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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES XXI

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Canada

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The present date list, GSC XXI, is the tenth 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 XXI

Abstract

This list includes 105 radiocarbon age determinations on 104 geological samples made by the Radiocarbon Dating Laboratory. They are on samples from various areas as follows: Labrador Shelf (2); Newfoundland (12); Nova Scotia (2); New Brunswick (1): Quebec (3); Ontario (1); Manitoba (1); Alberta (2); British Columbia (15); Yukon Territory (35); Northwest Territories, Mainland (10); Northwest Territories, Arctic Archipelago (21). Details of background and standard for the 2 L and 5 L counters during the period from November 4, 1980 to October 31, 1981 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 105 datations effectuées sur 104 échantillons géologiques par le Laboratoire de datation au radiocarbone. Ces échantillons proviennent des régions suivantes: plateau continental du Labrador (2); Ile de Terre-Neuve (12); Nouvelle-Ecosse (2); Nouveau-Brunswick (1); Québec (3); Ontario (1); Manitoba (1); Alberta (2); Colombie-Britannique (15); Yukon (35); Territoires du Nord-Ouest, continent (10); Territoires du Nord-Ouest, archipel Arctique (21). Les valeurs de mouvement propre et de l'étalonnage des compteurs 2 L et 5 L, pour la période allant du 4 novembre 1980 au 30 novembre 1981, 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 1980 to October 1981, 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 throughout the year; the 5 L counter was operated at 1 atmosphere, except for September, October, and part of November 1981 when it was operated at 4 atmospheres.

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

Table 1. Monthly Average Count for Background During the Period November 4, 1980 to October 30, 1981

Month	2 L Counter (2 atm) cpm*	5 L Counter (1 atm) cpm*
November 1980	1.189 ± 0.023	2.165 ± 0.042
December	1.252 ± 0.023	2.266 ± 0.027
January 1981	1.191 ± 0.036	2.260 ± 0.027
February	1.136 ± 0.048	2.236 ± 0.026
March	1.125 ± 0.027	2.243 ± 0.026
April	1.146 ± 0.031	2.231 ± 0.026
May	1.127 ± 0.018	2.204 ± 0.029
June	1.221 ± 0.036	2.165 ± 0.025
July	1.245 ± 0.022	2.197 ± 0.037
August	1.226 ± 0.019	2.176 ± 0.047
September	1.252 ± 0.019	2.838 ± 0.028**
October	1.256 ± 0.036	

* cpm = counts per minute

** Counted at 4 atmospheres

Table 2. Monthly Average Count (N_0)* for Oxalic Acid Standard During the Period November 4, 1980 to October 30, 1981

Month	2 L Counter (2 atm) cpm	5 L Counter (1 atm) cpm
November 1980	18.440 ± 0.098	28.152 ± 0.122
December	18.309 ± 0.103	27.857 ± 0.126
January 1981	18.416 ± 0.106	27.848 ± 0.174
February	18.543 ± 0.108	27.920 ± 0.151
March	18.358 ± 0.108	28.135 ± 0.123
April	18.496 ± 0.102	28.195 ± 0.124
May	18.367 ± 0.101	28.063 ± 0.127
June	18.370 ± 0.101	28.183 ± 0.118
July	18.534 ± 0.111	28.063 ± 0.121
August	18.367 ± 0.112	28.014 ± 0.129
September	18.508 ± 0.161	105.292 ± 0.190**
October	18.396 ± 0.098	

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

** Counted at 4 atmospheres

[1] The introduction has been prepared by J.A. Lowdon, Laboratory Supervisor. The date list has been compiled by W. Blake, Jr. from descriptions of samples and interpretations of age determinations 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 Report Period

Month	BACKGROUND 2 L	BACKGROUND 5 L	STANDARD 2 L	STANDARD 5 L
November 1980	4	4	3	3
December	4	4	3	3
January 1981	4	4	3	3
February	4	4	3	3
March	4	4	3	3
April	4	4	3	3
May	4	4	3	3
June	4	4	3	3
July	4	4	3	3
August	4	4	3	3
September	4	9*	3	7*
October	4		3	

*High pressure (4 atm) September/October.

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

Month	BACKGROUND 2 L	BACKGROUND 5 L	STANDARD 2 L	STANDARD 5 L
November 1980	3	2	2	2
December	3	3	2	3
January 1981	2	4	2	2
February	4	4	2	2
March	2	2	2	2
April	3	3	2	2
May	3	2	2	2
June	3	2	2	2
July	3	3	2	2
August	2	2	2	2
September	2	2	2	1
October	3		2	

Where $\delta^{13}C/\delta^{12}C$ ratios are available, a correction for isotopic fractionation has been applied to the age determination 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 $\delta^{13}C/\delta^{12}C$ determinations were made on aliquots of the sample gas used for age determinations. Since 1975 most $\delta^{13}C/\delta^{12}C$ ratios have been determined under contract by Professor P. Fritz and R.J. Drimmie of the Department of Earth Sciences, University of Waterloo, Ontario. Carbon-ratio determinations given in this paper were carried out by the following laboratories:

Teledyne Isotopes, Westwood, New Jersey (under contract) for

GSC-1159;

GSC Geochronology Section for

GSC -1562, -1669, -1671, -1717, -1724, -1737, -1833, -1833-2, and 1866;

Department of Earth Sciences, University of Waterloo, Waterloo, Ontario (under a series of contracts supervised by Professor P. Fritz and R.J. Drimmie) for

GSC -2075, -2100, -2133, -2149, -2172, -2187, -2256, -2531, -2540, -2549, -2569, -2575, -2580, -2593, -2602, -2606, -2607, -2613, -2616, -2617, -2622, -2628, -2642, -2643, -2664, -2686, -2690, -2699, -2730, -2758, -2762, -2779, -2785, -2808, -2818, -2852, -2854, -2871, -2893, -2898, -2903, -2909, -2928, -2952, and -2961;

Waterloo Isotope Analysts, Inc., Kitchener, Ontario (under contract; R.J. Drimmie, chief analyst) for

GSC -2985, -3102, -3103, -3136, -3166, -3180, -3182, -3183, -3200, -3201, and -3224.

Acknowledgments

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GEOLOGICAL SAMPLES

Eastern Canada

Labrador Shelf

Labrador Shelf Series

GSC-2642. Labrador Shelf (I) — 6050 ± 180
$\delta^{13}C = -0.2$ ‰

Marine pelecypod shells (piston core Hu 77-021-67; 82-88 cm interval; 5.2 g; **Macoma calcarea**; identified by F.J.E. Wagner). The core was obtained from a water depth of 199 m in a trough on southern Saglek Bank, locally called Karlsefni Trough, Labrador Shelf (58°48.9'N, 61°57.17'W). The enclosing sediment, part of the surficial veneer (Fillon et al., 1981), was a plastic marine mud with minor amounts of sand. The total length of the core is 600 cm. Collected August 1977 by R.H. Fillon (then Atlantic Geoscience Centre, GSC; now University of South Carolina, Columbia, South Carolina) and H. Veldhuyzen, McGill University, Montreal.[1]

Comment (R.H. Fillon): The 6050 year-old date appears to place a minimum age on the initiation of interglacial, modern-analogue shelf sedimentation and the termination of deglacial high sedimentation rates.

Comment (W. Blake, Jr.): The aragonitic shells were characterized by chalky exteriors, but one pair had some periostracum and both whole shells and fragments retained their internal lustre. The two intact pairs measured 3.7 by 2.8 cm and 3.4 by 2.6 cm. Because of the small sample size the HCl leach was omitted. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

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

GSC-2686. Labrador Shelf (II) 8380 ± 210
$\delta^{13}C = +1.4$ ‰

Marine pelecypod shells (piston core Hu 77-021-68; 608 and 617 cm; 5.7 g; **Chlamys islandicus**; identified by V. Conde, McGill University, Montreal). The shells, intact valves, were extracted from the core at two depth intervals, 607 and 618 cm. The core was recovered from 176 m of water on the northern flank of Karlsefni Trough, Labrador Shelf (58°51.61'N, 51°53.37'W). The enclosing sediment was a fine marine mud from the upper part of Unit 2 (Fillon et al., 1981). Acoustic profiles suggest that about an additional 5 m of marine mud exists between the dated shells and underlying marine "till". The total length of the core is 826 cm.

Comment (R.H. Fillon): The date suggests that active deglaciation with rapid influx of terrigenous sediment from meltwater streams was under way 8590 to 8170 years ago.

Comment (W. Blake Jr.): These two well preserved and aragonitic valves were both incomplete, but they retained their internal lustre. Both valves were at least 5 cm in height and width. HCl leach omitted because of small sample size. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Newfoundland

GSC-2985. Pouch Cove 8480 ± 90
$\delta^{13}C = -28.8$ ‰

Gyttja (sample PC 433-438; 89 g moist) from the base of a core 433 to 438 cm below the sediment/water interface in a pond known locally as "Birch Hills Gully Pond" (47°44'49"N, 52°45'31"W), south of the community of Pouch Cove and approximately 19 km north of St. John's, Newfoundland. The pond is at an elevation of 115 m; water depth, 1.73 m. Collected 1979 by J.B. Macpherson and G. Mellars, Memorial University of Newfoundland, St. John's.

