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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES XXII

W. BLAKE, JR.

Canada

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Tables

The present date list, GSC XXII, is the eleventh 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 XXII

Abstract

This list includes 117 radiocarbon age determinations on 114 geological samples made by the Radiocarbon Dating Laboratory. They are on samples from various areas as follows: Labrador (16); Nova Scotia (2); Quebec (17); Ontario (4); Manitoba (6); Saskatchewan (1); Alberta (2); British Columbia (31); Yukon Territory (25); Northwest Territories, Mainland (6); Northwest Territories, Arctic Archipelago (4). Details of background and standard for the 2 L and 5 L counters during the period of November 1, 1981 to November 3, 1982 are summarized in Tables 1 and 2; Table 3 gives the number of counts used to determine the average background and standard counting rates; and Table 4 lists the number of different background and standard gas preparations used for counting.

Résumé

Ce rapport présente les résultats de 117 datations effectuées sur 114 échantillons géologiques par le Laboratoire de datation au radiocarbone. Ces échantillons proviennent des régions suivantes: Labrador (16); Nouvelle-Ecosse (2); Québec (17); Ontario (4); Manitoba (6); Saskatchewan (1); Alberta (2); Colombie-Britannique (31); Yukon (25); Territoires du Nord-Ouest, continent (6); Territoires du Nord-Ouest, archipel Arctique (4). Les valeurs de mouvement propre et de l'étalonnage des compteurs 2 L et 5 L, pour la période allant du 1 novembre 1981 au 3 novembre 1982, sont présentées dans les tableaux 1 et 2; le tableau 3 donne le nombre de coups utilisés pour déterminer la moyenne des taux d'impulsions du mouvement propre et de l'étalonnage, et, le tableau 4 donne le nombre de préparations de gaz pour le mouvement propre et pour l'étalonnage utilisées pour le comptage.

INTRODUCTION[1]

During the period November 1981 through October 1982, both the 2 L counter (Dyck and Fyles, 1962) and the 5 L counter (Dyck et al., 1965) were operated for the entire 12 months. The 2 L counter was operated at 2 atmospheres and the 5 L at 1 atmosphere.

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, except for the marked increase in the background counts in February. Table 3 lists the number of one-day counts used to determine the average background and oxalic acid standard counting rates for the period noted above, and Table 4 gives the number of different background and (oxalic acid) standard-gas preparations used.

Sample gas preparation and purification were carried out as described in Lowdon et al. (1977). Carbon dioxide gas proportional counting techniques have been discussed by Dyck (1967).

Age calculations were done on a CDC Cyber 70 Series/Model 74 computer. Calculations are based on a ^{14}C half-life of 5568 ± 30 years and 0.95 of the activity of the NBS oxalic acid standard. Ages are quoted in radiocarbon years "before present" (B.P.), 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 et al., 1977). Finite dates are based on the 2σ criterion (95.5% probability) and "infinite" dates on the 4σ criterion (99.9% probability).

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

Table 1. Monthly Average Count for Background During the Period November 1, 1981 to November 3, 1982

Month	2 L Counter (2 atm) cpm*	5 L Counter (1 atm) cpm*
November 1981	1.242 ± 0.019	2.171 ± 0.026
December	1.191 ± 0.054	2.230 ± 0.026
January 1982	1.157 ± 0.028	2.215 ± 0.037
February	1.270 ± 0.029	2.354 ± 0.027
March	1.185 ± 0.060	2.299 ± 0.048
April	1.214 ± 0.034	2.276 ± 0.027
May	1.171 ± 0.023	2.324 ± 0.033
June	1.278 ± 0.052	2.237 ± 0.046
July	1.262 ± 0.028	2.208 ± 0.025
August	1.286 ± 0.019	2.240 ± 0.038
September	1.233 ± 0.056	2.262 ± 0.066
October	1.142 ± 0.027	2.237 ± 0.033

* cpm = counts per minute

Table 2. Monthly Average Count (N_o)* for Oxalic Acid Standard During the Period November 1, 1981 to November 3, 1982

Month	2 L Counter (2 atm) cpm	5 L Counter (1 atm) cpm
November 1981	18.514 ± 0.098	27.802 ± 0.119
December	18.442 ± 0.113	28.013 ± 0.141
January 1982	18.459 ± 0.100	27.949 ± 0.125
February	18.230 ± 0.105	27.905 ± 0.119
March	18.308 ± 0.118	27.724 ± 0.048
April	18.299 ± 0.101	27.857 ± 0.122
May	18.282 ± 0.102	27.759 ± 0.158
June	18.276 ± 0.109	27.841 ± 0.172
July	18.305 ± 0.120	27.998 ± 0.120
August	18.243 ± 0.115	28.020 ± 0.124
September	18.157 ± 0.111	27.805 ± 0.136
October	18.097 ± 0.129	27.731 ± 0.133

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

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

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

Month	Background 2 L	Background 5 L	Standard 2 L	Standard 5 L
November 1981	4	4	3	3
December	4	4	3	3
January 1982	3	3	2	2
February	5	7	4	4
March	3	5	3	3
April	5	4	3	3
May	3	4	3	3
June	5	5	3	3
July	4	4	3	3
August	4	4	3	3
September	4	4	3	3
October	4	4	3	3

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

Month	Background 2 L	Background 5 L	Standard 2 L	Standard 5 L
November 1981	3	2	2	2
December	4	4	2	2
January 1982	2	2	2	2
February	3	3	2	2
March	4	4	2	2
April	3	3	2	2
May	2	4	2	2
June	4	3	2	2
July	2	4	2	2
August	3	4	2	2
September	3	4	2	2
October	3	3	2	2

Isotope Analysts, Inc., Kitchener, Ontario (R.J. Drimmie, chief analyst) using the same equipment at the University of Waterloo.

Acknowledgments

Thanks are extended to I.M. Robertson, J.E. Tremblay, and A.M. Telka for the preparation, purification, and counting of samples in the laboratory. Since November 1981 this work has been carried out under the direction of R. McNeely, Laboratory Supervisor. Identification of materials used for dating or associated with the material being dated has been carried out by the following specialists, to whom we express our gratitude: R.J. Mott, L.D. Farley-Gill (wood and pollen); J.V. Matthews, Jr. (plant macrofossils); G.R. Brassard, Memorial University of Newfoundland, St. John's and H.J.B. Birks, University of Cambridge, Cambridge, England (mosses); F.J.E. Wagner, Atlantic Geoscience Centre, Dartmouth, G.L. Mackie, University of Guelph, Guelph, and M.F.I. Smith, National Museum of Natural Sciences, Ottawa (marine and freshwater molluscs); V.A. Zullo, University of North Carolina, Wilmington, North Carolina (barnacles). A.C. Roberts, Mineralogy Section, made the X-ray diffraction determinations on shell samples. R.J. Richardson and J.A. Snider assisted in the processing and examination of samples prior to their submission to the laboratory and in checking data in write-ups received for this date list.

GEOLOGICAL SAMPLES

Eastern Canada

Labrador

Lake Hope Simpson Series

A stratigraphic sequence of limnetic sediment samples was obtained from a small lake, Lake Hope Simpson (provisional name) located in the bedrock controlled hills of the Alexis River system, southeastern Labrador (52°27'N, 56°32'W), at an elevation of 242 m. The sediment was sampled with a 5 cm Livingstone corer in a series of overlapping drives with good depth control. The coring site is located in 7.6 m of water near the maximum depth of the lake, midway between the northeast shore and a small island on the south side. The sediment profile, 2.25 m in total length, consists of 1.15 m of dark brown dy/gyttja overlying 0.50 m of greenish brown gyttja. This organic-rich sediment grades downward into 0.40 m of silty gyttja with abundant moss layers, below which is coarse glacial sand of unknown depth. Coring was completed in August 1979 by D.R. Engstrom and H.E. Wright, Jr., Limnological Research Center, University of Minnesota, Minneapolis, Minnesota[1].

GSC-3158. Lake Hope Simpson (1) 3110 ± 70
$\delta^{13}C = -28.8‰$

Lake sediment (sample 785-795; 241.0 g wet; dy/gyttja) encompassing 10 cm of core at 0.25 to 0.35 m depth. Date is based on two 1-day counts in the 2 L counter.

GSC-3153. Lake Hope Simpson (2) 4820 ± 80
$\delta^{13}C = -27.8‰$

Lake sediment (sample 820-830; 244.0 g wet; dy/gyttja) encompassing 10 cm of core at 0.60 to 0.70 m depth. Date is based on two 1-day counts in the 2 L counter.

GSC-3140. Lake Hope Simpson (3) 7040 ± 80
$\delta^{13}C = -24.5‰$

Lake sediment (sample 870-880; 261.6 g wet; dy/gyttja) encompassing 10 cm of core at 1.10 to 1.20 m depth. Date is based on one 3-day count in the 5 L counter.

GSC-3109. Lake Hope Simpson (4) 8680 ± 150
$\delta^{13}C = -21.1‰$

Lake sediment (sample 905-915; 148.0 g wet; gyttja) encompassing 10 cm of core at 1.45 to 1.55 m depth. Date is based on one 3-day count in the 2 L counter.

GSC-3093. Lake Hope Simpson (5) 9000 ± 130
$\delta^{13}C = -24.8‰$

Lake sediment (sample 930-940; 312.0 g wet; silty gyttja including moss layers of **Drepanocladus, Calliergon;** identified by H.J.B. Birks, University of Cambridge, Cambridge, England) encompassing 10 cm of core at 1.70 to 1.80 m depth. Date is based on two 1-day counts in the 5 L counter.

GSC-3022. Lake Hope Simpson (6) 10 400 ± 140
$\delta^{13}C = -24.5‰$

Lake sediment (sample 953-964; 400.0 g moist; silty gyttja) encompassing 11 cm of core at 1.93 to 2.04 m depth. Date is based on one 5-day count in the 2 L counter.

Comment (D.R. Engstrom): This sediment sequence represents the entire postglacial history of organic deposition in the lake basin and overlies deposits of presumed glacial origin. The basal sample, GSC-3022 (10 400 ± 140 years), represents a minimum date for the deglaciation of southeastern Labrador and is consistent with dates from

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

nearby lake sites reported by Lamb (1980): 9810 ± 120 years (SI-3348) from Paradise Lake; 10 550 ± 290 years (SI-3139) from Eagle Lake; and 9820 ± 110 years (SI-3137) from Whitney's Gulch. An ice-free area in southeastern Labrador during the Late Wisconsin is not supported by these dates (cf. Vilks and Mudie, 1978). The dating sequence is conformable and represents a smooth age-depth curve for the sediment profile. Pollen and macrofossil analyses indicate that the first arrival of conifers (**Picea glauca**) occurred at 1.34 m core depth. This level falls between GSC-3140 and GSC-3109 and corresponds to an interpolated age of 7700 years B.P. (Engstrom and Wright, in press). Lamb (1980) placed the timing of white spruce invasion to roughly 6000 years B.P., however, there are some problems with dating control for his cores and discrepancies between sites in the timing of this event. Moreover, the Moraine Lake series, reported below, agrees exactly with the timing of conifer arrivals shown in the Lake Hope Simpson series. These dates strongly suggest an earlier arrival of all major conifer species (including **Abies balsamea** and **Picea mariana**) than previously assumed.

Comment (W. Blake, Jr.): NaOH leach was omitted from the pretreatment of all samples. With the exception of GSC-3153 and -3158, each sample was mixed with dead gas for counting.

Moraine Lake Series

A stratigraphic sequence of limnetic sediment samples was collected from a small lake, Moraine Lake (provisional name) located on the Paradise Moraine, southeastern Labrador (52°16'N, 58°03'W), at an elevation of 385 m. The sediment was sampled with a 5 cm Livingstone corer in a series of overlapping drives with good depth control. The coring site is located in 10.8 m of water near the maximum depth of the lake, midway between the narrowest east-west width. The sediment profile, 1.92 m in total length, consists of 1.57 m of dark brown dy/gyttja overlying 0.18 m of greenish brown silty gyttja. Dark inorganic silt of unknown depth forms the base of the profile. Coring was completed in August 1979 by D.R. Engstrom and H.E. Wright, Jr.

GSC-3212. Moraine Lake (1) 1630 ± 80
$\delta^{13}C = -29.2‰$

Lake sediment (sample m-1 (1105-1110 cm); 81.0 g, wet; dy/gyttja) encompassing 5 cm of core at 0.20 to 0.25 m depth.

GSC-3209. Moraine Lake (2) 2570 ± 130
$\delta^{13}C = -29.5‰$

Lake sediment (sample m-2 (1130-1135 cm); 108.7 g, wet; dy/gyttja) encompassing 5 cm of core at 0.45 to 0.50 m depth.

GSC-3196. Moraine Lake (3) 3840 ± 90
$\delta^{13}C = -29.0‰$

Lake sediment (sample m-3 (1157-1162 cm); 91.1 g, wet; dy/gyttja) encompassing 5 cm of core at 0.72 to 0.77 m depth.

GSC-3172. Moraine Lake (4) 5110 ± 120
$\delta^{13}C = -29.2‰$

Lake sediment (sample m-4 (1190-1195 cm); 89.1 g, wet; dy/gyttja) encompassing 5 cm of core at 1.05 to 1.10 m depth.

GSC-3162. Moraine Lake (5) 6870 ± 80
$\delta^{13}C = -29.4‰$

Lake sediment (sample m-5 (1220-1230 cm); 270.4 g, wet; dy/gyttja) encompassing 10 cm of core at 1.35 to 1.45 m depth.

GSC-3067. Moraine Lake (6) 9640 ± 170
$\delta^{13}C = -28.5‰$

Lake sediment (sample m-6 (1255-1260 cm); 203.0 g, moist; silty gyttja including a layer of the moss **Drepanocladus;** identified by H.J.B. Birks, University of Cambridge, Cambridge, England) encompassing 5 cm of core at 1.70 to 1.75 m depth.

