20 to 25 cm below the sediment/water interface. Date is based on two 1-day counts in the 2 L counter.

GSC-3184. Rock Basin Lake, 30-35 cm — 6780 ± 220; $\delta^{13}C = -37.2‰$

Organic lake sediment (sample BS-49-47 (3: 30-35 cm); 6.8 g dry) from 30 to 35 cm below the sediment/water interface. Date is based on one 3-day count in the 2 L counter.

GSC-3051. Rock Basin Lake, 46-51 cm — 8970 ± 160; $\delta^{13}C = -31.2‰$

Laminated lake sediment (sample BS-49-47 (3: 46-51 cm); 24.7 g dry) from 46 to 51 cm below the sediment/water interface. Organic carbon content ranged from 1.18% at 50-51 cm, to 3.85‰ at 47.5-48.5 cm, to 5.99% at 45-46 cm depth. Date is based on one 4-day count in the 2 L counter.

Comment (W. Blake, Jr.): In addition to the three dates reported above, a fourth age determination (GSC-3234) was attempted on the organic lake sediment at 40 to 45 cm depth, but the sample was lost in the laboratory. The three age determinations permit the calculation of sedimentation rates (0.04 to 0.07 mm/year) and four local pollen zones could be distinguished: BIR 1, Gramineae-Cyperaceae-**Oxyria** Zone (approximately 9000 to 8000 BP); BIR 2, **Salix** Zone (approximately 8000 to 7000 BP); BIR 3, Ericales-**Salix** Zone (approximately 7000 to 3500 BP); and BIR 4, Ericales-**Salix**-herb Zone (3500 to 0 BP; Hyvärinen, 1985). Similarly, four zones, each identified by characteristic diatom flora, were distinguished by Smol (1983, p. 2301), who stated, "Profiles of the concentrations and accumulation rates of diatoms and chrysophycean statospores indicate that these algae were abundant in the lake's early history, but then declined sharply about 4000 years ago at the transition to zone 4. Diatom and chrysophycean populations were especially low at the surface of the core". NaOH leach was omitted from the pretreatment of all three samples, and each sample was mixed with dead gas for counting.

Thumb Mountain Series

Shell samples from two sites near Thumb Mountain at the head of Irene Bay, Ellesmere Island, Northwest Territories.

GSC-1978. Thumb Mountain (I) — 8820 ± 90; $\delta^{13}C = -0.7‰$

Marine pelecypod shells (sample HCA-73-4-8-1; 21.8 g; **Portlandia arctica**; identified by W. Blake, Jr.) in fine sand approximately 5 m from the top of 70 m of silt rhythmites abutting the southwest flank of Thumb Mountain, head of Irene Bay (79°01.5'N, 81°31'W), at an elevation of 70 to 74 m. The rhythmites overlie glacially polished rock or till and are conformably overlain at the landward limit of their exposure by a gravelly sandur 80 m above sea level. Collected August 4, 1973 by D.A. Hodgson.

GSC-3388. Thumb Mountain (II) — 9140 ± 310; $\delta^{13}C = -1.1‰$

Marine pelecypod shells (sample HCA-78-26-7-3A; 5.1 g; **Portlandia arctica**; identified by D.A. Hodgson) believed to be from the same stratum as GSC-1978 (this series), within rhythmites flanking Thumb Mountain, head of Irene Bay (79°01.5'N, 81°31'W). Collected July 26, 1978 by D.A. Hodgson.

GSC-3397. Thumb Mountain (III) — 7340 ± 170; $\delta^{13}C = +1.5‰$

Marine pelecypod shells (sample HCA-78-21-7-2; 12.3 g; **Hiatella arctica**; identified by D.A. Hodgson) from the surface of marine/glaciomarine fine sand and silt adjacent to silt-sand rhythmites abutting the southeast flank of Thumb Mountain, head of Irene Bay (79°01'N, 81°28'W), at an elevation of 66 to 70 m. These rhythmites lie inland from GSC-1978 and GSC-3388 (this series) and were collected in a basin between the 80 m sandur and kame deltas at elevations of 75 to 78 m. Collected July 21, 1978 by D.A. Hodgson.