Comment (J.B. Macpherson and G. Mellars): The sample appears to be the basal organic sediment since further penetration with a modified Livingstone corer was impossible. The date is a minimum for deglaciation of the site and is similar to a date on basal organic material from Pouch Cove Northeast Pond, 3 km to the north (8370 ± 100 years; GSC-2961, this list), but is younger than the basal date from Sugar Loaf Pond, 13 km to the south (9270 % 150 years; GSC-2601; GSC XVIII, 1978, p. 3). The pollen assemblage indicates a sedge-shrub tundra vegetation (Mellars, 1981). The site lies beyond Grant's (1977) late Wisconsinan ice limit. The date is too young to support the absence of late Wisconsinan ice from this area of the Avalon Peninsula. NaOH leach omitted from sample pretreatment. Date based on two 1-day counts in the 5 L counter.

GSC-3182. Oxen Pond 9440 ± 360
$\delta^{13}C = -17.3$ ‰

Diatomaceous gyttja (sample OPII: 385-390; 58.1 g wet) from near the base of a core 385 to 390 cm below the sediment/water interface in Oxen Pond on the northwestern outskirts of St. John's, Newfoundland (47°34'20"N, 52°45'50"W), at an elevation of 134 m; water depth, 1.7 m. Collected March 1978 by J.B. Macpherson.

Comment: (J.B. Macpherson): The lake occupies a rock basin; the Livingstone corer penetrated a further 20 cm in clay to a hard base. The date is a minimum for deglaciation and is similar to dates on basal organic sediment from Sugar Loaf Pond (9270 ± 150 years, GSC-2601; GSC XVIII, 1978, p. 3) 8 km to the east and Bell Island (9240 ± 190 years, GSC-3166, this list) 16 km to the west. The pollen assemblage suggests a sedge-shrub tundra vegetation. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Northeast Pouch Cove Pond Series

Northeast Pouch Cove Pond is a small (7 ha) lake in a depression with an irregular floor of blocky till or fractured bedrock, approximately 22 km north of St. John's, Newfoundland (47°47'00"N, 52°46'45"W), at an elevation of 105 m. Penetrable sediment occurs only in the southern part of the pond beneath 2.75 to 3.35 m of water and consists of gyttja overlying grey silty clay. In one location (NEP I) 17 cm of gyttja was also encountered beneath the clay. Core NEP II failed to penetrate the clay. Collected 1979 by J.B. Macpherson and G. Mellars, Memorial University of Newfoundland, St. John's.

GSC-3102. Northeast Pouch Cove Pond, Core I, 400-415 cm 7990 ± 160
$\delta^{13}C = -21.7$ ‰

Gyttja (sample NEP I 400-415; 66 g wet) overlying the clay layer in core I. Water depth 2.75 m. Sample from 400 to 415 cm below the sediment/water interface.

GSC-2920. Northeast Pouch Cove Pond, Core I, 448-453 cm 2280 ± 100

Base of lower gyttja (sample (NEP I 448-453; 50.2 g wet) in core I. Water depth 2.75 m. Sample from 448 to 453 cm below the sediment/water interface.

GSC-2961. Northeast Pouch Cove Pond, Core II, 521-526 cm 8370 ± 110
$\delta^{13}C = -21.4$ ‰

Gyttja (sample NEP II 521-526; 57.0 g moist) overlying the clay layer in core II. Water depth 3.35 m. Sample from 521 to 526 cm below the sediment/water interface.

Comment (J.B. Macpherson and G. Mellars): The site lies outside the late Wisconsinan ice limit as drawn by Grant (1977), and it was considered that the lower gyttja might be of interstadial age. The basal 5 cm of this material, however, is dated at 2280 ± 100 years (GSC-2920). The remaining 12 cm of gyttja from immediately beneath the clay layer has been dated at 7630 ± 400 years B.P. (WAT-634; Mellars, 1981). The pollen assemblages of the gyttja segments are compatible with Holocene assemblages of similar age from elsewhere on the Avalon Peninsula, and the dates are therefore considered to be correct. Since no malfunction of the Livingstone corer is suspected, the lower gyttja was probably inverted and brought to its present position by postdepositional deformation. Similar sequence are known from Norway (K. Griffin, personal communication, 1980).

The most significant date from the series is GSC-2961 (8370 ± 110 years from core II), which is a minimum for deglaciation; it is similar to a date from Pouch Cove (8480 ± 90 years; GSC-2985, this list), 3 km to the south, but is younger than a date from Sugar Loaf Pond, 16 km to the south (9270 ± 150 years; GSC-2601; GSC VIII, 1978, p. 3; Mellars, 1981). The pollen assemblage from above the clay in core II indicates a shrub-tundra transition. The dates are too young to support the absence of late Wisconsinan ice from this area of the Avalon Peninsula.

Comment (W. Blake, Jr.): The NaOH leach was omitted from the pretreatment of all three samples, and each sample was mixed with dead gas for counting. GSC-2920 and-2961 each based on one 3-day count in the 2 L counter; GSC-3102 is based on two 1-day counts in the 2 L counter.

GSC-3166. Bell Island 9240 ± 190
$\delta^{13}C = -20.9$ ‰

Clay gyttja (sample LCP 457-462; 59.0 g wet) from near the base of a core 457 to 462 cm below the sediment/water interface in Lance Cove Pond, Bell Island, Conception Bay, Newfoundland (47°36'40"N, 52°58'45"W), at an elevation of 95 m; water depth, 1.5 m. Collected October 1978 by J.B. Macpherson.

Comment (J.B. Macpherson): The lake occupies a shallow rock basin with considerable development of marginal bog. The Livingstone corer penetrated a further 20 cm in silty clay to a hard base. The date is a minimum for deglaciation and is similar to a date on basal organic sediment from Sugar Loaf Pond (9270 ± 150 years, GSC-2601; GSC XVIII, 1978, p. 3) near the Atlantic coast 24 km to the east. The pollen assemblage suggests a shrub-tundra vegetation. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-3136. Golden Eye Pond 10 100 ± 250
$\delta^{13}C = -18.9$ ‰

Clay gyttja (sample GEP 419-424; 87.1 g wet) from near the base of a core 419 to 424 cm below the sediment/water interface in Golden Eye Pond, Butterpot Provincial Park, 33 km southwest of St. John's, Newfoundland (47°23'10°N, 53°03'15"W); lake level elevation is approximately 208 m; water depth, 1.95 m. Collected March 1980 by J.B. Macpherson, Memorial University of Newfoundland, St. John's, Newfoundland.

Comment (J.B. Macpherson): The lake (3.1 ha) occupies a shallow rock basin with considerable development of marginal bog. The Livingstone corer penetrated a further 7 cm in silty clay to a hard base. The date is a minimum for deglaciation of the interior upland of the Avalon Peninsula and is older than the basal organic material from: 1) Sugar Loaf Pond (9270 ± 150 years, GSC-2601; GSC XVIII, 1978, p. 3), a coastal site 39 km to the northeast and 2) Whitbourne (8420 ± 300 years, I(GSC)-4; Isotopes I, 1961, p. 50; Terasmae, 1963), a lowland site 37 km to the west. The pollen assemblage suggests a sedge-tundra vegetation. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Burin Peninsula Series

GSC-2569. Burin Peninsula (I) 970 ± 50
$\delta^{13}C = -27.1$ ‰

Peat (sample 7-033; 39.8 g dry) collected from 1.70 m below sea level. Material partly overlain by marine sand and cobbles 0.5 km south of Little St. Lawrence, southern Burin Peninsula, Newfoundland (46°44'25"N, 55°21'35°W). Collected June 1977 by C.M.Tucker, then McMaster University, Hamilton, Ontario, now Defence Research Establishment Suffield, Ralston, Alberta.

Comment (C.M. Tucker): Peat surrounds large stumps of wood (two samples identified as **Betula sp.** and **Abies balsamea,** respectively; unpublished GSC Wood Identification Report No. 77-50 by R.J. Mott). The date is significant in that it records postglacial marine submergence along the southeast coast of Newfoundland (Tucker, 1979). Date based on two 1-day counts in the 5 L counter.

GSC-2617. Burin Peninsula (II) 1080 ± 50
$\delta^{13}C = -24.6$ ‰

Wood (sample 7-033(B); 11.7 g **Abies balsamea;** unpublished GSC Wood Identification Report No. 77-50 by R.J. Mott) obtained 1.70 m below sea level, 0.5 km south of Little St. Lawrence, southern Burin Peninsula, Newfoundland (46°55'25°N, 55°21'35"W). Wood surrounded by peat (cf. GSC-2569, 970 ± 50 years, this series) and partly overlain by marine sand and cobbles. Collected June 1977 by C.M. Tucker.

Comment (C.M. Tucker): The drowned forest from which the wood was obtained extends well below low tide level and is not exposed at high tide. The date suggests a value of 15 cm/100 years as an approximate rate of submergence for the lower Burin Peninsula (Tucker, 1979; Tucker et al., in press).

Comment (W. Blake, Jr.): In cross-section log B measured 12x5 cm. The outermost wood was removed. The remaining wedge of clean, fresh-appearing wood (wet weight 47.2 g) was oven dried. Date based on two 1-day counts in the 5 L counter.