Comment (D.R. Engstrom): This sediment sequence represents the complete postglacial stratigraphy of organic sediment in the lake basin. It overlies inorganic silt of presumed glacial origin. The dating sequence is conformable and produces a smooth age-depth curve for the sediment profile. The basal date, GSC-3067 (9640 ± 170 years), represents the first available estimate for the minimum age of the Paradise Moraine (cf. Fulton and Hodgson, 1979) and is consistent with other basal lake-sediment dates from southeastern Labrador (see Lake Hope Simpson series, this list).

Comment (W. Blake, Jr.): NaOH leach was omitted from the pretreatment of all samples. With the exception of GSC-3162, not mixed and based on one 3-day count in the 5 L counter, each sample was mixed with dead gas for counting and each date is based on two 1-day counts in the 2 L counter.

North Central Labrador Series

This series of samples represents the basal organic material in lake sediment cores from north-central Labrador, east of the Quebec-Labrador boundary. Collected 1979 with a modified Livingstone sampler by H.E. Wright, Limnological Research Center, University of Minnesota, Minneapolis, Minnesota. Pollen analysis by H.F. Lamb, Botany School, University of Cambridge, Cambridge, England. The dates have been used to calculate sediment and pollen accumulation rates and to reconstruct the vegetational history of the area (Lamb, 1982).

GSC-3252. Gravel Ridge, 1070-1080 cm 6420 ± 150
$\delta^{13}C = -28.2‰$

Grey silty gyttja (sample Gravel Ridge B; 132.3 g, dry) from the basal sediments (1070 to 1080 cm depth below the water surface) of a small lake at Gravel Ridge (unofficial name), in the central Labrador forest tundra (55°02'N, 62°38'W), at an elevation of 559 m.

Comment (H.F. Lamb): Eight additional dates were obtained from higher levels in this core. Three of these (Q-2258, -2259, -2260) form a linear age-depth sequence with the basal date. The remaining five (Beta-2207, -2208, -2209, -2210, -2211) appear to be consistently older, and are not in sequence with the basal date. The basal silt accumulated at a slightly faster rate (0.714 mm/year) than the overlying gyttja which was deposited at a uniform rate of 0.55 mm/year. Open tundra persisted in the area for 1350 years after deglaciation. Some 5750 years ago, shrub cover increased, and trees immigrated 750 years later. Forest tundra has been the predominant local vegetation type since 5000 years B.P., with a decreased tree cover since 3000 years B.P. (Lamb, 1982).

GSC-3241. Border Beacon, 1630-1640 cm — 6500 ± 100; $\delta^{13}C = -26.3‰$

Grey-brown silt (sample Border Beacon; 223.2 g, dry) with gravel from the base (1630 to 1640 cm below the water surface) of a kettle lake at Border Beacon (unofficial name), in the central Labrador forest tundra (55°20'N, 63°12'W) close to the Quebec-Labrador boundary and at an elevation of 470 m.

Comment (H.F. Lamb): The date is the oldest of the present series of basal dates, which suggests that ice was gone from the area by at least 6500 years ago. Five dated segments of the same core (including Q-2189, -2190, -2191, and -2192) form an age-depth sequence with an average sedimentation rate of 0.44 mm/year. Pollen spectra from the core suggest that a sparse tundra was present between deglaciation and 6200 years ago, when **Alnus** invaded. Trees immigrated 1000 years later, increasing in abundance to form an open woodland by 4400 years B.P. Forest cover decreased substantially after 3000 years ago (Lamb, 1982). GSC-3241, together with GSC-3252 (6420 ± 150 years, this series), suggests a minimum age of about 6500 years B.P. for deglaciation of the area, in broad agreement with previously published dates from west of the boundary (SI-1959, 6815 ± 125 years, for Pyramid Hills Lake and QL-1002, 6200 ± 200 years, for Matthew Lake; Short and Nichols, 1977; Short, 1981). These dates have been related to the disappearance of proglacial lakes. A date from the area close to the present study sites suggests earlier deglaciation of the eastern plateau (SI-1955, 8610 ± 925 years; Short and Nichols, 1977).

GSC-3238. Caribou Hill, 880-890 cm — 6120 ± 140; $\delta^{13}C = -25.9‰$

Dark brown silty gyttja (sample Caribou Lake; 225.4 g, dry) from the base (880 to 890 cm below the water surface) of a core recovered from a lake at Caribou Hill (unofficial name), in the central Labrador forest tundra (55°40'N, 63°15'W), 15 km south of Mistastin Lake and at an elevation of 450 m.

Comment (H.F. Lamb): This date may represent the time of earliest organic productivity after deglaciation. Four additional dates from higher levels in the core (Q-2185, -2186, -2187, and -2188) are consistent with the basal date. The average sedimentation rate has been 0.5 mm/year. Pollen analysis of the core shows a 600 year period of open tundra vegetation following deglaciation, which then gave way to **Alnus-Betula** shrub communities before the immigration of trees about 4700 years ago (Lamb, 1982).

GSC-3233. Snow Lake, 1110-1115 cm — 5270 ± 150; $\delta^{13}C = -26.1‰$

Silty gyttja (sample Snow Lake; 50.0 g, dry) from the base (1110 to 1115 cm below the water surface) of a core taken from Snow Lake (unofficial name), in the central Labrador tundra (56°38'N, 63°53'W), about 12 km south of the headwaters of Fraser River and at an elevation of 535 m.

Comment (H.F. Lamb): The date suggests a minimum age for deglaciation of the plateau, but one which is rather later than that put forward by Short and Nichols (1977) – 8610 ± 925 years (SI-1955) – from Kogaluk Plateau Lake nearby (unofficial name; 56°04'N, 63°45'W). In combination with two other dates at higher levels in the same core (Q-2193 and Q-2194), the dates show that the average sedimentation rate in the lake has been 0.27 mm/year. Pollen analysis of the core suggets that a shrub community was present in the area until 2700 years ago, when the present tundra developed. Trees immigrated to nearby valleys about 4700 years ago, reaching their maximum altitudinal limit shortly afterwards (Lamb, 1982).

Comment (W. Blake, Jr.): NaOH leach was omitted from the pretreatment of each sample; each sample was mixed with dead gas for counting. GSC-3233, -3238, and -3252 are based on two 1-day counts in the 2 L counter; GSC-3241 is based on one 3-day count in the 2 L counter. With reference to date SI-1955 (8610 ± 925 years, 44-47 cm; Short and Nichols, 1977), cited above by Lamb, this determination seems anomalously old when one considers that the next date up the core is only 4655 ± 140 years (SI-2240 at 22 to 27.5 cm). The large error term attached to SI-1955 is presumably a result of the small amount of gas obtained from a sample that is classified as silty clay.

Nova Scotia

GSC-3289. Big Brook — >49 000

Wood (sample Stea-81-2b; 55.4 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 81-15 by R.J. Mott) from a 1 to 3 cm-thick organic lens which is imbedded in the lowermost grey clay till of five till sheets. Numerous other organic inclusions were present in the same till. The collection site is located in the Georgia-Pacific Ltd. Gypsum Quarry, 4 km southwest of River Denys, Cape Breton County, Nova Scotia (45°48.4'N, 61°12.9'W), at an elevation of approximately 150 m. Collected 1981 by R.R. Stea and G.A. O'Reilly, Nova Scotia Department of Mines and Energy, Halifax.

Comment (R.R. Stea and D.R. Grant): The stratigraphy of this locally variable sequence indicates that the nonglacial interval represented by the dated wood predates a major advance of ice southeastward across Cape Breton Island from distant northern sources. All subsequent advances were from local ice caps. R.J. Mott (unpublished GSC Palynological Report No. 81-6) found that the pollen assemblage of this organic zone is characterized by high values of **Picea**, **Alnus**, and fern species, from which he inferred a cool, wet northern boreal forest environment.

Comment (W. Blake, Jr.): The sample was a single piece of solid wood, wet at the time of submission. On drying in an electric oven its weight decreased from 650 to 316 g. Date is based on one 5-day count in the 5 L counter at 4 atmospheres.

GSC-3116. Lantz — 11 100 ± 100

Peat (sample 80-1; 46.9 g) overlain by 2.5 m of reddish brown, clay-rich diamicton and underlain by 1 m of brown sand and 10 m+ of grey-brown massive clay. The collection was made from a fresh exposure of the stripping wall in the quarry of the L.E. Shaw Brickyard, Lantz, Nova Scotia (44°58.67'N, 63°29.17'W), at an elevation of 15 m. Collected 1980 by R.R. Stea.

Comment (R.R. Stea and D.R. Grant): The Lantz occurrence is one of a growing number of late glacial (in the range of 10 000 to 12 000 years) organic beds in Nova Scotia that are overlain by a stony diamicton resembling till; see GSC-2062 (11 200 ± 100 years; GSC XV, 1975, p. 8) and GSC-540 (11 000 ± 170 years), -541 (11 300 ± 160 years), -1578 (10 300 ± 150 years), and -2146 (11 300 ± 90 years; all four dates in GSC XVI, 1976, p. 4-5). The diamictons are generally believed to represent solifluction deposits or remobilized till created during a late glacial climatic deterioration because in most cases the depositional sites are adjacent to steep bedrock slopes. The Lantz site, however, is on a relatively flat plain. The diamicton overlying the peat varies in thickness in a regular, undulating pattern suggestive of glacial fluting, and the peat bed itself is locally tilted and otherwise deformed. Inclusions of the underlying massive clay occur in the diamicton where they are in contact.

For these reasons the diamicton is regarded as a glacial till. Whether till or soliflucted mud, a severe climatic deterioration after 11 000 years B.P. is implied.

R.J. Mott (unpublished GSC Palynological Report No. 80-6) reported that the pollen spectrum of the Lantz peat is dominated by **Picea** and **Betula** with considerable amounts of non-arboreal pollen, including **Artemisia.**

Comment (W. Blake, Jr.): A portion of the wet sample was dried for two days in an electric oven; the weight decreased from 136 to 46.9 g. Date is based on one 3-day count in the 5 L counter.

Québec

GSC-3475. Sainte-Justine-Station 10 500 ± 100
$\delta^{13}C = -0.9‰$

Marine pelecypod shells (sample RAB-82-2; 49.0 g; **Mya arenaria**; identified by S.H. Richard and C.G. Rodrigues) from sand overlying compact, silty to clayey shelly diamicton exposed in a drainage ditch 3.2 km southwest of Sainte-Justine-Station, Vaudreuil County, Québec (45°20'25"N, 74°27'00"W), at an elevation of approximately 76 m. Collected 1982 by S.H. Richard.

Comment (S.H. Richard): GSC-3475 dates the penetration of **Mya arenaria** into the western Champlain Sea Basin. This is the first date obtained for this shallow water boreal species from littoral or sublittoral Champlain Sea sands west of Montreal and between the Ottawa and St. Lawrence River valleys. It suggests that milder marine conditions associated with the last phase of the Champlain Sea, named the **Mya arenaria** phase by Elson and Elson (1959), were prevailing by 10 500 years ago in this part of the basin (cf. Elson, 1969).

GSC-3475 is the second age determination obtained for this marine sand unit. The first date of 10 300 ± 100 years (GSC-2261; GSC XIX, 1979, p. 11) was obtained on articulated valves of **Mya truncata** found in living position at the base (∼75 m elevation) of the fossiliferous sand unit with the lower part of the specimens anchored in the underlying shell-bearing silty/clayey diamicton. A radiocarbon age determination of 10 500 ± 110 years (GSC-2391; GSC XIX, 1979, p. 11) was obtained for the diamicton on specimens of **Hiatella arctica**. These radiometric determinations show that the marine molluscs used for GSC-2391 and GSC-3475 are of the same age. They also suggest that the glaciomarine and marine events that made possible two sharply contrasting sediment facies were synchronous and occurred late during the submergence of the Ottawa-St. Lawrence Lowlands by the Champlain Sea (GSC XIX, 1979, p. 11).

Comment (W. Blake, Jr.): Sample GSC-3475 was composed of fragments for the most part; the pieces utilized represented 33 left valves and 32 right valves – the largest was 5.0 cm long, 3.1 cm high. All shells were <1 mm thick at the thickest point. No periostracum was preserved, but neither were the shells pitted or encrusted; they were characterized by good internal lustre. The date is based on two 1-day counts in the 5 L counter.

Territoire-du-Nouveau-Québec

Four small lakes were sampled in a southwest-northeast transect about 75 km long, centred on upper Rivière Caniapiscau, 200 km west of Schefferville, Québec. Collected July 1979 with a modified Livingstone piston corer in the deepest part of the lakes by P.J.H. Richard and A. Larouche, Université de Montréal, Montréal. The coring sites have been labelled with the name of a neighbouring large lake.

Daumont Site Series

A series of lake sediment samples from a 215 cm-long core, taken in the deepest part (3 m) of a small lake (elliptical, 100 x 200 m) located approximately 8 km southwest of Lac Daumont, Québec (54°52'N, 69°24'W), at an elevation of 600 m.

GSC-3203. Daumont, 15-20 cm — 720 ± 150, $\delta^{13}C = -28.5‰$

Organic lake mud (sample DAU 015-020; 56.6 g wet) from 15 to 20 cm below the mud/water interface.

GSC-3187. Daumont, 60-65 cm — 2460 ± 150, $\delta^{13}C = -29.8‰$

Organic lake mud (sample DAU 060-065; 68.5 g wet) from 60 to 65 cm below the mud/water interface.

GSC-3177. Daumont, 115-120 cm — 4480 ± 100, $\delta^{13}C = -29.5‰$

Organic lake mud (sample DAU 115-120; 72.4 g wet) from 115 to 120 cm below the mud/water interface.

GSC-3052. Daumont, 155-160 cm — 5490 ± 80, $\delta^{13}C = -28.1‰$

Organic lake mud (sample DAU 155-160; 23.5 g dry) from 155 to 160 cm below the mud/water interface, at the transition with varved, inorganic sediments.

Delorme-I Site Series

A series of lake sediment samples from a 190 cm-long core, taken in the deepest part (1.1 m) of a small lake (elliptical, 50 x 125 m) located approximately 50 m east of Lac Delorme (54°25'10"N, 69°55'10"W), at an elevation of 513 m.