Comment (D.A. Hodgson): The seaward (southwest) rhythmites were deposited at approximately 9000 BP, shortly before deposition of the 80 m sandur. Deposition of the landward (southeast) rhythmites by ice standing at the 75 to 78 m deltas was complete by approximately 7300 BP. Explanations offered by Hodgson (1985) for the small difference in sea levels (>1000 years different in age) include: (1) the ice front stood between the rhythmite deposits for >1000 years or (2) ice retreated and readvanced in this time. The supposition that the thin valves dated for GSC-1978 and GSC-3388 were contaminated by 'old' carbon from surrounding carbonate terrain was rejected after GSC-3823 (this list) was dated. Because of the small sample size, only the outer 5% of GSC-3388 and the outer 10% of GSC-3397 were removed by HCl leach. All three samples were mixed with dead gas for counting. GSC-1978 is based on one 3-day count in the 2 L counter; GSC-3388 is based on one 5-day and one 3-day count in the 2 L counter; GSC-3397 is based on two 1-day counts in the 2 L counter.

Comment (W. Blake, Jr.): The sample represented by GSC-1978 is composed completely of **Portlandia arctica**, mostly whole valves (up to 1.8 cm long), some paired, and virtually all valves still retain some periostracum.

For GSC-3397 the sample was cleaned of adhering silt in distilled water, then air dried. The sample submitted comprised two whole left valves plus two fragments, three whole right valves plus four fragments. The largest valve measured 3.4 x 1.9 cm.

GSC-3765. Strathcona Fiord, head — 6780 ± 80; $\delta^{13}C = +1.9‰$

Fragments of marine pelecypod shells (sample HCA-83-4-8-5; 27.0 g; **Mya truncata**; identified by D.A. Hodgson) from a gravelly silt beach on the crest of the end moraine blocking the head of Strathcona Fiord, Ellesmere Island, Northwest Territories (78°34'N, 82°19'W), at an elevation of 56 m; beaches rise to 59 m. Collected August 4, 1983 by D.A. Hodgson.

Comment (D.A. Hodgson): This sample provides a minimum age for a 56 m sea level, relative to the land. Kame deltas indicate a 70 m sea level when ice retreated from the moraine (Hodgson, 1985). Date is based on one 3-day count in the 2 L counter.

Comment (W. Blake, Jr.): All the shells comprising this collection were fragments and all had a yellowish brown stain, which was removed by scraping to expose the white shell beneath. Those shells with true encrustations (brown) were not used. The largest fragment was 3+ cm long by 2+ cm high; and the fragments were rarely >1 mm thick, even at the posterior ends. The shells had no periostracum, no pitting or chalkiness, and no internal lustre.

GSC-3728. Strathcona Fiord, west — 7230 ± 90; $\delta^{13}C = -28.0‰$

A twig (sample HCA-83-8-8-1b; 7.5 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 83-41 by R.J. Mott) from 70 m elevation in silty pebbly sand foreset beds traced to a delta surface at 80 m elevation, near the west end of Strathcona Fiord, Ellesmere Island, Northwest Territories (78°45.5'N, 83°23'W). Collected August 8, 1983 by D.A. Hodgson.

Comment (D.A. Hodgson): The date provides a minimum age for a 80 m sea level (shells also were found in the thinly bedded (<1 mm to 5 mm) foreset beds). The highest delta terrace lies at 100 m (Hodgson, 1985). Date is based on one 3-day count in the 2 L counter.

Comment (W. Blake, Jr.): The single twig used for this age determination had an orangey colour, probably the result of iron staining. Adhering silt was removed by scraping. The single largest piece was 20 cm long, but it fitted together with a second piece; total length of this twisted and contorted wood was 30 cm; maximum diameter was 1.6 x 1.2 cm.

GSC-3823. Bay Fiord 7590 ± 80
$\delta^{13}C = +0.9‰$

Whole valves and fragments of marine pelecypod shells (sample HCA-83-6-8-2; 80.0 g; **Mya truncata**; identified by D.A. Hodgson) from the surface of a drift-covered carbonate rock spur, elevation 92 m, 4 km northeast of Marie Island on the north shore of Bay Fiord, Ellesmere Island, Northwest Territories (78°43.5'N, 82°34'W). Collected August 6, 1983 by D.A. Hodgson. Two determinations were made on the shells, some of which bore a thick calcareous encrustation:

outer fraction	6110 ± 70 $\delta^{13}C = +0.9‰$
inner fraction	7590 ± 80 $\delta^{13}C = +0.9‰$

Comment (D.A. Hodgson): The sample provides a minimum age for a sea level close to the marine limit which is recorded by adjacent kame deltas at 100 m elevation (Hodgson, 1985). This date corroborates dates of 7340 ± 170 BP for GSC-3397 (75 to 78 m) and 7230 ± 90 BP for GSC-3728 (>78 m, both in this list). The outer fraction date is based on one 3-day count; the inner fraction date is based on two 1-day counts, both in the 5 L counter.