GSC-2580. Burin Peninsula (III) 3620 ± 60
$\delta^{13}C = -24.7$ ‰

Wood (sample 7-086A; 11.9 g; probably **Picea** sp.; unpublished GSC Wood Identification Report No. 77-60 by L.D. Farley-Gill) collected from a coastal section 1.1 m above normal high tide 0.9 km south of White Point, Burin Peninsula, Newfoundland (47°11'00"N, 44°45'10"W). The sample was dug from the base of a peat section which has been cut back by the encroaching sea. The section was buried by high tide debris. Collected July 1977 by C.M. Tucker.

Comment (C.M. Tucker): Date is correlative with GSC-2569, -2617, and -2613; it is the first series to outline the pattern of postglacial isostatic-eustatic responses on the southeast coast of Newfoundland. As much as 18.8 m of uplift has occurred at the head of Fortune Bay, whereas the lower Burin Peninsula and St. Pierre and Miquelon (France) are presently submerging (Tucker, 1979; Tucker et al., in press).

Comment (W. Blake, Jr.): The sample contained two pieces of wood: A, used for dating, was identified as **Picea** or **Larix,** probably **Picea** sp.; B was identified as **Picea** sp. Some bark was still attached to both pieces. The wet wood was washed to remove adhering sticky clay-peat and then oven dried. Date based on two 1-day counts in the 5 L counter.

GSC-2613. Burin Peninsula (IV) 5360 ± 70
$\delta^{13}C = -28.3$ ‰

Peat (sample 7.056; 28.6 g dry) from 1.2 m above normal high tide 5.2 km north along the coast from Point May, southern Burin Peninsula, Newfoundland (46°55'30"N, 55°58'25"W). The peat is underlain by localized, compact, grey clay containing well rounded pebbles and is overlain by recent marine sand and gravel. Collected July 1977 by C.M. Tucker.

Comment (C.M. Tucker): The sample was obtained from the base of the peat section, and it helps document a well developed pattern of marine encroachment onto a submerging land mass in the southern Burin Peninsula.

Comment (W. Blake, Jr.): The damp peat sample (320 g) was oven dried; the weight decreased to 40.5 g and the more organic-rich part was picked out for dating (clay/silt lumps were avoided). Date based on two 1-day counts in the 5 L counter.

GSC-2685. Jacques, Fontaine, Fortune Bay — 2330 ± 50

Basal oranic lacustrine sediment (sample 7140 (94-99 cm); 85.5 g wet) obtained from the bottom of a kettle hole on the proximal side of an ice-contact delta, 0.25 m below sea level in the town of Jacques Fontaine, Fortune Bay, Newfoundland (47°31'45"N, 54°55'30"W). The core, which was taken in 5.5 m of water, bottomed in pebble gravel. The surface elevation of the kettle pond is 6.25 m. Collected with a modified Livingstone sampler in February 1978 by C.M. Tucker and D.A. Leckie, McMaster University, Hamilton, Ontario.

Comments (C.M. Tucker): It was hoped that this material would date much closer to the time of deglaciation, but the age suggests that either the kettle hole was dry for a significant period following retreat of the ice, or that subaqueous slumping buried the lower and oldest part of the peat section. Considerably older basal organic materials have been recovered from sites on the Avalon Peninsula to the east: e.g., 8420 ± 300 years, I(GSC)-4 (Isotopes I, 1961, p. 50; Terasmae, 1963); 9270 ± 150 years, GSC-2601, (GSC XVIII, 1978, p. 3); and a series of dates reported in the present list.

Comment (W. Blake, Jr.): Six samples from depths between 60 and 100 cm were analyzed for pollen; the basal 5 cm shows an assemblage dominated by **Betula** and **Abies balsamea** (unpublished GSC Palynological Report No. 78-4 by L.D. Farley-Gill). The dated organic material contained a piece of wood nearly the length of the increment. NaOH leach omitted from sample pretreatment. Date based on two 1-day counts in the 5 L counter.

Nova Scotia

GSC-2772. West Brook — 9830 ± 100

Peat (sample 19; 50.3 g dry) from a 7.5 cm-thick layer that outcrops along a stream cut just below water level, 0.5 km east of the community of West Brook, Nova Scotia (45°33.5'N, 64°17.5'W), at an elevation of <30 m. The peat lies on top of a pebble gravel, interpreted as Pleistocene outwash, and underlies approximately 120 cm of floodplain sediments that become finer upwards from sand with large wood fragments at the base to silt and clay at the top (Wightman, 1980). The sample was dated to assist in establishing the chronology of deglaciation in the area. Collected August 1977 by D.M. Wightman, then Dalhousie University, Halifax, now Alberta Research Council, Edmonton.

Comment (D.M. Wightman): The pollen spectra indicate that the deposition of the peat took place during the spruce **(Picea)** pollen maximum (unpublished GSC Palynological Report No. 79-2 by R.J. Mott). In southwestern New Brunswick, this maximum ranges in age from 10 500 to 11 500 years B.P. (Mott, 1975), whereas on Prince Edward Island it is younger than 9500 years B.P. (Anderson, 1980); thus the date of 9830 years B.P. is realistic. A sample (76-2) of the same peat layer, but from a more basal position, yielded a date of 13 365 ± 420 years B.P. (DAL-300; Wightman, 1980 and a split of the same sample contained a tundra type pollen assemblage (unpublished GSC Palynological Report No. 78-11 by R.J. Mott). Sample 76-2 was expected to be older than 9830 years but the gap between DAL-300 and GSC-2772 is larger than anticipated; therefore the older date must be viewed with caution. Further dating of the peat should be carried out only after careful examination of the peat because of the possibility of contamination from the underlying coal-bearing Carboniferous bedrock.

Comment (W. Blake, Jr.): The basal 0.5 cm of peat was utilized for GSC-2772. Pebbles were removed from the sample after drying in an electric oven. Cones in the peat were identified as **Picea glauca** (unpublished GSC Wood Identification Report No. 79-8 by R.J. Mott). Date based on one 2-day count in the 5 L counter.

GSC-2730. Wards Brook — 4390 ± 70, $\delta^{13}C = -29.3$ ‰

Gyttja (sample Wards Brook 107-112; 53.8 g wet) from a kettle pond situated on the top of the outwash delta at Wards Brook, Nova Scotia (45°24.8'N, 54°33.4'W). The pond elevation is <30 m; water depth, 1.75 m. Only 122 cm of gyttja was cored before an impenetrable green pebbly clay was encountered; the sample comes from near the base of the gyttja. The pond was cored in hopes of obtaining a date from early postglacial sediments that would closely approximate the age of the outwash. Collected July 1978 by D.M. Wightman.

Comment (D.M. Wightman): The date indicates that the gyttja at the base of the core is relatively recent and is therefore not related to the timing of deglaciation. The date may be a good estimate of the age of the pebbly clay at the base of the core or, alternatively, the date may reflect animal-induced reworking or contamination of the thin gyttja layer. A slightly different and younger age of 3330 ± 178 years (DAL-315) was obtained for the gyttja just below (117-122 cm) this sample (Wightman, 1980).

Comment (W. Blake, Jr.): The outside of the 5 cm-long core increment was scraped clean, and several pebbles were removed. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

New Brunswick

GSC-2628. Gibson Lake, 344-349 cm — 7900 ± 120, $\delta^{13}C = -29.9$ ‰

Basal organic sediment (sample TB-68-32; 17.5 g dry) from Gibson Lake, a lake in a bedrock basin confined at the southeast end by a moraine (?). The lake is located 10.5 km north of St. Andrews, New Brunswick (45°10'15"N, 67°05'00"W), at an elevation of 36 m. Cores were obtained with a Livingstone sampler in 6 m of water; 349 cm of algal gyttja and silty gyttja overlies slightly organic silty clay to 366 cm. Below this is grey clay to a depth of 584 cm which grades into grey silt and sand. Collected 1968 by J. Terasmae, now Brock University, St. Catharines, and R.J. Mott.

Comment (R.J. Mott): The sample was dated to provide a minimum age for emergence for the basin from the sea. A study of microfossils by Scott and Medioli (unpublished Progress Report to the Department of Energy, Mines and Resources on Research Agreement 2239-4-31/78 entitled "Studies of relative sea level changes in the Maritimes", 79 p., Dec. 1978) indicated that marine conditions existed during the deposition of sediment from 491 to 445 cm, transitional conditions were represented by the sediment between 435 and 355 cm, and freshwater conditions prevailed during the deposition of sediment from 345 cm to the surface. However, the date differs considerably from one obtained on nearby Lower Power Line Lake–GX-5364 (6340 ± 340 years, on the first freshwater interval at 604 to 606 cm depth in the sediment; Scott and Medioli, 1980)–and more work is required to resolve the difference as both lakes are at the same elevation. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Quebec

GSC-2871. Daveluyville 11 400 ± 90
$\delta^{13}C = -16.3$ ‰

Sample of bone (sample CR-78-21; 760 g) cored from a vertebra of a common finback whale (**Balaenoptera physalus**, identified by R. Kellogg (Smithsonian Institution, Washington, D.C.; cf. Sternberg, 1951) excavated from a fresh trench in marine clay containing abundant marine mollusc shells (**Hiatella arctica, Mytilus edulis, Mya truncata, Portlandia arctica, Astarte** sp., and **Buccinum undatum**), 3.6 km southwest of Daveluyville, Quebec (46°10.5'N; 72°10'W), at an elevation of approximately 85 m. The vertebra, kindly offered for sampling by J. Huot, Université Laval, Québec, was originally part of a nearly complete skeleton collected by M. and A. Soucy, Daveluyville (Laverdière, 1950; Harington, 1977, 1980). Most of the original skeleton is preserved in the Archaeological Museum at Université du Québec à Trois Rivières (R. Ribes, personal communication, 1979). Submitted 1978 by C.R. Harington, National Museum of Natural Sciences, Ottawa.