GSC-3309. Delorme-I, 15-20 cm — 560 ± 180, $\delta^{13}C = -27.6‰$

Organic lake mud (sample DEL-I 015-020; 51.0 g wet) from 15 to 20 cm below the mud/water interface.

GSC-3303. Delorme-I, 75-80 cm — 2740 ± 130, $\delta^{13}C = -28.0‰$

Organic lake mud (sample DEL-I 075-080; 70.0 g wet) from 75 to 80 cm below the mud/water interface.

GSC-3301. Delorme-I, 125-130 cm — 3870 ± 170, $\delta^{13}C = -30.2‰$

Organic lake mud (sample DEL-I 125-130; 76.2 g wet) from 125 to 130 cm below the mud/water interface.

GSC-3139. Delorme-I, 175-180 cm — 5330 ± 120, $\delta^{13}C = -29.2‰$

Organic lake mud (sample DEL-I 175-180; 93.8 g wet) from 175 to 180 cm below the mud/water interface, at the transition with sandy basal inorganic sediments.

Delorme-II Site Series

A series of lake sediment samples from a 260 cm-long core, taken in the deepest part (4.5 m) of a small lake (elliptical, 75 x 200 m) located approximately 1 km west of Lac Delorme (54°25'25"N, 69°55'47"W), at an elevation of 538 m.

GSC-3280. Delorme-II, 15-20 cm — 1570 ± 100, $\delta^{13}C = -28.3‰$

Organic lake mud (sample DEL-II 015-020; 60.0 g wet) from 15 to 20 cm below the mud/water interface.

GSC-3245. Delorme-II, 75-80 cm — 3080 ± 150; $\delta^{13}C = -28.1‰$

Organic lake mud (sample DEL-II 075-080; 52.0 g wet) from 75 to 80 cm below the mud/water interface.

GSC-3240. Delorme-II, 135-140 cm — 4760 ± 120; $\delta^{13}C = -28.3‰$

Organic lake mud (sample DEL-II 135-140; 75.2 g wet) from 135 to 140 cm below the mud/water interface.

GSC-3237. Delorme-II, 195-200 cm — 5170 ± 130; $\delta^{13}C = -29.2‰$

Organic lake mud (sample DEL-II 195-200; 165.1 g wet) from 195 to 200 cm below the mud/water interface.

GSC-3094. Delorme-II, 252-257 cm — 6320 ± 180; $\delta^{13}C = -23.8‰$

Organic lake mud (sample DEL-II 252-257; 100.0 g wet) from 252 to 257 cm below the mud/water interface, at the transition with sandy clayey basal inorganic sediments.

Brisay-II Site Series

A series of lake sediment samples from a 143 cm-long core, taken in the deepest part (465 m) of a small lake (triangular, 100 x 200 m) located approximately 5 km southeast of Lac Brisay and 30 km west of Lac Delorme (54°21'20"N, 70°21'30"W), at an elevation of 595 m.

GSC-3338. Brisay-II, 35-40 cm — 2100 ± 90; $\delta^{13}C = -29.7‰$

Organic lake mud (sample BRI-II 035-040; 58.1 g wet) from 35 to 40 cm below the mud/water interface.

GSC-3324. Brisay-II, 95-100 cm — 4350 ± 100; $\delta^{13}C = -30.4‰$

Organic lake mud (sample BRI-II 095-100; 64.5 g wet) from 95 to 100 cm below the mud/water interface.

GSC-3154. Brisay-II, 138-143 cm — 5980 ± 240; $\delta^{13}C = -29.0‰$

Organic lake mud (sample BRI-II 138-143; 98.7 g wet) from 138 to 143 cm below the mud/water interface, at the transition with sandy basal inorganic sediments.

Comment (P.J.H. Richard): A percentage and influx pollen analysis has been performed on each of these cores, along with an identification of the macrofossils. The dates provide information on the age of the final deglaciation in the central part of Nouveau-Québec, and a secure chronology for the postglacial history of the vegetation. The final stages of deglaciation span the time from about 6200 to 5600 years, a period of rapid colonization of the newly uncovered land by trees (larch and others), shrubs (green alder), and herbs. The initial taiga appears to have been denser than at present. The tree cover was even denser from 5500 to 4400 years ago, after which period it became more and more open. The contemporaneous rates of pollen influx are much lower than in the early postglacial, just after regional ice melting (Richard et al., 1982).

Comment (W. Blake, Jr.): The oldest date from these four sites some 200 km west of Schefferville is GSC-3094, 6320 ± 180 years, from the base of the Delorme-II core. This age is similar to one of 6460 ± 200 years (GSC-1592; GSC XIII, 1973, p. 9) on mucky silt at 275 to 285 cm depth in a bog on the lake plateau (elevation 490 m) near Michikamau Lake, Labrador, approximately 265 km southeast of Schefferville. The dates on basal organic material in central Labrador-Ungava contrast greatly with dates on similar material nearer the coast (cf. Short and Nichols, 1977; Lamb, 1980; Labrador lake sediment series, this list), although some anomalously old dates have also been obtained from sites 50 km northwest of Schefferville (Short, 1981). NaOH leach was omitted from the pretreatment of all samples. Each sample was mixed with dead gas for counting. All samples were counted in the 2 L counter and each one is based on two 1-day counts, except the following: GSC-3177 and -3280, one 3-day count each; GSC-3052, one 4-day count; and GSC-3154, three 1-day counts.

Ontario

Pointe-Fortune Series

Wood samples from sand in a borrow pit excavated into an abandoned channel of the early Ottawa River, 2.2 km south-southwest of Pointe-Fortune, Prescott County, Ontario (45°32'30"N, 74°23'25"W), at an elevation of about 45 m.

GSC-3444. Pointe-Fortune (I) — >38 000

Flattened twigs (sample RAB-81-20 (MRA-9-16-81-1); 16.0 g). Collected 1981 by P.J. Barnett, Ontario Geological Survey, Toronto, and S.H. Richard, T.W. Anderson, J.V. Matthews, Jr., and R.J. Mott.

Comment (S.H. Richard): GSC-3444 provides evidence that this part of the Upper St. Lawrence Lowland was deglaciated during early or middle Wisconsin time, possibly during either the Port Talbot Interstadial or the St. Pierre Interstadial. GSC-3444 is the second ^{14}C date obtained for these sediments. The dated material was collected in the upper part of the sand unit (which gradually fines upwards to become a clayey silt unit) from a level approximately 5 m higher than the point at which the material for the first date was collected (GSC-2932; >42 000 years B.P.; GSC XXI, 1981, p. 6).

Examination of the working face of this active borrow pit in September 1981 revealed the presence of an erosional contact (not observable before) between the upper part of the interstadial fluvial sand unit and the overlying coarse, unfossiliferous, crossbedded, outwash sand. This sand unit is overlain by a ~3 m-thick till unit capping the section. The stratigraphy exposed at present differs from that observed in 1978-1979 by Gadd (Gadd et al., 1981). The upper sand unit corresponds to the only unit exposed earlier and described by Gwyn and Thibault (1975) and by Richard (1978). No fossil material has been found in the upper two stratigraphic units, but they likely are much younger and represent deposits laid down during the late Wisconsinan Laurentide ice advance in this area during the interval 25 000 to 13 000 years B.P. (cf. Dreimanis, 1977).

GSC-3459. Pointe-Fortune (II) — >40 000

A single compressed stick (sample RAB-82-1; 10.5 g; conifer wood; unpublished GSC Wood Identification Report No. 82-21 by R.J. Mott). Collected 1982 by S.H. Richard.

Comment (S.H. Richard): The dated material was collected from the same lens of black organic detritus containing flattened twigs and compressed wood fragments on which GSC-3444 (>38 000 years, this series) was determined.

Comment (W. Blake, Jr.): With regard to GSC-3444, R.J. Mott stated (in unpublished GSC Wood Identification Report No. 82-15), "The wood cannot be identified with certainty because of its strongly compressed and lignified condition. Part of one twig was softened and expanded somewhat in 10% KOH to allow some sections to be obtained by hand. Those features that could be seen are similar to those found in willow (**Salix** sp.), but the identification is not certain. The superficial appearance of all the twigs suggests that they are probably all the same kind of wood." The damp wood comprising GSC-3459 was 22 cm long and it had a maximum cross-section of 2.8 x 1.0 cm. The portion used for dating was 12.5 cm long; on drying in the electric oven it decreased in weight from 32.8 to 19.3 g. GSC-3444 is based on one 4-day count in the 5 L counter; GSC-3459 is based on one 5-day count in the 5 L counter.

Rainy River Series

GSC-2968. Rainy River (I) 10 400 ± 100

Freshwater bivalve shells (sample E.N.-1979-1; 36.0 g; **Elliptio** sp. identified by M.F.I. Smith, National Museum of Natural Sciences, Ottawa) from ~1.5 m below the surface in a 2.5 m-high exposure in the Upper Campbell beach 8 km south-southeast of Devlin and 9.2 km north of Rainy River, Ontario (48°33'52"N, 93°39'01"W), at an elevation of 350 m. Collected 1979 by E. Nielsen, Manitoba Department of Mines and Energy, Winnipeg.

Comment (E. Nielsen): The sample is slightly older than wood dates GSC-391 (9990 ± 160 years, GSC VI, 1967, p. 165), W-1361 (9820 ± 300 years, USGS VIII, 1965, p. 378; Moran et al., 1973; Clayton and Moran, 1982), and I-3880 (9940 ± 160 years; Isotopes VIII, 1970, p. 89; Arndt, 1977) from the beginning of the high water Emerson Phase of Lake Agassiz. The discrepancy is likely the result of recycled old carbon as indicated by a date of 570 ± 100 years (GSC-3281; this list) on a modern shell sample from Winnipeg River. The date establishes the Upper Campbell beach as having been formed at the beginning of the Emerson Phase of Lake Agassiz.

GSC-3114. Rainy River (II) 11 400 ± 410

Freshwater bivalve shells (sample E.N.-1979-2; 8.0 g; **Sphaerium striatinum** (Lamarck) identified by G.L. Mackie, Department of Zoology, University of Guelph, Guelph, Ontario) from a 5 m-thick fluvial sand unit exposed below approximately 30 cm of red clay at the junction of La Vallée and Rainy Rivers, Ontario (48°31'54"N, 93°37'53"W) at an elevation of approximately 330 m. Collected 1979 by E. Nielsen.

Comment (E. Nielsen): The sample is slightly older than wood dates W-723 (10 960 ± 300 years; USGS V, 1960, p. 152) and TAM-1 (10 820 ± 190 years; Texas A & M I, 1964, p. 190; Arndt, 1977) from the beginning of the low water Moorhead Phase of Lake Agassiz. The discrepancy is likely the result of recycled old carbon as indicated by a date of 570 ± 100 years B.P. (GSC-3281, this list) on a modern shell sample from Winnipeg River. The Moorhead Phase likely started about 11 000 years ago. The date establishes the age of the overlying red clay as having been deposited during the phase when the ice margin stood at the Hartman Moraine following the high water Emerson Phase (Nielsen et al., 1982).

Comment (W. Blake, Jr.): Caution must be exercised in applying the above-mentioned correction factor to freshwater shells of different species and at different sites (cf. Keith and Anderson, 1963). For GSC-2968 only the outer 10 per cent of shell material was removed with HCl leach, in order to retain enough sample for processing in the large counter. These aragonitic shells were all fragments; the largest were >5 cm in length and the maximum thickness (in the hinge area) was 5 mm. The $^{13}C/^{12}C$ ratio for this sample is -6.4‰, but the age given above is uncorrected for isotopic fractionation. Date is based on two 1-day counts in the 5 L counter.

The sample used for GSC-3114, also on aragonitic shells, contained some valves encrusted with a dark coating similar to desert varnish. These were excluded from the portion used for dating. Some valves had adhering, partially cemented sand grains, which were removed by scraping. The largest valves measured 1.4 x 1.2 cm; the smallest were <0.5 cm in both height and length. The $^{13}C/^{12}C$ ratio for GSC-3114 is -5.6‰, but the age given is uncorrected for isotopic fractionation. The sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Western Canada

Manitoba

Nelson River Series

Marine shell samples from two sites at or near the Sundance Power Station, Nelson River, Manitoba.

GSC-3326. Nelson River 7180 ± 70
$\delta^{13}C$ = +1.5‰

Marine shells (sample E.N. 442; 46.6 g; **Hiatella arctica**, identified by E. Nielsen) from the base of a 12 m-thick sandy unit exposed at the Sundance Power Station, 3 km downstream from the mouth of Limestone River at upper Limestone Rapids, Nelson River, Manitoba (56°32'N, 94°01'W), at an elevation of approximately 90 m. Collected 1981 by E. Nielsen, Manitoba Department of Mines and Energy, Winnipeg, and L.A. Dredge; submitted by L.A. Dredge.

Comment (E. Nielsen): The sample was dated as an independent check on a Brock University date from this site which at first appeared to be nearly 2000 years older. GSC-3326 corroborates a date of 7030 ± 170 years (GSC-2294; GSC XXI, 1981, p. 7) from a site 2 km upstream (cf. Nielsen and Dredge, 1982).

Comment (W. Blake, Jr.): The Brock laboratory now has discovered an error in their age calculation (because of a change in the oxalic acid standard); their new determination is 6900 ± 150 (BGS-714), a value which is in good agreement with GSC-3326 (Blake, 1983). These well preserved aragonitic pelecypod shells had no pitting or encrustations, their external ornamentation was intact (although no periostracum was preserved), and they were characterized by good internal lustre. All of the somewhat fragile shells making up this collection were whole; they varied in size from 1.3 x 0.6 cm to 2.7 x 1.3 cm, and most were >2 cm in length. The sample used for dating comprised 83 left valves and 83 right (not necessarily all pairs). Date is based on one 3-day count in the 5 L counter.

GSC-3367. Nelson River 6760 ± 80
$\delta^{13}C$ = +0.3‰

Marine shells (sample E.N. 411(C); 47.9 g; **Hiatella arctica**, identified by E. Nielsen) from the top of a coarse glaciofluvial gravel unit underlying 3 m of blue clay and 1 m of fossiliferous sand on the south side of Nelson River (opposite Sundance Power Station), 6 km downstream from Upper Limestone Rapids, Manitoba (56°32'N, 94°00'W) at an elevation of approximately 68 m. Collected 1981 by E. Nielsen and L.A. Dredge; submitted by L.A. Dredge.