Comment (W. Blake, Jr.): Because all the shells comprising this sample were partially encrusted, inside or out, with a dark brown layer, they provided an opportunity to determine the effect that such secondary deposits have on the age of samples. For this reason the usual 10 to 20% HCl leach of the outermost shell was omitted. It is obvious from the result on the outer fraction (representing 0 to 50% of shell material) that such encrustations have a pronounced effect. The sample comprised two whole left valves plus 34 fragments, 1 whole right valve plus 36 fragments. The largest shell measured 4.2 x 3.4 cm, and all shell material was <2 mm thick except in the hinge area. The shells retained no lustre, nor had they become chalky.

GSC-3016-2. Schei Summit >38 000
$\delta^{13}C = -28.5‰$

Wood (sample HCA-78-13-7-5) from a riverbank exposure at an elevation of 200 m, 12 km north of Schei Summit and 20 km south of Cañon Fiord, Ellesmere Island, Northwest Territories (79°23.5'N, 80°51'W), at an elevation of 200 m. The twigs dated came from stratified concentrations of plant debris within 8 m of finely bedded and in part cross-bedded fine sand and silt, underlain by laminated fines, overlain by coarse fluvial sediments and a planar surface. Collected July 13, 1978 by D.A. Hodgson. Two determinations were made:

GSC-3016. Schei Summit (I) >16 000

A single twig (0.7 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 80-7, by R.J. Mott). 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-3016-2. Schei Summit (II) >38 000
$\delta^{13}C = -28.5‰$

Several hundred small twigs (10.1 g; numerous twigs were examined and all were **Salix** sp.; unpublished GSC Wood Identification Report No. 83-7 by R.J. Mott). Date is based on one 3-day count in the 5 L counter.

Comment (D.A. Hodgson): The surrounding sediment was possibly deposited into a proglacial lake filling a small valley distal to a moraine ridge (now breached) which has been tentatively traced to kame deltas at 102 to 104 m elevation closer to Cañon Fiord (Hodgson, 1985). This implies a very restricted extent for the last glaciation. Alternatively, the deposit may not have been disturbed by more extensive overriding ice. The wood is unlikely to have come from the Tertiary Beaufort Formation (cf. Vendom Fiord wood series, GSC XVIII, 1978, p. 16) because J.V. Matthews, Jr. suggested that the state of preservation of plant and insect fragments precludes previous reworking (unpublished GSC Plant Macrofossil Report No. 82-27, and unpublished GSC Fossil Arthropod Report No. 82-29). Matthews also noted that the presence of **Potamogeton** and **Betula** seeds, together with fragments of insects not known to occur on Ellesmere Island today, indicates a low arctic environment.

Comment (W. Blake, Jr.): For GSC-3016 the single piece of wood had a maximum stem diameter of 5 mm; the main stem was 9 cm long, and the longest branch from this stem was 12 cm long. The bark was still attached to most of the stem and branches, but the branches had rounded ends, implying transport. For the second determination (GSC-3016-2) the largest twig used was >8.5 cm long and its diameter of 8 mm was the maximum diameter of any stick or twig in the sample; many were <1 mm in diameter. Most twigs were without bark and had sharp breaks at the ends – only a few were rounded.

GSC-3023. Cañon Fiord 7950 ± 130
$\delta^{13}C = +1.6‰$

Marine pelecypod shells (sample HCA-78-16-7-3; 11.6 g; a single **Mya truncata** pair, identified by W. Blake, Jr.) from marine silt exposed below gravelly silt beaches, at an elevation of 86 m (overlying beach surface at 91 m), on the west shore of the southernmost bay of Cañon Fiord, Ellesmere Island, Northwest Territories (79°34'N, 80°46'W). Collected July 16, 1978 by D.A. Hodgson.