Comment (C.R. Harington): Common finback whales are 18.3 to 25 m long and weigh between 36 and 63 tonnes. They are presently known from the Gulf of St. Lawrence – one even penetrated as far up St. Lawrence River as Montreal in 1901. This radiocarbon date is in accord with the only other date on a large Champlain Sea whale – a bowhead (**Balaena mysticetus**) from White Lake, Ontario, dated at 11 500 ± 90 years old (GSC-2269; Harington 1977, 1980; GSC XIX, 1979, p. 13). These dates suggest that common finback and bowhead whales occupied the Champlain Sea about 11 500 years ago – at least during its early cold phase. Date based on one 3-day count in the 5 L counter.

GSC-2664. Montréal 10 700 ± 140
$\delta^{13}C = -2.1$ ‰

Marine shells (sample 14A5; 27.6 g; **Macoma balthica**; identified by W. Blake, Jr.) from a coquina-like bed, with associated sand and coarse granules, exposed during excavations for a shopping centre in 1951, on the northeast corner of d'Ibervile and Masson Streets, in the eastern end of Montréal, Quebec (45°32.5'N, 73°34"W), at an elevation of 52 m. The exposures revealed about 0.3 m of disturbed fill and soil overlying 1.2 m of moderately fossiliferous sand, a 0.2 m-thick shell-rich bed, 0.9 to 1.4 m of grey, clay-silt-boulder till, and Trenton-age limestone. As the shell-bearing bed is close to the postulated 43 m lower limit of the Champlain Sea at this location (the saltwater/freshwater transition), it was believed that radiocarbon analysis would provide a near-minimum date on the demise of the sea. Collected 1951 and submitted 1978 by V.K. Prest.

Comment (V.K. Prest): The age of this sample is in good agreement with dated shells from gravels overlapping an esker south of Montréal. The latter, at an elevation of 43 m, gave an age of 10 450 ± 80 years (GrN-1696; Elson, 1969), although the disappearance of the sea from this area is thought to have occurred about 10 000 years ago.

Comment (W. Blake, Jr.): The 226 valves utilized were nearly all whole, with good internal lustre. They were determined by X-ray diffraction to be aragonitic and nearly all retained traces of the periostracum. The shells ranged in size from 2.0 by 1.8 cm (length x height) to 0.65 by 0.55 cm (smallest intact pair). Date based on one 3-day count in the 2 L counter.

GSC-2932. Pointe-Fortune >42 000

Wood fragments (sample GB-79-5; 38.9 g) from a sand and gravel borrow pit near Pointe-Fortune, Quebec (45°32'30"N, 74°23'20"W) at the Quebec-Ontario boundary and at an elevation of 45 m (based on topographic map). Exposed in the working face were 3 m of oxidized sandy silty till overlying 6 m of stratified, crossbedded sand with some silt bands, probably of fluvial origin. The dated material came from a lower level; transport-worn fragments of wood in relatively massive silty sand rich in disseminated organic matter were exposed by a backhoe excavation into the floor of the pit, below the local water table. Because of compression and distortion, the wood has not been identified to species, but the sample contains both coniferous and deciduous species (unpublished GSC Wood Identification Report 79-31 by L.D. Farley-Gill). Collected 1979 by N.R. Gadd.

Comment (N.R. Gadd): This discovery is the first known occurrence of pre-last-glacial organic remains in the Ottawa-St. Lawrence Lowland west of Lac St. Pierre where the St. Pierre peat beds occur (Gadd, 1971). Gadd et al. (1981) suggest a tentative correlation of the Pointe-Fortune materials with the presumed early Wisconsin (St. Pierre) interstadial sediments (cf. Stuiver et al. (1978), where a date of 74 700 $^{+2700}_{-2000}$ years (QL-198) is reported). Because of the limited size of this initial sample, the result is only >42 000 years, a figure that does not represent the full capability of the GSC laboratory (greater ages can be obtained when the 5 L counter is operated at 4 atmospheres). Thus, at present, a more positive correlation with other sites is not possible.

Bulk samples of organic-rich sediment collected at the same time as the dated material are slated for further paleoecological and possible geochronological analysis at the GSC, along with other organic materials collected on a different occasion and from other parts of the section. In addition, further sampling is planned. Date based on one 3-day count in the 5 L counter.

Ontario

GSC-3235. Vankleek Hill 10 300 ± 90

Freshwater bivalve shells (sample RAB-80-21; 48.0 g; **Lampsilis radiata** (Gmelin) **s. lat.**, identified by M.F.I. Smith, National Museum of Natural Sciences, Ottawa) from sand and gravel in a borrow pit excavated into an abandoned channel of the ancestral Ottawa River 4.2 km northwest of Vankleek Hill, Prescott County, Ontario (45°32'40"N, 74°41'35"W), at an elevation of about 61 m. Collected 1980 by S.H. Richard.

Comment (S.H. Richard): GSC-3235 is the second ^{14}C date obtained from alluvial deposits found in the now abandoned southern channel of the early Ottawa River. This channel was cut into marine sediments of the Champlain Sea between Ottawa and Hawkesbury via Bourget and Vankleek Hill. the radiocarbon age of 10 300 ± 90 years (GSC-3235) obtained for freshwater **Lampsilis** sp. shells in this eastern part of the channel correlates well with the age of 10 200 ± 90 years (GSC-1968) obtained by Gadd for similar freshwater **Lampsilis** sp. at an elevation of about 53 m near Bourget in the western part of the channel (Gadd, 1976; GSC XVI, 1976, p. 6).

Comment (W. Blake, Jr.): A somewhat younger date on **Lampsilis siliquoidea** has been obtained from a sample collected at 47 m southeast of Saint-Stanislas-de-Kostka, Quebec. The sample at that site (GSC-2414, 9750 ± 150 years old) is on shells in Lampsilis Lake sand overlying marine silty clay (Richard, 1978; GSC XIX, 1979,

p. 10). The shells comprising GSC-3235 were determined by X-ray diffraction to be aragonitic. Date based on one 3-day count in the 2 L counter.

Western Canada

Manitoba

GSC-2294. Nelson River 7030 ± 170

Marine shells (sample KJ-2-71; 6.2 g; **Hiatella arctica**; identified by W. Blake, Jr.) from the sandy clay surface unit (1 to 2 m thick over this part of the Hudson Bay Lowland) at the mouth of Limestone River at Upper Limestone Rapids, Nelson River, Manitoba (56°31'N, 94°05'W), at an elevation of approximately 90 m. Collected 1971 by R.W. Klassen.

Comment (R.W. Klassen): The sample is slightly younger than dated shells from the same unit along Hayes River (7570 ± 140 years, GSC-878) at an elevation of 114 m, and it overlaps in age with a dated shell sample from 140 m along Churchill River (7270 ± 120 years, GSC-92; both in Craig, 1969). Marine inundation of the Lowland along Nelson River likely occurred about 7500 years ago.

Comment (W. Blake Jr.): **Mya truncata** also occurred in the sample, but only **Hiatella arctica** was used for dating. The latter species comprised whole shells (up to 2.5 cm long) and fragments. All pieces were chalky on the exterior, some retained internal lustre, and the shells were aragonitic. HCl leach omitted because of the small sample size. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Alberta

GSC-2347. Onefour 80 ± 50

Wood (sample 75-01; 11.2 g; **Populus** sp; unpublished GSC Wood Identification Report No. 75-85 by R.J. Mott) from the bank of Milk River 16 km south-southwest of Onefour, Alberta, 24 km west of Wildhorse Customs Station and just north of the United States border, in SE¼ of sec. 4, tp. 1, rge. 5, W 4th Mer. (49°00'10"N, 110°37'W), at an elevation of 840 m. The wood came from a vertical stump nearly 1 m long and 40 cm in diameter, embedded in colluvial and floodplain sand and clay and rooted in river sand. The stump, which was later covered by 1 m of colluvial and alluvial clay, came from 2 m above the normal level of Milk River. Collected 1975 by R.W. Barendregt of Picture Butte, Alberta; submitted by A. MacS. Stalker.

Comment (A. MacS. Stalker): The wood is much younger than the more than 500 year-age that had been anticipated. The log probably was buried, chiefly by slope-wash debris, as the river meandered away from the site towards the far side of its valley.

Comment (W. Blake, Jr.): All outside wood was cut away from the clean, dry sample. Date based on two 1-day counts in the 5 L counter.