Comment (E. Nielsen): The sample, a re-collection, was dated as an independent check on a Brock University date from this site, which first appeared to be nearly 1500 years older.

Comment (W. Blake, Jr.): This large sample of well preserved shells was washed in distilled water to remove adhering sand, air dried, and then 533 valves were broken into half, so that a sample as nearly identical as possible to that utilized at the Geological Survey of Canada could be sent to Brock University (50.9 g). An identical result was obtained at

Brock (BGS-791, 6760 ± 100 years; Blake, 1983). The shells were characterized by good external ornamentation (but no periostracum), and good internal lustre. There were no encrustations or other contaminants. The largest valve was 2.5 x 1.2 cm; the smallest, representative of a number of fragile, juvenile shells, was <1 cm in length. Date is based on two 1-day counts in the 5 L counter.

GSC-2579. Caribou River 6790 ± 100
$\delta^{13}C = +2.5‰$

Marine shells (sample DU77-235A; 18.7 g; **Hiatella arctica**; identified by R.J. Richardson) from the south bank of an unnamed river (59°18'N, 95°23'W) between Caribou River and Seal River, at an elevation of 85 m. Some of the valves were paired when the sample was collected. Collected 1977 by L.A. Dredge and F.M. Nixon.

Comment (L.A. Dredge): The sample was taken from stratified deltaic deposits of silty sand, which relate to a sea level at about 90 m. The date does not fit well onto the smoothed emergence curve for the Churchill area. The discordant fit suggests that the emergence history for this area, which was under the influence of the Keewatin ice regime, differs from that of the Churchill area, which was additionally affected by Hudsonian ice.

Comment (W. Blake, Jr.): The sample utilized for dating comprised 26 right valves and 17 left valves; the largest measured 3.1 x 1.7 cm, the smallest 1.0 x 0.5 cm. The shell exteriors were somewhat chalky, but a good internal lustre was retained. Some valves were worn, others were not worn and had bits of periostracum intact. No pitting was evident, but a few shells were slightly discoloured (perhaps with thin encrusting matter). The sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3348. Churchill River 7760 ± 370

Freshwater bivalve shells (sample E.N.-7(b); 5.7 g; **Sphaerium** sp., identified by F.J.E. Wagner, Atlantic Geoscience Centre, Dartmouth) from a 9 m-thick sand unit in the 18 m-high river terrace exposed on Churchill River, 10 km south of its junction with Beaver Creek, Manitoba (57°40'N, 95°25'W), at an elevation of approximately 134 m. Collected 1981 by E. Nielsen; submitted by L.A. Dredge.

Comment (E. Nielsen): The date establishes a minimum age for the draining of Lake Agassiz from northeastern Manitoba. The terrace from which the sample was collected is tentatively correlated with a Tyrrell Sea beach at an elevation of 128 m which has been dated at 7770 ± 140 years B.P. (GSC-3070; this list).

Comment (W. Blake, Jr.): The $^{13}C/^{12}C$ ratio for this sample is -5.4‰, but the age given above is uncorrected for isotopic fractionation. The aragonitic shells were thin and well preserved; most shells were intact valves but some fragments were present also. Because of the small sample size, only the outer 10 per cent of shell was removed by HCl leach. The sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-3070. North Knife River 7770 ± 140
$\delta^{13}C = +1.3‰$

Marine shells (sample DU79-13; 11.3 g; **Hiatella arctica** identified by W. Blake, Jr.) from a bank exposure along North Knife River (58°33'N; 95°50'W) about 100 km west of Churchill, Manitoba. The sample, which included paired valves of **Hiatella** and other species, was collected from marine sands at an elevation of approximately 106 m, below 4 m of silty marine deposits. Collected 1979 by L.A. Dredge.

Comment (L.A. Dredge): The shells relate to an early phase of the Tyrrell Sea, but lie well below marine limit, which is at about 150 m in this area. The date is substantially older than Craig's date of 7270 ± 120 years (GSC-92; Craig, 1969; GSC III, 1964, p. 170) from a beach ridge near Churchill River at 141 m and is probably a better estimate of the beginning of marine submergence. The date is also older than any obtained from the Nelson River area to the south (cf. GSC-3326, 7180 ± 70 years; Nielsen and Dredge, 1982; this list).

The shell bed directly overlies a till emplaced when Hudsonian ice readvanced into Lake Agassiz. The age of the sample gives an approximate time for this glacial activity, which marked the end of Lake Agassiz. The date agrees well with GSC-3348, 7760 ± 370 years (Nielsen and Dredge, 1982; this list) on freshwater shells (presumably from Lake Agassiz) from Churchill River in this same general area.

Comment (W. Blake, Jr.): The sample was composed of 19 left and 32 right valves. The maximum size was >2.4 x 1.4 cm, and the smallest valve was 1.4 x 0.7 cm. Most valves were 2.0 to 2.2 cm long, with traces of periostracum and ligament as well as internal lustre. Because of small sample size, only the outer 10 per cent was removed by HCl leach. The sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

GSC-3281. Traverse Bay 570 ± 100

Freshwater bivalve shells (sample E.N.-1979-3; 10.5 g; **Strophitus undulatus** (Say), identified by W.B. McKillop, Manitoba Museum of Man and Nature, Winnipeg) from a modern beach along Traverse Bay near the mouth of Winnipeg River on Lake Winnipeg, Manitoba (approximately 51°40'N, 96°35'W), at an elevation of approximately 217 m. Collected 1941 by W.H. Rand; submitted by E. Nielsen.

Comment (E. Nielsen): The sample was dated to determine the error due to recycled old carbon in radiocarbon dates on freshwater shells from the area of Winnipeg River which is underlain by highly calcareous sediments. This date suggests that radiocarbon dates on freshwater molluscs of greater antiquity from this area could be several hundred years too old (cf. Nielsen et al., 1982).

Comment (W. Blake, Jr.): The $^{13}C/^{12}C$ ratio for this sample is -7.9‰, but the age given above is uncorrected for isotopic fractionation. As noted with regard to the Rainy River series (this list), caution must be used in applying the "apparent age" of this pelecypod sample to other species of freshwater molluscs collected at other sites. The aragonitic paired valves comprising this sample were whole and the periostracum was intact except in the hinge area. The inside of the shells was characterized by pearly lustre. Because of the small sample size, only the outer 10 per cent of shell material was removed by HCl leach. The sample was mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

Saskatchewan

GSC-3211. McClean Lake 6960 ± 80

Peat (sample 64L801328; 33.2 g, dry) from the base (190 to 194 cm depth, above sand) of a frozen raised peat sequence 0.5 km east of McClean Lake, Saskatchewan (58°16'N, 103°52'W), at an elevation of about 435 m. The sample was collected with a motor-driven CRREL-type auger in 1980 by W.B. Coker, then GSC, now with Kidd Creek Mines, Ltd., and R.N.W. DiLabio.

Comment (R.N.W. DiLabio): The date is a minimum age for deglaciation and organic accumulation at the site. Unpublished GSC Plant Macrofossil Report 81-7 and unpublished GSC Fossil Arthropod Report 81-8 by J.V. Matthews, Jr. indicate that the assemblage is typical of a poorly drained site within the spruce treeline.

Comment (W. Blake, Jr.): The site is approximately 240 km north of an unnamed lake on the distal side of the Cree Lake Moraine where the basal organic sediment is 8230 ± 250 years old (GSC-1466; Mott, 1971; GSC XV, 1975, p. 15) and 200 km southwest of a site near Kasmere Lake, Manitoba, where the basal frozen peat (240-254 cm depth) is 5990 ± 80 years old (Coker and DiLabio, 1979; GSC XIX, 1979, p. 15). NaOH leach was omitted in sample pretreatment. Date is based on two 1-day counts in the 5 L counter.

Alberta

GSC-3402. Upper Athabasca River delta 9910 ± 90

Wood (sample DGS-81-1; 12.0 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 82-1 by R.J. Mott) recovered from 10 m below the surface of a delta, now perched, which was deposited by Athabasca River into glacial Lake McConnell (Craig, 1965) or the early high stage of Lake Athabasca. The sample site is located precisely 170 km north of Fort McMurray on the right bank of Athabasca River, Alberta (58°15'N, 111°25'W), at an elevation of 230 m and 15 m above the river surface in a meander cutbank. Collected 1981 by D.G. Smith, University of Calgary, Calgary.

Comment (D.G. Smith): The wood was found in a 25 m-thick sandy fan-delta which marks the approximate high stage (about 245 m elevation) and age (9910 years B.P.) of early Lake Athabasca or glacial Lake McConnell. Half of the sample was sent to the amino acid dating lab at the Department of Geology, University of Alberta, resulting in an aspartic acid value of 0.12 (UA-1027; N.W. Rutter, personal communication, 1982).

Comment (W. Blake, Jr.): Two sections of log approximately 30 cm in length were received, wet. A small part of one log section was dried in an electric oven; the weight decreased from 26.2 to 12.0 g. Date is based on one 3-day count in the 5 L counter.

GSC-1723. North Saskatchewan River 2560 ± 130

The peat (sample DGS-71-2; 77 g), recovered 3.05 m below the modern floodplain surface of upper North Saskatchewan River in the northwestern part of Banff National Park, was buried in alluvial mud overbank deposits. The site is located 75 m southwest of the Banff Parkway (Highway 93), Alberta (52°03'00"N, 116°52'30"W), at an elevation of about 1430 m. Collected 1971 by D.G. Smith, University of Calgary, Calgary.

Comment (D.G. Smith): The peat is stratigraphically 0.45 m above the Bridge River ash. The date helps to verify the 2500 year-age assigned to the Bridge River ash by Westgate and Dreimanis (1967). Also the date indicates a fluvial sedimentation rate of 1.22 mm/year for the North Saskatchewan River floodplain in the vicinity of the sample site (Smith, 1974).

Comment (W. Blake, Jr.): The peat was composed mainly of mosses, with some fragments of **Carex** sp. The most common moss was **Drepanocladus exannulatus**; **Calliergon giganteus** was common and **D. revolvens** and **Scorpidium scorpioides** were rare. This assemblage is characteristic of the transition zone between shallow, stagnant water and boggy (swampy) habitats (unpublished GSC Bryological Report No. 181 by M. Kuc). Date is based on one 2-day count in the 5 L counter.

British Columbia

GSC-3424. Montrose 17 000 ± 180

Wood (sample EL-80-1; 7.3 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 82-14 by R.J. Mott) from an exposure downslope from a culvert under the Burlington Northern Railway opposite the village of Montrose, on the south side of Beaver Creek about 2.5 km upstream from Columbia River (49°04.4'N, 117°35.1'W), at an elevation of 520 m. The wood was from a thin compact organic layer, included in an 8 m-thick unit of compact silty sand and sand interbedded with silty gravel, that underlies at least 8 m of silty, sandy, stony till. Collected 1980 by E. Livingston, Pacific Hydrology Consultants, Vancouver; submitted by R.J. Fulton.

Comment (R.J. Fulton): The only conclusion that could be drawn from the description of the stratigraphic setting of the sample was that the wood was deposited previous to an ice advance which was probably the last glaciation of the area. This date is the youngest pre-last glaciation date obtained in the Southern Interior of British Columbia and indicates that trees were growing in the area immediately prior to the ice advance. Prior to the dating of this sample the youngest dates for ice advance in this area were 17 240 ± 330 and 17 440 ± 330 years B.P. (I-10 022 and I-10 021, respectively; Clague et al., 1980) which were obtained for samples of spruce wood collected from what appeared to be a kame terrace in Pend Oreille River valley about 7 km south of the Montrose site. Date is based on two 1-day counts plus one 3-day count in the 2 L counter.

GSC-2829. Saanich Peninsula 17 000 ± 240 $\delta^{13}C = -21.8‰$

Bone (sample GK-76-1; 516 g) cored from the head of a mammoth humerus (**Mammuthus** sp.; identified by C.R. Harington, National Museum of Natural Sciences, Ottawa). The sample was found in place in sandy and silty gravel (Quadra Sand of Clague, 1977) and earlier referred to as Saanichton gravel by Halstead (1968), in the west wall of the Trio Ready Mix Gravel Pit, Saanich Peninsula, Vancouver Island, British Columbia (48°31'52"N, 123°22'45"W), at an elevation of approximately 70 m. The sample was found ~16.5 m below the base of a 4.5 m-thick till deposited towards the close of the Fraser Glaciation. Collected 1976 by G. Keddie, British Columbia Provincial Museum, Victoria.

Comment (C.R. Harington): Clague (1977) noted that Quadra Sand is older than 29 000 years at the north end of the Strait of Georgia, but is younger than 15 000 years at the south end of Puget Sound. This bone date is in accord with the relatively late dates (i.e., somewhat earlier than 15 000 years B.P.) expected for organic material in Quadra Sand in such a southerly location. It provides the first indication of the geological age of Pleistocene land mammals on Vancouver Island (Harington, 1975, 1976, 1977, 1979; Keddie, 1979; Clague et al., 1980).

Comment (W. Blake, Jr.): This sample was wet sieved to remove sand and silt from the porous bone, then cleaned in a sonic bath and dried. This process reduced the sample weight from 1146 to 523 g. Pretreatment included leaches with 3N HCl and 0.1N NaOH plus distilled water rinses; 109 g of dry collagen remained. The sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

Klastline River Series

GSC-3365. Klastline River (I) 8610 ± 80
$\delta^{13}C = -24.8‰$

Charcoal (sample H81-1-C14; 17.0 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 81-37 by R.J. Mott) from a single burnt stick about 5 cm in diameter and greater than 5 cm in length imbedded in gravel less than 1 cm underneath the basalt which charred the wood. The sample comes from the back scarp of a recent slide on the north bank of Klastline River, 1.0 km upstream from its junction with Stikine River, British Columbia (58°02'19"N, 130°46'06"W), at an elevation of 340 m. The unweathered back scarp exposes a porphyritic (augite, olivine, plagioclase) basalt flow of the Big Raven Basalt (Souther et al., in press) overlying fluviatile gravels containing the burnt wood. Collected 1981 by P.B. Read, Geotex Consultants Limited, Vancouver; submitted by P.B. Read and H. Gabrielse.