Comment (D.A. Hodgson): The date is a minimum for the 91 m sea level, which lies just below the inflection in the central Ellesmere emergence curve (Hodgson, 1985, Fig. 8). The highest adjacent beach is at 102 m elevation, although deltas (kames?) lie at 122 m on the east side of the bay. Up valley to the south, kame deltas are at 110 to 102 m elevation. Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

Comment (W. Blake, Jr.): Only the single largest pair (4.7 x 3.8 cm; broken into five pieces) was used for dating. These aragonitic shells still retained most of the periostracum and had some internal lustre.

Blacktop Creek (Eureka) Series

Marine pelecypod shells collected from a flight of raised marine beaches on the east side of Blacktop Creek, east of Eureka weather station, Ellesmere Island, Northwest Territories. Lower samples are from approximately 79°58'N, 85°37'W and highest sample from 79°59'N, 85°35'W.

GSC-590. Blacktop Creek (I) 2710 ± 130

Shells (sample FG-61-210a; 63.0 g; **Astarte** sp.; identified by J.G. Fyles) from a gravelly silt beach surface at 1.5 m elevation. Collected August 26, 1961 by J.G. Fyles. Date is based on one 3-day count in the 5 L counter.

GSC-589. Blacktop Creek (II) 3420 ± 130

Shells (sample FG-61-210b; 56.5 g; **Astarte** sp.; identified by J.G. Fyles) from a gravelly silt beach surface at 3.5 m elevation. Collected August 26, 1961 by J.G. Fyles. Date is based on one 4-day count in the 5 L counter.

GSC-592. Blacktop Creek (III) 4220 ± 130

Shells (sample FG-61-210c; 41.2 g; **Astarte** sp.; identifed by J.G. Fyles) from a gravelly silt beach surface at 11 m elevation. Collected August 26, 1961 by J.G. Fyles. Date is based on one 3-day count in the 5 L counter.

GSC-1800. Blacktop Creek (IV) 8880 ± 120
$\delta^{13}C = +2.4‰$

Shells (sample HCA-72-22-7-5B; 28.5 g; **Mya truncata** paired valves, with periostracum and siphons attached; identified by D.A. Hodgson) within a lens of clayey silt in interbedded sand and silt, 0.5 m below a gravel ridge cut by a gully, at 124 m elevation. Collected July 22, 1972 by D.A. Hodgson. Date is based on two 1-day counts in the 2 L counter.

Comment (D.A. Hodgson): Beaches rise from present sea level to 143 m elevation over 3 km; a possible wavecut notch of unknown age lies at 160 m. These dates, together with shells dated 8450 ± 140 and 8710 ± 140 BP (two preparations of GSC-254; GSC IV, 1965, p. 42-43) from 140 m at Blue Man Cape, 25 km to the southwest, and dates in the Mokka Fiord series (this list), all form part of an accordant emergence curve for northern Eureka Sound (Hodgson, 1985, Fig. 8). Shells collected by F. Müller from a beach surface at 110 m in the vicinity of Blacktop Creek dated 9550 ± 250 BP (L-647B; Müller, 1963, p. 172). Further information on the latter sample is not available; Hodgson (1985) suggested that this date is anomalous, and in situ shells may have become mixed with older ones.

Comment (W. Blake, Jr.): 'Old' shells are common in this part of Ellesmere Island, hence the potential danger for mixing as cited by Hodgson; for example, shells (mainly **Hiatella arctica** and **Mya truncata**) near Slidre Fiord gave an age of 19 500 ± 1100 BP (L-548; Lamont VII, 1961, p. 151; Sim, 1961), and other 'old' dates from this region are listed in GSC II (1963, p. 54) and GSC III (1964, p. 178-179).

GSC-1822. Cape Lockwood 8190 ± 110
$\delta^{13}C = +2.2‰$

Whole valves and fragments of marine pelecypod shells (sample HCA-72-23-7-2; 28.3 g; **Mya truncata**; identified by D.A. Hodgson) from the surface of gravel and sand beach ridges at an elevation of 91 m, 4 km west of Cape Lockwood, Greely Fiord, Ellesmere Island, Northwest Territories (80°15.5'N, 84°17.5'W). Collected July 23, 1972 by D.A. Hodgson.