GSC-2256. Kipp 650 ± 50
$\delta^{13}C = -20.2$ ‰

Bison bone (sample SF-74-191; 431 g; identified by C.S. Churcher, University of Toronto, Toronto) from Ponomar gravel pit on the northeast side of Oldman River in SW¼ of sec. 26, tp. 9, rge. 23, W 4th Mer. (49°45'40"N, 113°01'20"W), about 13 km west-northwest of Lethbridge and 4 km west-southwest of Kipp, Alberta. The bones were at an elevation of approximately 860 m in the poorly sorted sand and gravel of the second terrace above Oldman River, and 1 to 3 m below the surface of that terrace. The terrace base is 7 m above the normal river level and its top, 10 m. Collected August 1974 by G. and R. Ponomar of Magrath, Alberta; submitted by A. MacS. Stalker.

Comment (A. MacS. Stalker): The bone is substantially younger than the previously estimated age of 3000 years, and the young date indicates a fairly recent rejuvenation of Oldman River, with deepening of its valley, after it had incised to near its present grade. Such rejuvenation is further indicated by decreased meandering of the river in recent time. The cause of this rejuvenation is not know.

Comment (W. Blake, Jr.): Pretreatment of the bone included 3N HCl until effervescence stopped and 0.1N NaOH for one hour. Utilizing the KOH method (Lowdon et al., 1977) 40 g of collagen produced 35.5 cm of CO_2. Date based on two 1-day counts in the 5 L counter.

British Columbia

Granite Mountain Series

GSC-1833. Granite Mountain (I) 11 300 ± 110
$\delta^{13}C = 0.0$ ‰

Basal marl (sample GM 2; 93.5 g wet) from 215 to 220 cm below the surface of a subalpine bog on the north flank of Granite Mountain, 9.6 km south of Birch Island, British Columbia (51°30'N, 119°55'W), at an elevation of 1950 m. The bog occupies a small depression in hummocky moraine. Collected August 1972 with a Hiller peat corer by N.F. Alley, then under contract to the Geological Survey of Canada, now with the Soil Conservation Authority, Kew, Victoria, Australia. Comment (N.F. Alley): This date provides a minimum age for the underlying moraine and for the deglaciation of the southern end of Cariboo Mountains at this elevation (Alley, 1980). The date also provides time control for a pollen diagram being constructed for this site. Date based on one 3-day count in the 5 L counter.

GSC-1833-2. Granite Mountain (II) 9650 ± 110
$\delta^{13}C = -27.0$ ‰

Peat fragments (sample GM 2; 9 g burned) separated from the basal marl (215 to 220 cm depth) used for GSC-1833.

Comment (N.F. Alley): The difference in age between GSC-1833 and -1833-2 is difficult to understand. Dates made on similar mixed materials in the same age range (GSC-1994 and GSC-1994-2; GSC-2036 and GSC-2036-2, unpublished) showed differences of only a few hundred years. In the case of GSC-1833-2, fluid peat may have leaked down the edges of the core barrel from younger horizons above, contaminating the sample. The correct age probably lies around 11 000 years B.P. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-1996. Granite Mountain (III) 3960 ± 80

Peat (sample GM 1; 78 g dry) from 170 to 180 cm depth in the peat core, at the same location as GSC-1833.

Comment (N.F. Alley): This date fixes the age of a level in the pollen diagram being drawn up for the core at this site. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 5 L counter.

GSC-2842. Aldergrove 11 700 ± 120

Detrital wood (sample FAB185W; 11.7 g; **Pinus** sp., probably **Pinus contorta** var. **latifolia**; unpublished GSC Wood Identification Report No. 79-20 by R.J. Mott) from a bore-hold 700 m north of Fraser Way at Aldergrove, near 272nd Street, British Columbia (49°03'50"N, 122°28'12"N), at an elevation of 87 m. The sample is from a glaciomarine stony silty clay. Collected 1978 by E.C. Halstead, Environment Canada, Vancouver; submitted by J.E. Armstong.

Comment (J.E. Armstong): The material at the surface (elevation 104 m) at this site was mapped as Fort Langley glaciomarine sediments. The date confirms the fact that the Fort Langley glaciomarine sediments in this area are at least 17 m thick. Shells from a glaciomarine stony clayey silt exposed 4 km to the northwest were dated at 11 680 ± 180 years B.P. (GSC-186; GSC IV, 1965, p. 35). These dates help confirm the large areal extent of the Fort Langley Formation.

Comment (W. Blake, Jr.): This damp piece of wood measured 42 by 8 cm, but it was broken at both ends during sampling. Bark was still present in places. An inner section comprising six annual rings was cut out for dating. The correspondence between the age of wood and of marine shells from the same formation is extraordinarily close. Date based on one 2-day count in the 5 L counter.

Boundary Road Series

Fluvial sediments were exposed below Vashon till in a new Highway cut along Boundary Road which forms the boundary between the cities of Vancouver and Burnaby, British Columbia. The collection sites are near Southeast Marine Drive (49°12.5'N, 123°01.3'W). The section is about 20 m thick and beneath the Vashon till consists of approximately 10 m of medium sand overlying approximately 10 m of horizontally bedded silt and sand with wood layers. The two units appear to be separated by an unconformity; wood samples were collected from both units. Collected June 1980 by S.R. Hicock, University of Western Ontario, London, and J.E. Armstrong.

GSC-3101. Boundary Road (I) >42 000

Wood (sample FAB200W(A); 12.4 g; **Tsuga** sp; unpublished GSC Wood Identification Report No. 80-19 by L.D. Farley Gill). The sample was collected from 43 m elevation, immediately above the contact between the two units described above.

Comment (J.E. Armstrong): The sand from which this sample was obtained was thought to be Quadra Sand, but unless the wood was rafted into place it is too old for Quadra (cf. Armstrong and Clague, 1977). Consequently the sand is tentatively correlated with Cowichan Head Formation.

GSC-3083. Boundary Road (II) >39 000

Wood (sample FAB198W; 12.6 g; **Tsuga** sp.; unpublished GSC Wood Identification Report No. 80-19 by L.D. Farley-Gill). The sample, at 34 m elevation, is from the base of the section exposed, i.e., from the lower of the two units described above.

Comment (J.E. Armstrong): The silt and sand from which this sample was obtained was thought to be part of the Cowichan Head Formation. The "greater than" date makes the conclusion somewhat tentative but does not prove that the correlation is not the best; cf. GSC-3290 (Lynn Canyon series, 47 800 ± 1100 years; this list) a determination on a sample which is definitely from the Cowichan Head Formation. Throughout Fraser Lowland a fairly large number of radiocarbon determinations have been attempted on material thought to be part of the Cowichan Head Formation, but many of the samples have proved to be beyond the range of the method (at least when dated at normal pressure).

Comment (W. Blake, Jr.): Both age determinations were on single pieces of wood (both wet at time of submission). The wood used for GSC-3083 measured 36x9x2.5 cm; its weight decreased from 714 to 215 g upon drying in an electric oven. GSC-3101 measured 23.5x9.5x7.5 cm (all rounded corners), and its weight decreased from 800 to 330 g upon drying. Each date based on one 3-day count in the 5 L counter.

Cowichan Head Series in Lynn Canyon

Nonglacial organic sediments exposed in the west bank of Lynn Creek, in Lynn Canyon Park, 2 km northeast of Lynn Valley, British Columbia (49°20'40"N, 123°01'10"W). The specimens were obtained from compressed organic sediments (peat) overlying till (age unknown) and underlying sand (age unknown). The compressed organic sediments are 85 cm thick and form two layers 55 and 30 cm thick separated by 2 cm of sand. The 55 cm-thick layer is at the base of the section and is underlain by 2 cm of silt which separates it from a lodgment till lying on granitic bedrock.

GSC-2793. Lynn Canyon (I) 33 000 ± 620

Peat (sample FAB196W; 137 g moist) at approximately 116 m. The sample is from the top of the 30 cm-thick upper layer of organic sediments overlain by sand of unknown age.

GSC-2873. Lynn Canyon (II) 34 900 ± 810

Wood (sample FAB193W; 11.6 g; **Abies** sp.; unpublished GSC Wood Identification Report. No. 79-28 by R.J. Mott) approximately 30 cm below sample GSC-2793. The sample is from the base of the 30 cm-thick upper layer of organic sediments.

GSC-2726. Lynn Canyon (III) >39 000

Wood (sample FAB192W; 11.8 g; **Tsuga** cf. **heterophylla**; unpublished GSC Wood Identification Report No. 78-37 by R.J. Mott) at an elevation of approximately 115 m from near the base of the lower 55 cm-thick layer of organic sediments. The organic sediments are separated from the underlying till by 2 cm of silt.

GSC-3290. Lynn Canyon (IV) 47 800 ± 1100

Wood (sample FAB201W; 45.5 g; **Tsuga** cf. **heterophylla**; unpublished GSC Wood Identification Report No. 81-22 by R.J. Mott) from exactly the same level and site at which GSC-2726 was collected.

Comment (J.E. Armstrong): The above four dates, together with GSC-93 (36 200 ± 500 years; GSC II, 1963, p. 48), which was from the 55 cm-thick lower layer of organic sediments, indicate that at this site the organic sediments of the Cowichan Head Formation range in age from 33 000 ± 620 to 47 800 ± 1100 years. These dates indicate that the deposition of organic sediments at this site took place over a period of 13 000 years or more. A Cowichan Head parastratotype has been designated on the Upper Levels Highway immediately west of Lynn Creek (49°19'N, 123°03'W). This parastratotype section is approximately 3 km southwest at an elevation of approximately 100 to 110 m. Three dates have been obtained from the parastratotype, namely I(GSC)-214 at 32 200 ± 3300 years (Isotopes II, 1962, p. 35-36), GSC-2394 at >39 000 years, and GSC-2394 at >54 000 years (both in GSC XIX, 1979, p. 22).