Comment (P.B. Read): The sample comes from the lower of two levels of basalt flows in Klastline River near its confluence with Stikine River. The lower level of flows is up to 10 m thick with its upper surface blocky and unglaciated. The radiocarbon age of 8610 ± 80 years is a maximum for this part of the Big Raven Basalt. Because this basalt flow extends down Klastline River and across Stikine River, the date of 8610 ± 80 years also gives a maximum age for terraces developed at 380 m elevation in Stikine River valley between Klastline and Tanzilla rivers as a result of the flow damming Stikine River. In the last 8610 ± 80 years Klastline River has downcut approximately 70 m from 350 m at the top of the flows to about 10 m below the present river level of 290 m. Date is based on one 3-day count in the 5 L counter.

GSC-3370. Klastline River (II) >41 000

Three small burnt twigs (sample H81-2-C14; 14.0 g; bark? of angiosperm wood; unpublished GSC Wood Identification Report No. 81-41 by R.J. Mott) embedded in dry sand, 5 to 50 mm below the bottom of the lava flow that charred the wood. The sample is from a fresh cliff face of dry, unoxidized material exposed at 485 m elevation on the south bank of Klastline River, 4.5 km upstream from its junction with Stikine River, British Columbia (58°00'48"N, 130°44'09"W). Collected by J.F. Psutka, Geotex Consultants Limited, Vancouver; submitted by P.B. Read and H. Gabrielse.

Comment (P.B. Read): The sample comes from a 1 m-thick sand layer between porphyritic (augite, olivine, plagioclase) basalt flows near the base of the upper of two levels of basalt flows developed in Klastline River near its confluence with Stikine River. The upper level of flows is up to 50 m thick, and near the collection site it overlies fluviatile sediments which intervene between the upper level and the top of the lower level of flows at 425 m elevation. The upper level of flows is overlain by glacial outwash which covers the Tanzilla Plateau between the Tuya and Tanzilla rivers. These flows extend down the Klastline and into the Stikine where they temporarily dammed Stikine River and caused the development of a set of terraces at 425 m which extend upstream as far as Tanzilla River. The upper flows are petrographically similar to the Klastline Formation (Souther et al., in press). The radiocarbon age of >41 000 years shows that the highly dissected upper level of flows is older than the lower level dated at 8610 ± 80 years B.P. (GSC-3365, this series), and it yields a minimum age for the widespread terraces in Stikine valley between Klastline and Tanzilla rivers. Date is based on one 3-day count in the 5 L counter.

GSC-2741. Northeastern Moresby Island 1270 ± 60
$\delta^{13}C = +1.3‰$

A single valve of **Saxidomus gigantea** (sample CIA-78-199; 36.0 g; identified by M.F.I. Smith, National Museum of Natural Sciences, Ottawa) from a shallow roadside excavation on the east coast of Moresby Island, 7 km south-southeast of Sandspit, Queen Charlotte Islands, British Columbia (53°11.3'N, 131°46.6'W), at an elevation of approximately 5 m above mean sea level (1.5 m above higher high water level). The sample was collected from sandy beach gravel 50 cm below the top of the excavation. Collected 1978 by J.J. Clague.

Comment (J.J. Clague): The dated beach deposits are about 1.5 to 2 m above the maximum elevation at which similar deposits are forming at this site today; 1.5 to 2 m of uplift in the last 1270 years or less is indicated; comments on the discrepancy between radiocarbon and true ages made by J.J. Clague for the northern Graham Island dates in this list also apply to GSC-2741. Only the outer 10 per cent of shell was removed by HCl leach. Date is based on two 1-day counts in the 5 L counter.

Eastern Graham Island Series

Marine shells, wood, peat, and macroscopic plant detritus collected from sea cliffs and the present-day intertidal platform of eastern Graham Island, Queen Charlotte Islands, British Columbia (Sutherland Brown, 1968; Clague, 1981; Clague et al., 1982a,b; Mathewes and Clague, 1982). The samples were collected to provide chronological control on late Quaternary sea level fluctuations, to date buried organic horizons that have been analyzed for plant macrofossils and microfossils, and to provide constraints on the age of the surface drift on Graham Island.

GSC-2963. Eastern Graham Island (I) 5460 ± 70
$\delta^{13}C = -25.7‰$

Wood (sample CIA-78-194-3; 11.4 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 79-47 by R.J. Mott) from the base of terrestrial peat exposed in the sea cliff of eastern Graham Island, 18 km north-northeast of Tlell (53°44.3'N, 131°52.6'W), at an elevation of about 12 m above mean sea level (8 to 9 m above higher high water level). The dated peat directly underlies the land surface and overlies, in succession, sandy silt of marine and estuarine origin, terrestrial peat (GSC-2957, 11 000 ± 100 years, this series), and pebbly sand. The sea cliff is 10 m high at this site. Collected 1978 by J.J. Clague.

GSC-2738. Eastern Graham Island (II) 8610 ± 80
$\delta^{13}C = +1.0‰$

Four valves (two pairs) of marine pelecypods (sample CIA-78-195; 44.5 g; **Saxidomus gigantea**; identified by M.F.I. Smith, National Museum of Natural Sciences, Ottawa) from sandy gravel exposed in the sea cliff of eastern Graham Island, 16 km north-northeast of Tlell (53°43.2'N, 131°52.4'W), at an elevation of about 7 m above mean sea level (3 m above higher high water level). The 50 cm-thick gravel from which the dated sample was collected is a littoral deposit overlying late Pleistocene glaciomarine stony mud and underlying marine and/or littoral sand. The sea cliff is about 8 m high at this site. Collected 1978 by J.J. Clague.

GSC-2734. Eastern Graham Island (III) 8860 ± 120
$\delta^{13}C = +1.6‰$

Four valves (two pairs) of marine pelecypods (sample CIA-78-191-1; 34.9 g; **Clinocardium nuttalli**; identified by M.F.I. Smith) from stony sandy mud exposed in the sea cliff on eastern Graham Island, 19 km north-northeast of Tlell (53°45.5'N, 131°52.9'W), at an elevation of about 8 m above mean sea level (4 m above higher high water level). The dated sample was collected from stony marine sediments underlain by a terrestrial peat (GSC-2879, 11 300 ± 110 years; and GSC-2853, 12 100 ± 140 years; both in this series) and overlain successively by marine or estuarine mud and peat. The sea cliff is about 8 m high at this site. Collected 1978 by J.J. Clague.

GSC-2867. Eastern Graham Island (IV) — 9040 ± 80; $\delta^{13}C = +1.4‰$

Whole and fragmented valves of marine pelecypods (sample CIA-78-193-3; 49.5 g; **Clinocardium nuttalli**; identified by M.F.I. Smith) from stony mud exposed in the sea cliff of eastern Graham Island, 20 km north-northeast of Tlell (53°45.6'N, 131°53.0'W), at an elevation of 5 m above mean sea level (1 m above higher high water level). The dated sample and the sample for GSC-2884 (9060 ± 90 years, this series) were collected from stony marine sediments overlain, at an elevation of about 7 m above mean sea level, by sandy silt grading upwards into silty sand. The sea cliff is 7 m high at this site. Collected 1978 by J.J. Clague.

GSC-2884. Eastern Graham Island (V) — 9060 ± 90; $\delta^{13}C = -24.5‰$

Wood (sample CIA-78-193-4; 11.9 g; **Tsuga** sp.; unpublished GSC Wood Identification Report No. 79-27 by R.J. Mott) from stony mud exposed in the sea cliff of eastern Graham Island, 20 km north-northeast of Tlell (53°45.6'N, 131°53.0'W), at an elevation of 5 m above mean sea level (1 m above higher high water level). The dated sample and the sample for GSC-2867 (9040 ± 80 years, this series) were collected from stony marine sediments overlain at an elevation of about 7 m above mean sea level by sandy silt grading upwards into silty sand. The sea cliff is about 7 m high at this site. Collected 1978 by J.J. Clague.

GSC-3129. Eastern Graham Island (VI) — 9160 ± 90; $\delta^{13}C = -24.2‰$

Wood (sample CIA-80-33-2; 11.4 g; probably **Abies** sp.; unpublished GSC Wood Identification Report No. 80-23 by L.D. Farley-Gill) from the top of buried terrestrial peat exposed in the sea cliff of eastern Graham Island, 13 km north-northeast of Tlell (53°41.7'N, 131°52.8'W), at an elevation of 7 m above mean sea level (4 m above higher high water level). The peat from which the dated sample was collected underlies sandy silt of marine and estuarine origin (GSC-3120, 9350 ± 80 years; this series) and overlies, in succession, silt and sand of undetermined origin, outwash gravel, till, and glaciomarine stony mud. The sea cliff is about 6 m high at this site. Collected 1980 by J.J. Clague.

GSC-3120. Eastern Graham Island (VII) — 9350 ± 80; $\delta^{13}C = +0.3‰$

Paired valves of marine pelecypods (sample CIA-80-33-1; 45.6 g; **Macoma inquinata** (Deshayes); identified by M.F.I. Smith, National Museum of Natural Sciences, Ottawa) from sandy silt exposed in the sea cliff of eastern Graham Island, 13 km north-northeast of Tlell (53°41.7'N, 131°52.8'W), at an elevation of 8 m above mean sea level (4 m above higher high water level). The 2 m-thick sandy silt from which the dated sample was collected is of marine and estuarine origin, and overlies the peat from which GSC-3129 (9160 ± 90 years; this series) was obtained. The sea cliff is about 6 m high at this site. Collected 1980 by J.J. Clague.

GSC-3112. Eastern Graham Island (XII) — 12 400 ± 100; $\delta^{13}C = -28.5‰$

Peat (sample CIA-80-49-1; 62.0 g) from the top of a buried terrestrial organic layer exposed in the sea cliff of eastern Graham Island, 18 km north-northeast of Tlell (53°44.3'N, 131°52.6'W), at an elevation of 5 m above mean sea level (1 m above higher high water level). The 70 cm-thick dated peat bed is underlain by pebbly sand and is overlain, in succession, by sandy silt of marine and estuarine origin and by surface peat. GSC-3112 (12 400 ± 100 years, this series) is a date from the base of the buried peat at this site. The sea cliff here is 10 m high. Collected 1980 by J.J. Clague.

GSC-2957. Eastern Graham Island (IX) — 11 000 ± 100; $\delta^{13}C = -29.4‰$

Wood (sample CIA-78-194-2; 12.1 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 79-47 by R.J. Mott) from near the base of buried terrestrial peat exposed in the sea cliff of eastern Graham Island, 18 km north-northeast of Tlell (53°44.3'N, 131°52.6'W), at an elevation of 4 m above mean sea level (approximate higher high water level). The 50 cm-thick dated peat is underlain by pebbly sand and is overlain successively by sandy silt of marine and estuarine origin and by surface peat (GSC-2963, 5460 ± 70 years, this series). The sea cliff is 10 m high at this site. Collected 1978 by J.J. Clague.

GSC-2879. Eastern Graham Island (X) — 11 300 ± 110; $\delta^{13}C = -28.0‰$

Wood (sample CIA-78-191-2; 11.4 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 79-29 by L.D. Farley-Gill) from the top of buried terrestrial peat exposed in the sea cliff of eastern Graham Island, 19 km north-northeast of Tlell (53°45.5'N, 131°52.9'W), at an elevation of 6 m above mean sea level (2 m above higher high water level). The 40 cm-thick dated peat is underlain by sand and is overlain, in succession, by stony marine sediments (GSC-2734, 8860 ± 120 years, on marine shells, this series), marine or estuarine mud, and peat. GSC-2853 (12 100 ± 140 years, this series) is a date from the base of the buried peat at this site. The sea cliff here is about 8 m high. Collected 1978 by J.J. Clague.

GSC-2853. Eastern Graham Island (XI) — 12 100 ± 140; $\delta^{13}C = -26.4‰$

Wood (sample CIA-78-191-3; 5.4 g; possibly **Salix** sp.; unpublished GSC Wood Identification Report No. 79-15 by R.J. Mott) from the base of buried terrestrial peat exposed in the sea cliff of eastern Graham Island, 19 km north-northeast of Tlell (53°45.5'N, 131°52.9'W), at an elevation of 6 m above mean sea level (2 m above higher high water level). The 40 cm-thick dated peat is underlain by sand and is overlain, in succession, by stony marine sediments (GSC-2734, 8860 ± 120 years, on marine shells, this series), marine or estuarine mud, and peat. GSC-2879 (11 300 ± 110 years, this series) is a date from the top of the buried peat at this site. The sea cliff here is about 8 m high. Collected 1978 by J.J. Clague.

GSC-3112. Eastern Graham Island (XII) — 12 400 ± 100; $\delta^{13}C = -28.5‰$

Silty sandy peat (sample CIA-80-49-2; 99.5 g) from the base of a buried terrestrial organic layer exposed in the sea cliff of eastern Graham Island, 18 km north-northeast of Tlell (53°44.3'N, 131°52.6'W), at an elevation of 5 m above mean sea level (1 m above higher high water level). The 70 cm-thick dated peat bed is underlain by pebbly sand and is overlain, in succession, by sandy silt of marine and estuarine origin and by surface peat. GSC-3159 (10 200 ± 90 years, this series) is a date from the top of the buried peat at this site. The sea cliff here is 10 m high. Collected 1980 by J.J. Clague.

GSC-3222. Eastern Graham Island (XIII) 13 700 ± 100

Bryophytes (sample CIA-80-87-1; 54.1 g) from silty sand exposed in the sea cliff of eastern Graham Island, 17 km north-northeast of Tlell (53°44.1'N, 131°52.6'W), at an elevation of 8 m above mean sea level (4 m above higher high water level). The bryophytes are in growth position and occur as laminae within a 1 to 2 cm-thick organic mat in silty sand. Thinner, weaker organic horizons occur both above and below the dated horizon at this site but have not been dated. The dated bryophyte layer is 1.4 m below a 25 cm-thick buried peat bed which, in turn, is overlain by a few metres of silt and sand of marine, estuarine, and littoral origin. The sea cliff is 8 to 9 m high at this site. Collected 1980 by J.J. Clague.