Comment (D.A. Hodgson): The date is a minimum for the 91 m sea level (Hodgson, 1985, Table 1). Date is based on one 3-day count in the 2 L counter.

Comment (W. Blake, Jr.): The shells comprising this sample were in general well preserved and not especially thick; 14 whole valves and fragments were submitted to the laboratory. A few of these had slight encrustations; other shells in worse condition were not utilized. The shells retained some periostracum and lacked chalkiness, but were pitted and iron stained.

GSC-2369. Greely Fiord 8450 ± 100
$\delta^{13}C = +2.2‰$

Marine pelecypod shell fragments (sample HCA-73-24-6-12, 17.7 g; **Mya truncata**; identified by W. Blake, Jr.) from the margins of frost fissures in gravelly sand littoral deposits on the south shore of Greely Fiord midway between Cañon and d'Iberville fiords, Ellesmere Island, Northwest Territories (80°24'N, 81°30'W), at an elevation of 127 m. Collected June 24, 1973 by D.A. Hodgson.

Comment (D.A. Hodgson): This is the highest Holocene shell sample from Greely Fiord. The sample was farther upslope than any beach ridge, but lower than a (marine?) bench/terrace at 146 m elevation, 6 km to the east (Hodgson, 1985). The date accords with the northern Eureka Sound emergence curve (Blacktop Creek Series, this list). Sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

Comment (W. Blake, Jr.): This collection of shells was, in general, not too well preserved (pitted, stained, encrusted); only the best-looking fragments (aragonitic) were selected for dating. **Hiatella arctica** was also present in the collection.

GSC-104. Webber Glacier >37 700

Wood (sample FG-61-201c; 15.0 g dry; probably **Salix** sp.; tentative identification by J.G. Fyles) from an exposure directly beneath the southwest terminal cliff of Webber Glacier, Ellesmere Island, Northwest Territories (80°53'N, 82°18'W). Collected August 21, 1961 by J.G. Fyles.

Comment (D.A. Hodgson based on J.G. Fyles' field notes): Sticks up to 10 cm in diameter were noted in 2 m of peaty fine sand and silt overlain by in situ tundra vegetation, all thrust up by the advancing glacier. Finite dates have been obtained for wood (**Salix** sp.) from shear planes at the foot of the same glacier (e.g. GSC-3427, 38 200 ± 1240 BP and H5607-5148, 37 550 ± 1420 BP; Blake, 1983a). Barsch et al. (1981), on the basis of the first of these dates (obtained from the laboratory at Heidelberg) suggested that Webber Glacier is now the farthest advanced it has been in 35 000 years. Glacier margins in central and southern Ellesmere Island, however, have been shown to have readvanced ca. 1000 and 100 years BP (Blake, 1981) to positions still proximal to earlier Holocene margins (Hodgson, 1985).

GSC-593. Otto Fiord 8280 ± 150

Marine pelecypod shells (sample FG-61-205b; 54.3 g; **Hiatella arctica**, **Mya truncata**; identified by J.G. Fyles) from beaches at 82 m elevation flanking a kame terrace or delta west of Degerbols Island, on the north shore of Otto Fiord, Ellesmere Island, Northwest Territories (81°06'N, 87°12'W). Collected August 22, 1961 by J.G. Fyles.

Comment (D.A. Hodgson based on J.G. Fyles' field notes): The highest beach lies at 85 m elevation, the delta top is at 116 m. First reported by Hodgson (1985, Table I). Date is based on one 3-day count in the 5 L counter.

Lake Hazen Series

Peat samples from a 2+ m-thick deposit exposed in the northwest-facing bank of Skeleton Creek on the north shore of Lake Hazen, Ellesmere Island, Northwest Territories (81°49'N, 71°18'W). The site, at an elevation of 230 m and approximately 1.5 km northwest of Hazen Camp, is located approximately 10 m above the level of glacial Lake Hazen, which was present in the area at approximately 6200 BP (England, 1983). A till-like material (10 cm thick) covered the surface of the deposit. The organic material continued below 245 cm but could not be extracted because it was frozen below that depth. Collected July 28, 1981 by J. Gould (then Erindale Campus, University of Toronto, Mississauga, Ontario, now Ministry of Natural Resources, Richmond Hill, Ontario) and J. Svoboda, Erindale Campus, University of Toronto.