Comment (W. Blake Jr.): The wet wood (37x9x4 cm) used for GSC-2726 was cut from a large trunk. During drying in an electric oven the weight decreased from 447 to 161 g. For GSC-2873 only the largest (13x6x5 cm) of three pieces of wood was used for dating. The outer part of this dry dense wood was lignitized. In the preparations of both samples the outer wood was cut away. For GSC-3290, also, only a single piece of wood (out of a collection of several pieces) was used for dating. GSC-2793 and -2873 each based on one 3-day count in the 5 L counter; GSC-2726 based on one 4-day count in the 5 L counter; GSC-3290 based on one 5-day count in the 5 L counter at 4 atmospheres.

Gold River Series

Wood samples from a river exposure on Muchalat River, Vancouver Island, British Columbia, (49°50'40"N, 126°07'W). The samples were collected by D.E. Howes, Terrestrial Studies Branch, Ministry of Environment, Province of British Columbia, Victoria, and J.J. Clague.

GSC-2591. Gold River (I) 40 900 ± 2000

Wood (sample GR 6; 11.7 g; **Abies** sp; unpublished GSC Wood Identification Report No. 77-63 by L.D. Farley-Gill) at an elevation of 185 m. The sample was collected from a silty diamicton mudflow deposit, approximately 2 m thick. The mudflow deposit overlies, in succession, 3 m of glaciolacustrine silts and 1 to 2 m of till, and is overlain in turn by 4 to 6 m of wood-bearing outwash sand and gravels (from which both GSC-2764 and -2828 were obtained), 4 to 6 m of till, and approximately 14 m of recessional outwash sands and gravels (Howes, 1981). Collected August 1977 by D.E. Howes.

Comment (D.E. Howes): The date indicates that the lower till and glaciolacustrine sediments are older then 40 900 ± 2000 years B.P. The dated mudflow deposit represents the only Olympia nonglacial interval sediment documented on north-central Vancouver Island (Howes, 1981).

GSC-2764. Gold River (II) 35 400 ± 880

Wood (sample GR 6; 11.9 g; **Abies** sp; unpublished GSC Wood Identification Report No. 78-47 by R.J. Mott) from the wood-bearing outwash sand and gravels detailed above (see GSC-2591, this series) at 190 m. Collected September 1978 by D.E. Howes and J.J. Clague.

GSC-2828. Gold River (III) >36 000

Wood (sample GR-6a; 10.9 g; **Abies** sp; unpublished GSC Wood Identification Report. No. 79-17 by L.D. Farley-Gill) from the wood-bearing outwash sand and gravels detailed above (see GSC-2591, this series) at an elevation of 187 m. Collected August 1978 by D.E. Howes and J.J. Clague.

Comment (D.E. Howes): Both pieces of wood dated from the outwash gravels and sands are believed to have been reworked and redeposited; thus, they do not reflect the age of this deposit. This interpretation is supported as the age of GSC-2764 (35400 ± 880 years) falls within the Olympia nonglacial interval established on southern Vancouver Island and in the Fraser Lowland by Armstrong and Clague (1977), and this age is incompatible with the outwash origin of the gravels (Howes, 1981).

Comment (W. Blake, Jr.): GSC-2591 based on one 3-day count in the 5 L counter; GSC-2764 and -2828 each based on one 4-day count in the 5 L counter.

GSC-2594. Woss Camp 25 200 ± 330

Wood (sample W-1; 11.9 g; **Abies** sp; unpublished GSC Wood Identification report No. 77-64 by L.D. Farley-Gill) from a river bulff on Nimpkish River, 3.8 km southeast of Woss Camp, Vancouver Island, British Columbia (50°11'15"N, 126°34'20°W), at an elevation of 164 m. The sample was collected from a glaciolacustrine silt, 6 to 9 m thick, overlain by 1 to 2 m of outwash gravels which in turn are overlain by 12 to 15 m of till. Collected 1977 by D.E. Howes, Terrestrial Studies Branch, Ministry of Environment, Province of British Columbia, Victoria.

Comment (D.E. Howes): The sample was deposited in a proglacial lake during the advance stage of Fraser Glaciation ice. The local stratigraphy and age of the sample indicate that glacial conditions (Fraser Glaciation) were well established on north-central Vancouver Island prior to 25 200 ± 330 years ago (Howes, 1981).

Comment (W. Blake, Jr.) After removal of the enclosing clayey silt, a portion of the largest piece (70 cm long) of damp wood (239 g wet, 124 g dry) was utilized for dating. The wood was hard and brittle and was characterized by a sulphurous odour. Date based on one 3-day count in the 5 L counter.

GSC-2435. Artlish River 8300 ± 70

Wood (sample Artlish Site #1; 11.2 g; **Abies** sp; unpublished GSC Wood Identification Report No. 76-65 by L.D. Farley-Gill) from a river bluff on Artlish River, 7.6 km south of Wolfe Lake, northern Vancouver Island, British Columbia (50°08'20"N, 126°53'30"W), at an elevation of 285 m. The sample was collected from the lowest wood bed in a unit consisting of alternating beds of (1) black clayey silt with organic detritus and (2) wood fragments surrounded by coarse sand, approximately 3.4 m above the level of Artlish River. The unit overlies 2 m of laminated glaciolacustrine silts and is unconformably overlain by approximately 6 m of fluvial sands and gravels. Approximately 1 km downstream from the site, the present day Artlish River plunges underground into a karst drainage system. Collected 1976 by D.E. Howes and J. Senyk, Terrestrial Studies Branch, Ministry of Environment, Province of British Columbia, Victoria.

Comment (D.E. Howes): The lower laminated silts are thought to represent glacial lake sediments deposited during the deglaciation stage of Fraser Glaciation on northern Vancouver Island. With the disappearance of the ice, however, the lake did not drain as downstream flow was impeded by a continuous rock ridge and the karst drainage system was probably plugged with glacial drift. This interval was characterized by lake infilling and periodic inundation during which the wood sample (GSC-2435) was deposited. A period of fluvial aggradation followed, and the date implies that fluvial erosion in the upper Artlish did not commence until well after 8300 years ago. Macroflora from the dated wood-bearing bed strongly suggests that the climate was warmer and drier than that at present (Howes, 1981).

Comment (W. Blake, Jr.): The dated sample is from the single largest piece (29 cm long, 4.5 cm in diameter) of wood, which was submitted wet and then dried in an electric oven; the weight decreased from 354 to 104 g. After removal of the bark, approximately the outer 23 rings were used for dating. Date based on one 3-day count in the 5 L counter.

Northern Canada, Mainland and Offshore Islands

Yukon Territory

Tom Creek Series

Samples were taken from an intertill, organic-rich silt (Klassen, 1978) exposed in the bank of Tom Creek about 1.6 km west of the Robert Campbell Highway and 16 km north of Watson Lake airport, Yukon Territory (60°13'45"N, 129°00'25"W), at an elevation of approximately 670 m. Collected 1978 and 1979 by R.W. Klassen.

GSC-2811. Tom Creek (I) 23 900 ± 1140

Fragile bits of twigs (sample KJ-27-78; 1.5 g) from the upper zone of the 2.5 m-thick silt unit.

GSC-2949. Tom Creek (II) >30 000

Fragile bits of twigs (sample KJ-40-79; 3.0 g) at the base of the silt unit. The "fragments are too compressed and decomposed to obtain an accurate identification" (unpublished GSC Wood Identification Report No. 79-49 by R.J. Mott).

Comment (R.W. Klassen): The organic-rich silt unit appears to be an interstadial deposit of mid-Wisconsin age that was covered by till during the Late Wisconsin glaciation of the Liard Plain. Plant and insect fossils within the silt (unpublished GSC Palynological Report No. 80-4 by R.J. Mott; unpublished GSC Plant Macrofossil Report No. 80-8, 80-11, and unpublished GSC Fossil Arthropod Report No. 80-5, all by J.V. Matthews, Jr.) appear to reflect a tundra environment in contrast to the boreal forest environment that has prevailed for the past 10 000 years. Paleomagnetic measurements show the characteristic magnetization to be of a single component and well represented by the direction of the remanent magnetization. Lack of an established paleomagnetic scale for terrestrial Pleistocene deposits in North America, however, precludes verification of the radiocarbon dates at this time.

Comment (W. Blake, Jr.): For GSC-2811, 26 twig fragments were used; the largest was 3.7 cm long and 5x33 mm in cross-section. Adhering clay and silt were removed. The pieces of wood used for GSC-2949 were of the same size, and some exhibited flattening. In both collections some bark remained and the corners and edges were not rounded or worn-appearing. Both samples mixed with dead gas for counting. Each date based on one 3-day count in the 2 L counter.