GSC-3242. Eastern Graham Island (XIV) 36 700 ± 1060

Wood (sample CIA-80-39-1; 11.4 g; **Tsuga** sp.; unpublished GSC Wood Identification Report No. 81-12 by L.D. Farley-Gill and R.J. Mott) from till exposed in the sea cliff of eastern Graham Island, 15 km north-northeast of Tlell (53°42.6'N, 131°52.3'W), at an elevation of 5 m above mean sea level (1 m above higher high water level). The till from which the dated sample was collected is overlain, in succession, by interbedded silt and sand containing a compressed peat bed (GSC-3207, >43 000 years; -3207-2, >51 000 years; and -3208, >33 000 years; this series), glaciomarine stony mud, and undifferentiated drift (silt, sand, and till). The sea cliff is about 17 m high at this site. Collected 1980 by J.J. Clague.

GSC-3208. Eastern Graham Island (XV) >33 000 $\delta^{13}C = -29.1‰$

Peat (sample CIA-80-38-1; 57.0 g) from interbedded silt and sand exposed in the sea cliff of eastern Graham Island, 15 km north-northeast of Tlell (53°42.5'N, 131°52.4'W), at an elevation of 6 m above mean sea level (2 m above higher high water level). The dated sediments overlie till (GSC-3242, 36 700 ± 1060 years, this series) and are overlain successively by glaciomarine stony mud and undifferentiated drift (silt, sand, and till). The sea cliff is about 16 m high at this site. Collected 1980 by J.J. Clague. GSC-3208 and GSC-3207 (>43 000 years, this series) are dates on the same sample. GSC-3208 was determined by acidifying the filtrate from GSC-3207 after base treatment; the resultant precipitate was washed, dried, and burned.

GSC-3118. Eastern Graham Island (XVI) >37 000

Wood (sample CIA-80-108-2; 11.5 g; probably **Abies** sp.; unpublished GSC Wood Identification Report No. 80-24 by L.D. Farley-Gill) from a lens of sand within glaciomarine stony mud (GSC-2788, >39 000 years, on marine shells, this series) exposed in the sea cliff of eastern Graham Island, 17 km south of Tlell (53°25.7'N, 131°54.7'W), at an elevation of 10 m above mean sea level (6 m above higher high water level). The glaciomarine sediments are overlain by outwash gravel, till, and beach gravel. The sea cliff is up to 8 m high at this site. Collected 1980 by J.J. Clague.

GSC-2788. Eastern Graham Island (XVII) >39 000 $\delta^{13}C = +2.7‰$

Fragments of marine shells (sample CIA-78-196; 35.0 g; **Chirona evermanni** (Pilsbry); identified by V.A. Zullo, University of North Carolina, Wilmington) from glaciomarine stony mud exposed in the sea cliff of eastern Graham Island, 17 km south of Tlell (53°25.7'N, 131°54.7'W), at an elevation of 5 to 8 m above mean sea level (1 to 4 m above higher high water level). The glaciomarine sediments, which contain wood-bearing sand lenses (GSC-3118, >37 000 years, this series), are overlain by outwash gravel, till, and beach gravel. The sea cliff is up to 8 m high at this site. Collected 1978 by J.J. Clague.

GSC-3232. Eastern Graham Island (XVIII) >40 000

Wood (sample CIA-80-56; 11.4 g; probably **Picea** sp.; unpublished GSC Wood Identification Report No. 81-11 by L.D. Farley-Gill) from stony mud exposed in the sea cliff of eastern Graham Island, 19 km north-northeast of Tlell (53°45.0'N, 131°52.7'W), at an elevation of 8 m above mean sea level (4 m above higher high water level). The sediments from which the dated sample was collected occur as a lens in sand that is overlain successively by till, interbedded silt and sand, glaciomarine stony mud, and sand. The sea cliff at this site is about 40 to 50 m high. Collected 1980 by J.J. Clague.

GSC-3151-2. Eastern Graham Island (XIX) >52 000

Peat (sample CIA-80-70; 246.9 g) from a compressed organic bed exposed on the intertidal platform of eastern Graham Island, 9 km north-northeast of Tlell (53°39.7'N, 131°54.3'W), at an elevation of 2 m above mean sea level (2 m below higher high water level). The dated peat bed overlies undifferentiated drift (silt, sand, and till); it is stratigraphically below sandy gravel and till exposed in the sea cliff adjacent to the sample collection site. Collected 1980 by J.J. Clague. Two determinations were made:

GSC-3151. 60.0 g of peat, standard treatment with NaOH, HCl and distilled water rinses. Date is based on one 5-day count in the 5 L counter. >42 000

GSC-3151-2. An additional 186.9 g was treated as above, and the CO_2 obtained by burning was added to the CO_2 used for GSC-3151. Date is based on one 5-day count in the 5 L counter at 4 atmospheres. >52 000

GSC-3207-2. Eastern Graham Island (XX) >51 000

Peat (sample CIA-80-38-1; 220.3 g) from a compressed organic bed exposed in the sea cliff of eastern Graham Island, 15 km north-northeast of Tlell (53°42.5'N, 131°52.4'W), at an elevation of 6 m above mean sea level (2 m above higher high water level). The silt and sand containing the dated peat bed overlie till (GSC-3242, 36 700 ± 1060 years, this series) and are overlain successively by glaciomarine stony mud and undifferentiated drift (silt, sand, and till). The sea cliff is about 16 m high at this site. GSC-3207, -3207-2, and -3208 are dates on the same sample. GSC-3207 and -3207-2 were determined on the less soluble fraction by pretreatment with NaOH, HCl, and distilled water. GSC-3208 was determined by acidifying the filtrate from GSC-3207 after base treatment. Collected 1980 by J.J. Clague.

GSC-3207. 57.0 g of peat. Date is based on one 3-day count in the 5 L counter. >43 000 $\delta^{13}C = -29.6‰$

GSC-3207-2. An additional 163.3 g of peat was utilized, and the CO_2 from the two preparations was combined. Date is based on one 5-day count in the 5 L counter at 4 atmospheres. >51 000

Comment (J.J. Clague): The radiocarbon dates from eastern Graham Island may be broadly subdivided into two groups: (1) those from sediments overlying the uppermost till and (2) those from sediments underlying this till (Clague et al., 1982b).

(1) The oldest date above till is 13 700 ± 100 years (GSC-3222). This date was obtained on bryophytes occurring within a unit of interbedded silt and sand of undetermined origin and is a minimum for deglaciation of the Cape Ball area of eastern Graham Island (however, data collected by R.W. Mathewes and B.G. Warner, Simon Fraser University, indicate that this area was deglaciated at least 2000 years earlier and that plant refugia possibly existed somewhere in the region throughout the last glaciation).

A buried peat bed locally overlies the interbedded silt and sand unit from which GSC-3222 was obtained. Six of the dates in the Eastern Graham Island Series (GSC-3129, -3159, -2957, -2879, -2853, and -3112) are from this peat bed. The dates range from 9160 ± 90 to 12 400 ± 100 years and indicate that the peat is of late Pleistocene and locally earliest Holocene age. Mathewes and Clague (1982) summarized the palynology and paleoecological significance of this peat. Because the peat is terrestrial and is exposed in the present-day intertidal zone, sea levels on eastern Graham Island at the close of the Pleistocene were lower than at present (Fladmark, 1975; Clague et al., 1982a,b).

Shell- and wood-bearing marine, estuarine, and littoral sediments locally overlie the buried peat described above. Five of the dates in this list (GSC-2738, -2734, -2867, -2884, and -3120), ranging from 8610 ± 80 to 9350 ± 80 years, are from these sediments. Other similar dates have been obtained from raised marine sediments on northwestern Graham Island (GSC-2443, 8460 ± 80 B.P.; GSC-2534, 8850 ± 90 B.P.; Alley and Thomson, 1978; Clague, 1980) and on eastern Graham Island near the mouth of Cape Ball River (GSC-242, 8620 ± 150 B.P.; Sutherland Brown, 1968; GSC XI, 1971, p. 301). In addition, shells collected from raised marine sediments at Tasu Sound, southern Moresby Island, have been dated at 8060 ± 140 years (GSC-292; Sutherland Brown, 1968; GSC XI, 1971, p. 301). The sediments that yielded these dates were deposited during a marine transgression of lowland areas of the Queen Charlotte Islands during latest Pleistocene and early Holocene time (Fladmark, 1975; Clague et al., 1982a,b). This transgression apparently culminated about 7500 to 8000 years ago when sea level on eastern Graham Island was about 15 m higher relative to the land than at present. GSC-2963 indicates that the sea had fallen several metres from the early Holocene marine limit by 5460 ± 70 years B.P. During the middle and late Holocene marine regression, beaches, spits, bars, wave-cut scarps, and wave-cut benches overlain by beach gravel formed on the Graham Island lowlands below 15 m elevation. The dates of the northern Graham Island series (this list) show that regression has continued until recently and, in fact, probably is still occurring.

(2) Several of the radiocarbon dates of the Eastern Graham Island Series are from units underlying the uppermost till. GSC-3118 and -2788 are dates on wood and shells collected from glaciomarine sediments (sand and stony mud) unconformably overlain by outwash gravel and a single till. GSC-3151 and -3151-2 are dates on a highly compressed peat bed which also is overlain by outwash gravel and a single till. GSC-3207, -3207-2, and -3208 were obtained from a compressed peat bed occurring within a silt and sand unit that is overlain by glaciomarine stony mud, till, and associated outwash. These sediments overlie a till which contained the piece of wood that yielded GSC-3242. Finally, GSC-3232 is a date on wood from glaciomarine stony mud underlying this lower till. With the exception of GSC-3242, the dates cited above exceed the radiocarbon limit, and it is likely that the sediment units from which the samples were collected predate the last glaciation. GSC-3242 (36 700 ± 1060 years) is anomalously young, in that peat occurring higher in the section has yielded older dates (GSC-3207 and -3207-2). Although the wood sample for GSC-3242 appeared fresh and uncontaminated, minor modern contaminants may have escaped notice, giving rise to the reported finite age.

None of the above dates are from the surface till. In view of these dates, it is possible that this till was deposited during a glaciation predating the Fraser Glaciation (late Wisconsin). It seems equally plausible however that this till is substantially younger than underlying dated units and consequently may have been deposited during the Fraser Glaciation. Relevant to this question is a date of $32\,200^{+2600}_{-1900}$ years (GaK-3273; Fladmark, 1971) obtained on a piece of wood in the surface till at Lawn Point (near the site where the samples for GSC-3118 and -2788 were collected). The dated wood probably was eroded by glacier ice from older sediments and redeposited in the till. Assuming that the dated wood indeed is ca. 32 000 years old, as suggested by the date, the till must have been deposited during the Fraser Glaciation. Additional dates on the surface drift are required to substantiate this age assignment.

Comment (W. Blake, Jr.): With the exception of the pairs of samples for which laboratory data have been given already (GSC-3151, -3151-2, -3207, and -3207-2), details regarding the other samples in this series are as follows: for GSC-2788, because of the small sample size, only the outer 10 per cent of shell was removed by HCl leach. GSC-3129 and -3208 were mixed with dead gas for counting; GSC-2853 is based on two 1-day counts in the 2 L counter. GSC-3208 is based on one 3-day count in the 2 L counter. GSC-2738, -2788, -2867, -2957, -3112, -3118, -3120, -3129, -3159, -3232, and -3242 are each based on one 3-day count in the 5 L counter; GSC-2734, -2879, -2884, and -2963 are each based on two 1-day counts in the 5 L counter; and GSC-3222 is based on one 5-day count in the 5 L counter.

Northern Graham Island Series

Marine shells collected from auger holes and natural exposures on a beach-ridge plain between Masset and Rose Point, northern Graham Island, Queen Charlotte Islands, British Columbia (Sutherland Brown, 1968; Clague and Bornhold, 1980; Harper, 1980; Clague, 1981; Clague et al., 1982a). The plain from which the samples were collected is up to 2 km wide and is underlain by sandy gravel and gravelly sand of littoral origin, in most places capped by eolian sand. The surface of the plain is characterized by vegetated dune ridges which, in general, are parallel to the present shore. These ridges extend inland to a prominent wave-cut scarp cut in late Pleistocene drift. At the northeastern corner of Graham Island southeast and east of Tow Hill, this wave-cut scar is inconspicuous, and the beach-ridge plain is bordered inland by a higher area of fossil spits and bars. These latter features extend up to about 10 to 15 m elevation. All samples for dating were collected from littoral sediments underlying the lower part of the beach-ridge plain.

GSC-3025. Northern Graham Island (I) — 530 ± 70 — $\delta^{13}C = +1.6‰$

Part of a single right valve of **Saxidomus gigantea** (sample QCH-1-183; 19.5 g) from an auger hole 2.2 km east of the bridge over Sangan River and 30 m south of the road from Masset to Tow Hill (54°02.0'N, 131°56.9'W), at an elevation of 4.0 ± 0.5 m above mean sea level (ca. 0.5 ± 0.5 m above higher high water level). The sample was collected at a depth of 1.83 m from gravelly beach sand which is overlain by well sorted, fine to medium, eolian sand. Collected 1979 by J.R. Harper, then GSC, now Woodward-Clyde Consultants, Victoria, British Columbia.

GSC-2978. Northern Graham Island (II) — 540 ± 70 — $\delta^{13}C = +0.9‰$

The single largest fragment of **Saxidomus gigantea** (sample QCH-17-220; 18.2 g) from an auger hole 2.2 km east of the bridge over Sangan River and 30 m north of the road from Masset to Tow Hill (54°02.05'N, 131°56.9'W), at an elevation of 3.6 ± 0.5 m above mean sea level (approximate higher high water level). The sample was collected at a depth of 2.2 m from gravelly beach sand which is overlain in succession by (1) medium to coarse, upper swash sand, (2) well sorted, fine to medium, eolian sand, and (3) peat. Collected 1979 by J.R. Harper.