GSC-3540. Lake Hazen, 45-50 cm — 3260 ± 70

Peat (sample Peat Pit 2 (45-50 cm); 100.0 g dry) from 45 to 50 cm below the surface.

GSC-3451. Lake Hazen, 235-245 cm — 4980 ± 70

Peat (sample Peat Pit 1 (235-245 cm); 116.8 g dry) from 235 to 245 cm below the surface.

Comment (J. Gould): The radiocarbon dates from this site near Lake Hazen are younger than the range of dates obtained for the deglaciation of northern Ellesmere Island (Hattersley-Smith and Long, 1967; Blake, 1972; England, 1978, 1982, 1983; Stewart and England, 1983). The age of the basal peat, however, must be obtained for a definite determination of the time of deglaciation of the area and for confirmation of the history of the creek in relation to the glacial lake. Examination of the macrofossil component of this peat deposit indicates that a wet sedge meadow, similar to that of the present day, has been in existence in the Skeleton Creek valley for approximately 5000 years (Gould, 1985).

Comment (W. Blake, Jr.): Upon drying in an electric oven, the weight of GSC-3451 decreased from 242.2 to 116.8 g, that of GSC-3540 from 185.8 to 114.9 g. Both peat samples received an NaOH leach and showed no reaction with HCl. Each date is based on two 1-day counts – GSC-3451 in the 5 L counter and GSC-3540 (which contained a much higher percentage of inorganic matter) in the 2 L counter.

Svalbard

Kong Karls Land

GSC-3039. Kongsøya — 9850 ± 80, $\delta^{13}C = -24.4‰$

A log (sample -79, Sa. nr. 26; 11.5 g; **Larix** sp.; unpublished GSC Wood Identification Report No. 80-14 by R.J. Mott) exposed in beach gravel by a temporary stream on the north coast of eastern Kongsøya, Kong Karls Land, Svalbard (78°55'N, 29°04'E), at an elevation of 100 m (determined by repetitive altimetry). Collected August 16, 1979 by O. Salvigsen, Norsk Polarinstitutt, Oslo, Norway. Two determinations were made on this inter-laboratory check sample.

First determination — 9850 ± 80, $\delta^{13}C = -24.4‰$

The sample received the standard leaches with NaOH and HCl followed by distilled water rinses. Date is based on one 3-day count in the 5 L counter.

Second determination — 9910 ± 110, $\delta^{13}C = -24.4‰$

For this result the same gas was used but a new $^{13}C/^{12}C$ determination was made. Date is based on one 3-day count in the 2 L counter.

Comment (W. Blake, Jr.): This driftwood sample was considered to be of particular importance as it was the highest single piece of Holocene driftwood collected in Svalbard (cf. Blake, 1961; Hoppe et al., 1969; Knape, 1971; Salvigsen, 1978; Häggblom, 1982a,b; Jonsson, 1983), an area where the oldest driftwood logs have proven to be approximately 1000 years older than any known logs from the raised beaches in the Canadian Arctic Archipelago (cf. Blake, 1972; Stewart and England, 1983). The opportunity was taken to count the CO_2 derived from the sample in both of our counters as an internal cross-check, and the results agree closely. The best determination, because of the small error term, is that carried out in the 5 L counter: 9850 ± 80 BP (GSC-3039). This determination also agrees well with the result obtained at the Radiological Dating Laboratory of the Norwegian Institute of Technology, Trondheim, Norway: 9790 ± 120 BP (T-3397; $\delta^{13}C = -26.1‰$; Salvigsen and Nydal, 1981).

The age determinations show that the high-level beaches on Kongsøya, the island in the southeastern part of the Svalbard archipelago where the wood was found, are indeed Holocene in age. This fact is of interest since four pieces of driftwood from lower elevations, but still in the upper range (62 to 80 m a.s.l.) of the raised beaches on Kongsøya, are beyond the limit of the radiocarbon dating method (Salvigsen, 1981), and hence the upper beaches might have been considered as belonging to a separate, older generation (cf. Boulton, 1979; Salvigsen and Nydal, 1981; Schytt, 1981a,b). Further discussion on the topic of the Barents Sea ice sheet can be found in Elverhøi and Solheim (1983).

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* Two fractions dated of same sample.
** Same CO_2 counted in two counters.