Lake Alsek Series

Driftwood, charcoal, and soil were dated in order to establish a chronology for Neoglacial Lake Alsek, a former glacier-dammed lake in southwestern Yukon Terriroty. Lake Alsek formed repeatedly during the last 2900 years when Lowell Glacier, a large valley glacier in the St. Elias Mountains, advanced across Alsek valley and blocked south-flowing Alsek River. The lake extended east of the front of the St. Elias Mountains and inundated parts of Dezadeash valley which are presently populated. At its maximum, Lake Alsek was about 200 m deep at the glacier dam and more than 100 km long. Staircase flights of beaches, wave-cut benches, layers of driftwood, and thin lacustrine sediments provide evidence of the former lake (Clague, 1979; Rampton, 1981; Clague and Rampton, in press).

Historical records, radiocarbon and tree-ring dates on driftwood, and radiocarbon dates on buried soils separating lacustrine units indicate that Lake Alsek extended into Dezadeash vally sometime between A.D. 1848 and 1891 (upper limit of this lake, 595 m elevation), between A.D. 1736 and 1832 (623 m elevation), twice between 250 and 500 years ago (637 and 640 m elevation), and at least once between 800 and 2900 years ago (approximately 678 m elevation). In addition, a small lake may have existed in Alsek valley after 1891, but before 1917, although the evidence for this is equivocal.

GSC-2831. Alsek Valley modern

Crudely carved wooden paddle (sample CIA-78-101-2; 11.8 g; **Picea** sp; unpublished GSC Wood Identification Report No. 79-16 by L.D. Farley-Gill) from an accumulation of driftwood on a beach on the west wall of Alsek valley, 21 km north-northeast of Lowell Glacier and 35 km southwest of Haines Junction, Yukon Territory (60°28.3'N, 137°49.1'W), at an elevation of approximately 561 m. The driftwood layer in which the paddle was found is 28 m above the adjacent floor of Alsek valley. The dated material consisted of 17 annual rings from the shaft (3.7 cm in diameter) of the paddle; there were an additional 12 rings between the outermost dated ring and the weathered surface of the paddle. Collected 1978 by J.J. Clague.

GSC-2822. Dezadeash Valley, "Big Bend" (I) modern

Wood (sample CIA-78-133; 11.7 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 79-14 by L.D. Farley-Gill) from a driftwood layer on a beach on the north wall of Dezadeash valley near the front of the St. Elias Mountains, 13 km west of Haines Junction, Yukon Territory (60°46.2'N, 137°44.1'W), at an elevation of approximately 623 m, 48 m above the adjacent valley floor. Dated material consisted of 20 annual rings. Collected 1978 by J.J. Clague.

GSC-2149. Dezadeash Valley, "Big Bend" (II) 60 ± 40
$\delta^{13}C = -24.3$ ‰

Wood (sample ROA-8A-137-7); 10.7 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 75-9 by L.D. Farley-Gill) from a driftwood layer on a beach on the north wall of Dezadeash valley near the front of the St. Elias Mountains, 13 km west of Haines Junction, Yukon Territory (60°46.2'N, 137°44.1'W), at an elevation of approximately 623 m, 48 m above the adjacent valley floor. Collected 1974 by V.N. Rampton, Terrain Analysis and Mapping Services Ltd., Carp, Ontario.

GSC-2779. Dezadeash Valley, "Big Bend" (III) 120 ± 50
$\delta^{13}C = -24.4$ ‰

Wood (sample (CIA-78-132-1; 11.6 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 78-57 by R.J. Mott) from a driftwood layer on a beach on the north wall of Dezadeash valley near the front of the St. Elias Mountains, 14 km west of Haines Junction, Yukon Territory (60°45.2'N, 137°45.4'W), at an elevation of approximately 595 m, 20 m above the adjacent valley floor. Dated material consisted of 17 annual rings; there were an additional 20 rings between the outermost dated ring and the weathered surface of the driftwood. Collected 1978 by J.J. Clague.

GSC-2133. Beachview Creek (I) 60 ± 50
$\delta^{13}C = -22.3$ ‰

Wood (sample 90ROA; 6.2 + 5.0 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 74-64 by L.D. Farley-Gill) from a driftwood layer on a beach on the east wall of Alsek valley at Beachview Creek, 19 km southwest of Haines Junction, Yukon Territory (60°39.0'N, 137°46.5'W), at an elevation of approximately 595 m, 20 m above the adjacent valley floor. Dated material consisted of less than 10 annual rings. Collected 1974 by V.N. Rampton.

GSC-2132. Beachview Creek (II) 180 ± 50

Wood (sample 88ROA; 7.1 + 5.1 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 74-65 by L.D. Farley-Gill) from a beach on the east wall of Alsek valley at Beachview Creek, 19 km southwest of Haines Junction, Yukon Territory (60°39.0'N, 137°46.5'W), at an elevation of approximately 640 m, 65 m above the adjacent valley floor. Dated material consisted of 10 to 15 annual rings, from the outer 2.5 cm of a large log. Collected 1974 by V.N. Rampton.

GSC-2100. Beachview Creek (III) 370 ± 60
$\delta^{13}C = -25.0$ ‰

Wood (sample 89R0A; 10.7 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 74-41 by L.D. Farley-Gill) from a beach on the east wall of Alsek valley at Beachview Creek, 19 km southwest of Haines Junction, Yukon Territory (60°39.0'N, 137°46.5'W), at an elevation of approximately 633 m, 58 m above the adjacent valley floor. Dated material consisted of less than 30 annual rings from the outer 1.5 cm of a large log. Collected 1974 by V.N. Rampton.

GSC-2958. Bear Creek 140 ± 60

Wood (sample 6RY; 11.2 g; **Juniperus** cf. **communis**; unpublished GSC Wood Identification Report No. 81-43 by R.J. Mott) from a beach 400 m east of Bear Creek, 10 km northwest of Haines Junction, Yukon Territory (60°47.9'N, 137°40.0'W), at an elevation of approximately 670 m. Collected 1979 by V.N. Rampton.

GSC-2952. Dezadeash River (I) 270 ± 50
$\delta^{13}C = -24.6$ ‰

Wood (sample CIA-78-143-2; 11.9 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 79-46 by R.J. Mott) from a driftwood layer on a beach north of Dezadeash River, 21 km east-northeast of Haines Junction, Yukon Territory (60°50.4'N, 137°09.7'W), at an elevation of approximately 636 m, 13 m above the adjacent valley floor. Dated material consisted of about 25 annual rings. Collected 1978 by J.J. Clague.

GSC-2818. Dezadeash River (II) 410 ± 50
$\delta^{13}C = -25.1$ ‰

Wood (sample CIA-78-143-1; 11.9 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 79-13 by L.D. Farley-Gill) from a driftwood layer on a beach north of Dezadeash River, 21 km east-northeast of Haines Junction, Yukon Territory (60°50.4'N, 137°09.7'W), at an elevation of approximately 639 m, 16 m above the adjacent valley floor. Dated material (part of a root) consisted of 17 annual rings. Collected 1978 by J.J. Clague.

GSC-2762. Dezadeash River (III) 910 ± 50
$\delta^{13}C = -24.2$ ‰

Wood (sample 85MF-1; 11.5 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 78-49 by R.J. Mott) on which the outside had been charred, from an unvegetated slope north of Dezadeash River, 21 km east-northeast of Haines Junction, Yukon Territory (60°50.4'N, 137°09.7'W), at an elevation of approximately 645 m, 22 m above the adjacent valley floor. Collected 1978 by V.N. Rampton.

GSC-2980. Alaska Highway (I) 290 ± 80

Charcoal, charred wood, and wood (sample CIA-79-206-10; 3.5 g; **Picea** sp., unpublished GSC Wood Identification Report No. 79-55 by L.D. Farley-Gill) from a paleosol exposed in a trench about 150 m east of the Alaska Highway and 7 km west-northwest of Haines Junction, Yukon Territory (60°46.8'N, 137°37.8'W), at an elevation of approximately 610 m, 25 cm below the surface of the ground. The paleosol is developed on a Neoglacial lacustrine (?) unit and is overlain by 20 cm of lacustrine silt and fine sand, also probably of lacustrine origin. GSC-2602 (2210 ± 50 years) and GSC-2112 (2820 ± 60 years; both in this list) are dates on older paleosols at this site. Collected 1979 by J.J. Clague.

GSC-2602. Alaska Highway (II) 2210 ± 50
$\delta^{13}C = -21.5$ ‰

Soil (sample 85R0A-3A; 449 g) exposed in a trench about 150 m east of the Alaska Highway and 7 km west-northwest of Haines Junction, Yukon Territory (60°46.8'N, 137°37.8'W), at an elevation of approximately 609 m, 1.2 m below the surface of the ground. The paleosol is developed on a Neoglacial lacustrine (?) unit and is overlain by silt and fine sand of probable lacustrine origin containing the 1200 year-old White River tephra. The tephra-bearing silt and sand are capped by another buried soil which yielded GSC-2980 (290 ± 80 years; this list); GSC-2112 (2820 ± 60 years; this list) is a date on a soil below that dated by GSC-2602 (from the same trench). Collected 1974 by V.N. Rampton.

GSC-2112. Alaska Highway (III) 2820 ± 60

Soil (sample 85R0A-2A; ca. 200 g) exposed in a trench about 150 m east of the Alaska Highway and 7 km west-northwest of Haines Junction, Yukon Territory (60°46.8'N, 137°37.8'W), at an elevation of approximately 609 m, 1.4 m below the surface of the ground. The paleosol is the Hypsithermal Slims Soil. GSC-2980 (290 ± 80 years) and GSC-2602 (2210 ± 50 years; both in this list) are dates on two younger buried soils separating probable lacustrine units at this site. Collected 1974 by V.N. Rampton.