GSC-2955. Northern Graham Island (III) — 580 ± 70 — $\delta^{13}C = 0.0‰$

The single largest left valve of **Saxidomus gigantea** (sample QCH-156-100; 50.7 g) from an auger hole 1.7 km west of the bridge over Chown Brook and north of the road from Masset to Tow Hill (54°01.6'N, 132°01.1'W), at an elevation of about 3.5 m above mean sea level (approximate higher high water level). The sample was collected 1.0 m below the surface from gravelly beach sand which is overlain by well sorted medium sand. Collected 1979 by J.R. Harper.

GSC-2915. Northern Graham Island (IV) — 790 ± 70 — $\delta^{13}C = +0.7‰$

Two valves of **Saxidomus gigantea** (sample CIA-78-184; 43.2 g; identified by W. Blake, Jr.) from a river bank exposure near the mouth of Sangan River, 11 km east-northeast of Masset (54°01.6'N, 131°59.1'W), at an elevation of about 5 m above mean sea level (1.5 m above higher high water level). The sample was collected about 2 m below the top of the exposure from beach deposits or fluvially reworked beach deposits consisting of sandy gravel and gravelly sand. These sediments are overlain by eolian sand. Collected 1978 by J.J. Clague.

GSC-2815. Northern Graham Island (V) — 940 ± 60 — $\delta^{13}C = +0.6‰$

A single left valve of a marine pelecypod (sample CIA-78-183; 31.5 g) from the wall of a sand and gravel pit directly south of Chown Brook, 9 km east-northeast of Masset (54°01.4'N, 132°01.1'W), at an elevation of about 5.5 m above mean sea level (2 m above higher high water level). The sample was collected 50 cm below the top of the pit face from gravelly beach sand overlain by 20 cm of peat. Collected 1978 by J.J. Clague.

GSC-2954. Northern Graham Island (VI) — 1150 ± 70 — $\delta^{13}C = +0.9‰$

Part of a single left valve of **Saxidomus gigantea** (sample QCH-160-150; 20.4 g; identified by W. Blake, Jr.) from an auger hole 1.7 km west of the bridge over Chown Brook and 0.5 km south of the road from Masset to Tow Hill (54°01.3'N, 132°01.25'W), at an elevation of about 5.5 m above mean sea level (2.0 m above higher high water level). The sample was collected 1.5 m below the surface from gravelly beach sand which is overlain successively by moderately to poorly sorted, medium sand and peat. Collected 1979 by J.R. Harper.

Comment (J.J. Clague): The beach-ridge plain on northern Graham Island formed as a result of tectonic uplift and beach progradation during late Holocene time (Harper, 1980). The dates in this series provide information on the rates of these processes. It should be borne in mind, however, that marine shells typically have a finite radiocarbon age at the time of death of the organism. As a consequence, isotopically corrected radiocarbon ages of fossil shells, in general, are older than their true ages, and a correction must be applied. The required correction for the Queen Charlotte Islands is unknown, although it may be several hundred years. Thus, the shell dates listed above should be considered maxima, and emergence and progradation rates calculated using these dates are likely to be minima.

Notwithstanding this problem, the radiocarbon dates of this series display consistent relationships with respect to elevation and distance from the present shore; specifically, there is an increase in radiocarbon age with increasing elevation and distance from the shoreline. The oldest sample (GSC-2954, 1150 ± 70 years) occurs at 5.5 m elevation, 600 m from the landward edge of the present-day beach; a metre or two of uplift in the last 1150 years or less is indicated. Such uplift is consistent with contemporary crustal movements inferred from tide gauge records (Clague et al., 1982a), with the high seismicity of the Queen Charlotte Islands (Milne et al., 1978), and with the location of the Islands near the active boundary of the Pacific and American lithospheric plates (Riddihough, 1982).

Comment (W. Blake, Jr.): With regard to the correction to be applied to marine shells, compare GSC-2867 (9040 ± 80 years, marine shells) and GSC-2884 (9060 ± 90 years, **Tsuga** wood) from the same unit and level on eastern Graham Island (this list). Because of the small sample size of GSC-2954, only the outer 5 per cent was removed by HCl leach. GSC-2978 and -3025 were mixed with dead gas for counting. GSC-2815, -2954, -2978, and -3025 are each based on two 1-day counts in the 2 L counter; GSC-2915 and -2955 are each based on two 1-day counts in the 5 L counter. All valves of **Saxidomus gigantea** utilized were determined to be aragonitic by X-ray diffraction.

Northern Canada, Mainland

Yukon Territory

'Volcano Creek' Series

Silty peat was exposed by a recent collapse in a thermokarst zone 3.5 km southeast from the junction of Grizzly Creek and 'Volcano Creek' in the St. Elias Mountains, Yukon Territory (61°07'N, 139°04'W), at an elevation of about 1585 m. The site is located in an alpine tundra where sedges are the dominant species. The samples were extracted from peat monoliths cut out about 20 cm behind the natural face. Collected 1979 by M.A. Geurts, University of Ottawa, Ottawa, and J. Bourgeois, then University of Ottawa, now Polar Continental Shelf Project, Department of Energy, Mines and Resources, Ottawa.

GSC-3230. Volcano Creek (I) — 400 ± 60

Fibrous peat (sample YuF_2; 12.7 g, dry) from the lowermost 2 cm of a 3 cm-thick band, 54.5 to 56.5 cm below the surface.

GSC-3225. Volcano Creek (II) 1850 ± 70

Silty peat (sample YuF$_3$; 51.0 g, dry) containing a fine ash layer, from 85.5 to 92 cm below the surface.

Comment (J. Bourgeois): The peat section, 94 cm high, contains three distinct pollen zones. The zones also appear at two other sites in Grizzly Creek valley. Zone I and III are defined by their high spruce values whereas Zone II shows a significant decrease of the species. At two other sites, a major increase in birch also occurs in Zone II. This zone is interpreted as a slightly drier episode, unfavourable to spruce reproduction (Bourgeois, 1982).

The sequence, which spans less than 2000 years, contains two ill defined volcanic ash layers. The lowermost, dated at approximately 1850 years B.P., is possibly associated with the oldest layer of the White River Ash. The uppermost, at 14 cm below the surface, likely corresponds to a younger eruption dated at 1200 years B.P. (cf. Hughes et al., 1972; also the Donjek River Bridge series in GSC XIII, 1973, p. 29-30). Because the sample dated at 400 ± 60 years is situated between these two ash layers, and neither the sediments nor the pollen sequences have been disturbed, it is reasonable to suspect the accuracy of the date obtained.

Comment (W. Blake, Jr.): Nothing in the laboratory data with regard to GSC-3230 was out of the ordinary. However, because of the small size of both samples, the NaOH leach was omitted from the pretreatment. Thus, rootlets that may have penetrated from above, or younger humic materials that may have percolated downward, were not removed. Each date is based on two 1-day counts in the 2 L counter.

GSC-3032-2. Big Creek 48 100 ± 1100

Wood (sample KJ-20-79; **Salix** sp.; unpublished GSC Wood Identification Report No. 79-50 by R.J. Mott) from a bed of permanently frozen peat exposed by gold placer mining along a small tributary (local name – Revenue Creek) to Big Creek just west of its confluence with Seymour Creek, Yukon Territory (62°21'N, 137°12'30"W), at an elevation of approximately 720 m. The peat bed contains vertebrate bones including **Mammuthus** sp. (C.R. Harington, personal communication, 1979). The peat is separated from bedrock by a thin bed of gold-bearing gravel and is overlain by about 1.5 m of similar gravel devoid of gold. Collected 1979 by R.W. Klassen. Two determinations were made:

GSC-3032. Big Creek (I) >37 000

The sample used for this determination weighed 11.2 g. Date is based on one 3-day count in the 5 L counter.

GSC-3032-2. Big Creek (II) 48 100 ± 1100

The second determination utilized an extra 24.3 g of the sample. Date is based on one 5-day count in the 5 L counter at 4 atmospheres.

Comment (R.W. Klassen): The site is on Bostock's (1966) 'Nansen Drift' that he considered to represent the oldest glaciated surface in the region. A date of >39 000 years (GSC-2817; GSC XIX, 1979, p. 29) was obtained in a similar setting in unglaciated terrain about 45 km southwest of this locality. Some of the bone fragments collected on 'Revenue Creek' may be artifacts (C.R. Harington, personal communication, 1979).

Comment (W. Blake, Jr.): The sample submitted was a single, tapering piece of wood, approximately 25 cm long and over 5 cm in diameter at the wide end. Both ends were sharp, not rounded, implying little transport despite the absence of bark. The CO_2 derived from the first preparation (GSC-3032) was saved and added to the gas obtained from the second burn in order to obtain enough CO_2 for the high pressure age determination.

Hanging Lake Series

A series of lake sediment samples were extracted from a 403 cm-long core from 'Hanging Lake' (informal name) in northern Yukon Territory (68°23'N, 138°23'W), at an elevation of 500 m. Collected 1 May 1976 by L.C. Cwynar and J.C. Ritchie (Scarborough College, University of Toronto, Toronto) with a modified Livingstone piston sampler. This large set of samples from Eastern Beringia (cf. Cwynar and Ritchie, 1980) was dated so that detailed sedimentation rates could be estabished for calculating pollen influx values. Depths are distances below the mud/water interface, and sample weights are dry weights except where otherwise stated.

GSC-2807. Hanging Lake, 13-18 cm 1870 ± 180 $\delta^{13}C = -27.4‰$

Organic silt (sample H16; 10.7 g). Date is based on two 1-day counts in the 2 L counter.

GSC-2744. Hanging Lake, 23-28 cm 2930 ± 130 $\delta^{13}C = -27.5‰$

Organic silt (sample H13; 36.5 g). Date is based on two 1-day counts in the 2 L counter.

GSC-2518. Hanging Lake, 28-33 cm 5100 ± 180 $\delta^{13}C = -27.0‰$

Organic silt (sample H3; 36.0 g, moist). Date is based on two 1-day counts in the 2 L counter.

GSC-2517. Hanging Lake, 53-58 cm 4360 ± 150 $\delta^{13}C = -26.3‰$

Organic silt (sample H4; 27.6 g, moist). Date is based on two 1-day counts in the 2 L counter.

GSC-2515. Hanging Lake, 78-83 cm 5640 ± 140 $\delta^{13}C = -31.8‰$

Organic silt (sample H5; 33.7 g, moist). Date is based on one 3-day count in the 2 L counter.

GSC-2399. Hanging Lake, 103-108 cm 7870 ± 280 $\delta^{13}C = -29.0‰$

Organic silt (sample H2; 16.1 g). Date is based on two 1-day counts in the 2 L counter.

GSC-2794. Hanging Lake, 115.5-120.5 cm 10 200 ± 190 $\delta^{13}C = -29.3‰$

Organic silt (sample H14; 45.9 g). Date is based on one 3-day count in the 2 L counter.

GSC-2514. Hanging Lake, 128-133 cm 11 500 ± 250 $\delta^{13}C = -26.0‰$

Organic silt (sample H6; 45.8 g, moist). Date is based on two 1-day counts in the 2 L counter.

GSC-2826. Hanging Lake, 140.5-145.5 cm 9220 ± 140 $\delta^{13}C = -27.0‰$

Organic silt (sample H15; 39.5 g). Date is based on two 1-day counts in the 2 L counter.

GSC-2503. Hanging Lake, 153-158 cm 10 500 ± 200 $\delta^{13}C = -27.6‰$

Organic silt (sample H7; 25.9 g, moist). Date is based on two 1-day counts in the 2 L counter.

GSC-2502. Hanging Lake, 178-183 cm 10 900 ± 210 $\delta^{13}C = -27.4‰$

Organic silt (sample H8; 25.8 g, moist). Date is based on two 1-day counts in the 2 L counter.

GSC-2489. Hanging Lake, 203-208 cm — 11 700 ± 150; $\delta^{13}C = -27.4‰$

Organic silt (sample H9; 30.5 g, moist). Date is based on one 3-day count in the 2 L counter.

GSC-2500. Hanging Lake, 228-233 cm — 12 600 ± 270; $\delta^{13}C = -24.7‰$

Organic silt (sample H10; 18.2 g, moist). Date is based on one 2-day count in the 2 L counter.

GSC-2491. Hanging Lake, 253-258 cm — 12 400 ± 210; $\delta^{13}C = -25.9‰$

Organic silt (sample H11; 16.5 g, moist). Date is based on one 3-day count in the 2 L counter.

GSC-2846. Hanging Lake, 263-268 cm — 12 800 ± 320; $\delta^{13}C = -25.4‰$

Organic silt (sample H19; 20.1 g). Date is based on one 3-day count in the 2 L counter.

GSC-2388. Hanging Lake, 273-278 cm — 15 800 ± 450; $\delta^{13}C = -27.0‰$

Organic silt (sample H1; 28.9 g) and the felted remains of the aquatic moss **Drepanocladus fluitans** (identified by G.R. Brassard, Memorial University of Newfoundland, St. John's). Date is based on one 2-day count in the 2 L counter.

GSC-2868. Hanging Lake, 278-283 cm — 17 700 ± 380; $\delta^{13}C = -25.0‰$

Organic silt (sample H21; 46.3 g) with the felted remains of the aquatic moss **Drepanocladus fluitans** (identified by G.R. Brassard). Date is based on one 3-day count in the 2 L counter.

GSC-2830. Hanging Lake, 293-298 cm — 16 800 ± 320; $\delta^{13}C = -24.0‰$

Organic silt (sample H23; 34.1 g) with the felted remains of the aquatic moss **Drepanocladus fluitans** (identified by G.R. Brassard). Date is based on one 3-day count in the 2 L counter.

GSC-2482. Hanging Lake, 303-308 cm — 20 200 ± 510; $\delta^{13}C = -23.0‰$

Organic silt (sample H12; 54.5 g). Date is based on two 1-day counts in the 2 L counter.

GSC-2790. Hanging Lake, 318-323 cm — 20 200 ± 660; $\delta^{13}C = -25.6‰$

Organic silt (sample H27; 38.4 g) with felted remains of the aquatic moss **Drepanocladus fluitans** (identified by G.R. Brassard). Date is based on one 3-day count in the 2 L counter.

GSC-2710. Hanging Lake, 323-336.5 cm — 24 900 ± 600; $\delta^{13}C = -25.9‰$

Organic silt (sample H28; 201 g). Date is based on one 3-day count in the 2 L counter.

Comment (L.C. Cwynar): "Twenty-one radiocarbon dates indicate that the section is at least 25 000 and possibly 33 000 yr old; they permit the calculation of pollen influxes for the full-glacial in eastern Beringia. Numerical methods were used to divide the pollen stratigraphy into five zones. From prior to 33 000 to 18 450 BP, a herb zone was dominant (zone HL 1) with high percentages of Gramineae, **Artemisia**, and Cruciferae. However, the low pollen influx, ranging from 5-100 grains$\cdot$cm$^{-2}\cdot$yr^{-1}, the low organic content of the sediment, and the occurrence of open-ground taxa all indicate that the vegetation cover was sparser than it is today. The arctic-alpine affinities of the herb pollen show that generically the vegetation was akin to modern arctic plant communities. Modern fellfield communities in the northern Yukon and Siberia have a rich and endemic **Artemisia** flora and they can produce pollen spectra comparable to that of the herb zone. Percent and influx values for spruce, alder, and birch increased slightly during subzone H 1B (21 680-18 450 BP); this subzone probably represents an interstadial. From 18 450 to 14 600 BP, a **Salix**-Cyperaceae zone (HL 2) occurred, suggesting the development of snowbed and willow scrub communities in sheltered areas. Between 14 600 and 11 100 BP **Betula** pollen dominated (zone HL 3) indicating the spread of dwarf birches, but the influx data show that this initial increase was modest compared with the subsequent zone and thus dwarf birches were probably restricted at this time to more favourable habitats. The spread of birch together with the increased total pollen influx, the higher organic content of the sediment, and the increased richness of herb pollen indicates that the local flora was more diverse and that the vegetative cover increased. The climate must have warmed. Zone HL 4 (Ericales zone) spanned the period from 11 100 to 8900 BP. Wet heath communities became locally abundant, poplar was more abundant at the beginning of this zone than at any subsequent time, the ranges of **Typha latifolia** and **Myrica gale** were greater than today, and pollen influx and sedimentation rate both increased greatly. Spruce became regionally abundant. These varied changes are probably in response to a warmer and wetter climate; they provide evidence for a late Pleistocene to early Holocene warm interval initially recognized by McCulloch and Hopkins (1966). Zone HL 5 (**Alnus crispa** zone) has been dated from 8900 BP to the present; it reflects the regional expansion of **Alnus crispa** on organic soils." (Cwynar, 1982, p. 1).

Comment (W. Blake, Jr.): The NaOH leach was omitted from the pretreatment of all 21 samples. Each sample was mixed with dead gas for counting. With regard to the validity of the basal age determination, GSC-2710 (24 900 ± 600 years), Cwynar (1982, p. 7) stated, "The chronology and deposition times were extrapolated only to the change in sediment lithology at 370 cm (Figs. 3 and 4) which corresponds to about 33 000 BP. Because of the low organic content of the section from which GSC-2710 was taken and the possibility that the shale bedrock contains some inert carbon, this sample's date of 24 900 BP may be too old. Nambudiri et al. (1980) have suggested that minimum corrections for fine-grained sediments contaminated by noncarbonate carbon of "infinite" age may be made by using the relative abundance of pre-Quaternary microfossils as a guide. Such a correction applied to GSC-2710, where pre-Quaternary spores constituted ~10% of the microfossils, would amount to about 700 yr. All other samples submitted for dating contained <1% pre-Quaternary spores. Several samples, e.g., GSC-2388, GSC-2830 and GSC-2790, consisted primarily of felted remains of an aquatic moss (**Drepanocladus fluitans**); their radiocarbon ages are therefore reliable."

GSC-2667. Kay Point — 2520 ± 70

Wood (sample FZ-P1(85)(A) = FZ-401085; 10.5 g; **Salix** sp.; identified by L.D. Farley-Gill) from 0.85 m below the top of a 3.9 m-high peat section exposed 3.2 km south of Kay Point along the east shore of the Babbage Estuary, Yukon Territory (69°16'N, 138°24'W), 2.3 m above present mean sea level. Collected 1977 by D.L. Forbes and M. Church then both University of British Columbia, Vancouver; submitted 1978 by D.L. Forbes.

Comment (D.L. Forbes, now GSC): GSC-2667 represents a distinctive thin bed of unabraded large twigs, apparently in situ and associated with **Salix** sp. larger than any now found at the coast; similar beds occur in peat exposures at the southern edge of Babbage Delta. The peat at the Kay Point site, the base of which lies at 0.7 m below sea level, is interpreted as a thermokarst basin fill (Forbes, 1980, in press). GSC-2667 postdates the regional climatic deterioration thought to have begun about 4000 years ago (Ritchie, 1972). The change of vegetation at this location is thought instead to represent a change in local microclimatic or other site conditions. Other dates from the Babbage River and Babbage River delta are reported in a previous list (GSC XX, 1980, p. 14).

Comment (W. Blake, Jr.): Only the single largest piece of wood (of three in the sample) was utilized for dating; it measured 21 cm in length by 1.5 cm in diameter. Date is based on two 1-day counts in the 5 L counter.

Northwest Territories

Natla River Bog Series

Autochthonous peat samples were collected from a river-dissected bog approximately 13 km east of O'Grady Lake, Northwest Territories, along Natla River (63°01'N, 128°48'W), at an elevation of approximately 1370 m. The peat exposure is a lenticular unit with a maximum thickness of 2.3 m. The peat is underlain by a diamicton and bedrock. The top of the exposure is approximately 10 m above river level. Collected 1980 by G.M. MacDonald, Scarborough College, West Hill, Ontario, and L.E. Jackson, Jr.

GSC-3176. Natla Bog (I) 2980 ± 50
$\delta^{13}C = -25.8‰$

Peat (sample GMP-4; 18.7 g, dry) from 30 cm below the top of the exposure.

GSC-3171. Natla Bog (II) 5450 ± 70
$\delta^{13}C = -25.7‰$

Peat (sample GMP-10; 13.7 g, dry) from 90 cm below the top of the exposure.

GSC-3169. Natla Bog (III) 7720 ± 90
$\delta^{13}C = -26.7‰$

Peat (sample GMP-17; 22.5 g, dry) from 150 cm below the top of the exposure.

GSC-3333. Natla Bog (IV) 9400 ± 130
$\delta^{13}C = -26.8‰$

Peat (sample GMP-20; 44.2 g, dry) from 200 cm below the top of the exposure.

GSC-3383. Natla Bog (V) 8400 ± 80
$\delta^{13}C = -26.4‰$

Peat (sample GMP-22; 15.3 g, dry) from 220 cm below the top of the exposure.

GSC-3097. Natla Bog (VI) 8630 ± 160
$\delta^{13}C = -26.0‰$

Peat (sample JJN80-1; 11.2 g, dry) from 230 cm below the top of the exposure.

Comment (G.M. MacDonald): This series provides radiometric age control for relative and influx pollen profiles and a plant macrofossil sequence obtained from the Natla River Bog Section (MacDonald, 1982, in press). Additional chronological control was provided by a layer of White River Ash (~1250 years B.P., identified by S. Robertson, University of Toronto) found at a depth of 10 cm from the top of the exposure. The paleobotanical data indicate that **Betula**-dominated tundra was present in the region from at least 8630 years B.P. to approximately 7700 years B.P. **Picea** expanded into the area approximately 7700 years B.P. to shortly after 5000 years B.P. GSC-3333 (9400 ± 130) is not internally consistent with the other dates in the series (GSC-3169, -3383, and -3097). This anomaly is not explainable at present.

Comment (W. Blake, Jr.): Changes in sample weight upon drying overnight in an electric oven were as follows: GSC-3097 (77.0 to 11.2 g), GSC-3169 (110.0 to 21.2 g), GSC-3171 (90.0 to 12.7 g), GSC-3176 (100.0 to 17.7 g), GSC-3333 (140.5 to 44.2 g), and GSC-3383 (105.8 to 15.3 g). GSC-3097 was mixed with dead gas for counting. GSC-3169, -3171, and -3333 are each based on two 1-day counts in the 5 L counter; GSC-3097 is based on two 1-day counts in the 2 L counter; GSC-3176 and -3383 are each based on one 3-day count in the 5 L counter.

Northern Canada, Arctic Archipelago

Baffin Island

GSC-3157. Eggleston Bay 8690 ± 120

Whole shells and fragments of marine molluscs (sample GRL-793-S; 19.3 g; **Hiatella arctica**; identified by E.V. Lind) in float on the western shore of the first lake directly northwest of Eggleston Bay, Frobisher Bay, Baffin Island, Northwest Territories (63°13'N, 68°13'W), at an elevation of 82 m. Collected 1980 by E.K. Lind, University of Colorado, Boulder, Colorado.

Comment (E.K. Lind): The shells (**Astarte striata** was also present) were collected from lake level at 82 m, but they probably come from the silt/fine sand deposit 22 m higher up the slope. The surface of the deposit is gullied and slopes to lake level. No shells were found in situ in the lake sand or in the silt/fine sand at the 104 m level, but shell abundance increased near the silt/fine sand outcrop. The marine limit on Pugh Island (about 6 km to the northeast) is 119 m, with decreasing elevations both up- and down-bay. These shells represent one of the highest datable marine limits thus far observed in inner Frobisher Bay (Lind, 1982; cf. Blake, 1966; also GSC VI, 1967, p. 182; shell fragments 4.0 km south of Cape Rammelsberg at 84 to 87 m a.s.l. were 8230 ± 240 years old (GSC-462)).

Comment (W. Blake, Jr.): The sample utilized for dating comprised only **Hiatella arctica** – 20 left valves, 19 right valves, and 2 miscellaneous fragments; the largest valve was 2.6 cm long with a maximum shell thickness of 2 mm. Most shells retained their internal lustre, but none had good external ornamentation – all were worn. Some shells had greyish encrustations, but none of these were utilized in the dated sample. Because of the small sample size, only the outer 10 per cent was removed by HCl leach. The sample was mixed with dead gas for counting. Date is based on one 3-day count in the 2 L counter.

Bylot Island

GSC-2984. Possession Bay 150 ± 60

Wood from a 2 m-long piece of driftwood (sample 1979-TU-3; 11.7 g; **Picea** sp.; identified by L.D. Farley-Gill) that was partially buried in the beach backshore zone of Possession Bay, approximately 5.3 km south of Cape Fanshawe, Bylot Island, Northwest Territories (73°31'05"N, 77°20'00"W), at an elevation of 3.5 m above mean high tide level. Collected 1979 by R.B. Taylor.

Comment (R.B. Taylor): This sample, found at the upper limit of a concentrated driftwood-whalebone line that extends from 2.5 to 3.5 m above mean high tide level, is the highest wood sample found during two years of observations along the coast of northeastern Bylot Island. The sample is significant because there is no clear evidence of beach ridges above this elevation. The driftwood line (90 m inland from MHTL) coincides with a series of backshore ponds and/or the landward extent of overwash deposits. Beach morphological evidence suggests that the northeastern Bylot Island shoreline is in a transgressive sequence. The present beach is composed of overwash deposits (pebble-cobble) overlying a thin till and bedrock which are exposed in both the nearshore and backshore zones (Taylor, 1981). Date is based on one 1-day count in the 5 L counter.

Ellesmere Island

Alexandra Fiord Series

Samples from two sites, a delta near the head of Alexandra Fiord and Skraeling Island at the entrance to the Fiord.

GSC-3288. Head of Alexandra Fiord — 7000 ± 70; $\delta^{13}C = +1.1‰$

Marine pelecypod shells (sample BS-81-94; 45.0 g; **Mya truncata**; identified by W. Blake, Jr.) from sand in an emerged delta near the head of Alexandra Fiord, Ellesmere Island, Northwest Territories (78°51.0'N, 76°25.0'W), at an elevation of 50 m (altimeter determination). Collected 1981 by W. Blake, Jr.

GSC-3391. Skraeling Island pond, 83-87 cm — 6650 ± 70; $\delta^{13}C = -21.6‰$

Basal organic sediment (sample BS-81-8 (1:83-87 cm); 79.4 g, dry) from a core of frozen sediment collected with a motor-powered CRREL coring unit in a small pond near the summit of Skraeling Island, Alexandra Fiord, Ellesmere Island, Northwest Territories (78°54.5'N, 75°38.5'W), at an elevation of 76 m (levelling to pond surface from high tide level). Collected 1981 by O. Salvigsen, Norsk Polarinstitutt, Oslo, Norway; F.M. Nixon and W. Blake, Jr.

Comment (W. Blake, Jr.): The sample used for GSC-3288 included 24 left and 25 right valves; the largest valve was 4.1 x 3.2 cm. GSC-3288 is the oldest date obtained on marine shells in a fiord-head situation along the coast of east-central Ellesmere Island, and yet the date – 7000 ± 70 years – is roughly 2000 years younger than marine shell dates at Herschel Bay on the outer coast (e.g., GSC-3103, 8930 ± 100 years; Blake, 1981; GSC XXI, 1981, p. 18).

GSC-3391 is the oldest date obtained in the course of the frozen coring program conducted since 1978 in eastern Ellesmere Island (Blake, 1982). The cores from Skraeling Island pond are still being analyzed (new ones were taken in 1982); so far unequivocal evidence that the sand lower in the core is marine has not been found, but the elevation of the lake is such that earlier in Holocene time the sea may well have penetrated into the basin now occupied by the pond. As Skraeling Island emerged from the sea, it became the site of a succession of prehistoric occupations, starting with the Arctic Small Tool tradition (cf. Schledermann, 1978, 1980, 1981). NaOH leach was omitted from the pretreatment of GSC-3391; date is based on one 4-day count in the 5 L counter. GSC-3288 is based on one 3-day count in the 5 L counter.

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