GSC-2616. Kaskawulsh Valley 360 ± 50
$\delta^{13}C = -23.2$ ‰

Wood (sample 210R0; 11.9 g; **Picea** sp.; unpublished Wood Identification Report No. 77-41 by L.D. Farley-Gill) from a beach on the east wall of Dezadeash and Kaskawulsh rivers and 18 km west-southwest of Haines Junction, Yukon Territory (60°41'N, 137°48'W), at an elevation of approximately 634 m. Collected 1977 by V.N. Rampton.

GSC-2287. Pine Creek 1600 ± 70

Charcoal (sample R0A-7A-63-5A; 5.1 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 75-82 by R.J. Mott) from a paleosol exposed near the top of the east valley wall of Pine Creek directly west of the Haines Junction Emergency Air Strip, 5 km north-northwest of Haines Junction, Yukon Territory (60°47.3'N, 137°34.1'W), at an elevation of approximately 641 m, 60 cm below the surface of the ground. The paleosol is developed on silt and is overlain by silt and fine sand, which are probably eolian in part. White River tephra occurs 7 cm above the top of the paleosol. Collected 1974 by V.N. Rampton.

Comment (J.J. Clague): The dates on driftwood indicate that Lake Alsek is of very young age. The lowest major driftwood layer at 595 m elevation was deposited furing the mid-nineteenth century; GSC-2133 (60 ± 50 years) and GSC-2779 (120 ± 50 years) date this layer. The driftwood paddle occurring at 561 m elevation (GSC-2831, modern) was deposited either when the 595 m lake drained or during a separate younger lake phase when waters were confined to Alsek valley. A second major driftwood layer at 623 m elevation likely was deposited in the eighteenth or early nineteenth century; GSC-2822 (modern) and GSC-2149 (60 ± 40 years) were obtained from this layer. Driftwood and deadfall samples from beaches above 623 m elevation have yielded older radiocarbon dates: 633 to 636 m – GSC-2952 (270 ± 50 years), GSC-2616 (360 ± 50 years), GSC-2100 (370 ± 60 years); 639 to 640 m – GSC-2132 (180 ± 50 years), GSC-2818 (410 ± 50 years); 645 m – GSC-2762 (910 ± 50 years). A few of the dated samples perhaps are deadfall rather than driftwood. For example, GSC-2958 (140 ± 60 years) is much younger than its associated beach at 670 m elevation. Other dates on isolated pieces of wood that may be deadfall include GSC-2132 (180 ± 50 years) and GSC-2762 (910 ± 50 years).

It should be emphasized that radiocarbon ages are not equivalent to calendar ages. There is a complex, non-linear relationship between radiocarbon and calendar age because of past variations in atmospheric radiocarbon activity (e.g., Stuiver and Suess, 1966). In general, for the period of the last several centuries, radiocarbon dates on wood and charcoal may be as much as 150 years younger than corresponding true sample ages.

The interpretation of young driftwood dates is further complicated by the fact that the dated portion of each sample is an aggregate of many annual rings some distance inside the weathered outer surface of the sample. Although an attempt was made to date a relatively small number of rings near the outside of the sample, the date so obtained must be older than the outermost ring. Consequently, the date is a maximum for the time of the ponding phase during which the driftwood layer was deposited. Compounding this problem is the possibility that much of the driftwood originally was deadfall derived from trees already dead when ponding occurred (for a further discussion of this and other problems related to the interpretation of young Lake Alsek driftwood dates, see Clague and Rampton, in press).

Notwithstanding these problems, the Lake Alsek driftwood dates are in agreement with other data, indicating that the lake has filled and emptied several times in the past several centuries.

The paleosol dates are in correct stratigraphic order with respect to one another and with respect to the 1200 year-old White River tephra. GSC-2602 (2210 ± 50 years) and GSC-2112 (2820 ± 60 years) indicate that at least one major ponding phase occurred during early Neoglacial time (sometime between 2150 and 2820 radiocarbon years ago). GSC-2762 (910 ± 50 years) indicates that ponding to above 645 m elevation occurred prior to about 910 radiocarbon years ago (it follows that Lake Alsek attained its maximum extent prior to this time). GSC-2762 also indicates that dead wood may survive many hundred years on the surface without rotting at dry sites in this region.

Comment (W. Blake, Jr.): Sample pretreatment included NaOH leach except for the soils GSC-2602 and -2112, and only a 10 minute-long cold NaOH leach for GSC-2287 (charcoal). GSC-2287 and -2980 mixed with dead gas for counting. Counting was carried out as follows: GSC-2287 is based on one 2-day count in the 2 L counter; GSC-2980 is based on two 1-day counts in the 2 L counter; GSC-2822, -2831, and -2958 are each based on one 1-day count in the 5 L counter; GSC-2100, -2112, -2132, -2133, -2602, -2616, -2762, -2779, -2818, and -2952 are each based on two 1-day counts in the 5 L counter; and GSC-2149 is based on one 3-day count in the 5 L counter.

GSC-3030. Dezadeash River >41 000

Twigs and branches (sample 238PY; 11.1 g; **Picea** sp. and **Salix** sp; unpublished GSC Wood Identification Report No. 79-54 by L.D. Farley-Gill) from the actively eroding north bank of Dezadeash River about 700 m south of Alaska Highway, Yukon Territory (60°50.5'N, 137°11.5'W), at an approximate elevation of 640 m. The dated material was abraded due to water transport, lignified, and, in part, compressed. It was obtained from a 0.8 m-thick unit of crossbedded, medium-grained sand about 11 m above river level. The bank below the sampled unit was covered, but appeared to be lacustrine clayey silt. The sampled unit was overlain by 1.4 m of ripple-bedded and horizontally bedded sand, 2 m of pebbly medium- to coarse-grained sand, a 5 m covered interval (probably sand), and 1.5 m of crossbedded pebbly medium-grained sand, respectively. The crest of the bank was eroded into 1.5 m of stony silty colluvium derived from gravel and till that laterally cap the above sequence. The vegetated upland at the site is underlain by glaciolacustrine clays and silts. Collected 1979 by V.N. Rampton, Terrain Analysis and Mapping Services Ltd., Carp, Ontario.

Comment (V.N. Rampton): The sand containing the dated wood appears to have been deposited in an alluvial environment during a nonglacial interval. Near Kluane Lake to the west, nonglacial sediments (of the Boutellier nonglacial interval) have been dated between 30 000 and 38 000 years old (Denton and Stuiver, 1967). It was believed that the sampled material was probably overlain by only one till and might date from the same interval; however, the date indicates clearly that it was deposited during an earlier nonglacial interval. It is not known whether the area was covered by glaciers during the Boutellier nonglacial interval or whether the stratigraphy at the site does not record all late to middle Wisconsin events. Date based on one 5-day count in the 5 L counter.

Kluane Lake Landslide Series

Wood associated with landslide deposits on the west side of Shakwak valley, 3 km north of the mouth of Slims River near the southwestern shore of Kluane Lake, Yukon Territory. Collected 1978 by J.J. Clague.

GSC-2850. Kluane Lake (I) 1950 ± 50

Wood (sample CIA-78-116-1; 10.7 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 79-22 by R.J. Mott) from a roadcut on the Alaska Highway 100 m west of the shore of Kluane Lake, Yukon Territory (61°01.8'N, 138°29.7'W), at an elevation of 788 m. The sample is part of a large log from an organic bed, probably a forest layer, at the top of fan gravel and beneath 6 m of rubbly landslide debris.

GSC-2860. Kluane Lake (II) 490 ± 50

Wood (sample CIA-78-147; 11.7 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 79-21 by R.J. Mott) from an in situ stump in a small pond 150 m east of the Alaska Highway and 50 m north of the shore of Kluane Lake, Yukon Territory (61°01.7'N, 138°29.6'W), at an elevation of 782 m. The dated wood comprises the innermost 30 to 50 rings of a stump with 210 annual rings. The stump is rooted on landslide debris.

Comment (J.J. Clague): The landslide deposits overlying the log which yielded GSC-2850 and beneath the stump which yielded GSC-2860 were emplaced during two separate catastrophic slope failures from the east flank of the Kluane Ranges west of the date site (Clague, 1981). GSC-2850 is a maximum for the older failure event, whereas GSC-2860 is a minimum for the younger failure event. In addition, the latter date provides chronologic control on Neoglacial fluctuations in the level of Kluane Lake (Bostock, 1969; Clague, 1981). When Kaskawulsh Glacier reached its maximum Neoglacial extent about 315 to 435 calendar years ago, Kluane Lake could no longer drain south to the Pacific Ocean as it had during much of the Holocene. Consequently, the level of the lake rose until a new outlet formed at its north end, and drainage into the Yukon River system ensued. Fluvial downcutting of this outlet has resulted in a 12 m fall in the level of Kluane Lake in the last few hundred years. GSC-2860 and related dates (e.g., GSC-1569, 120 ± 130 years; GSC XIII, 1973, p. 29; and GSC-867, 340 ± 130 years; GSC IX, 1970, p. 75) support this scenario and indicate that Kluane Lake rose above its present level approximately 300 ± 50 years ago (i.e., the age of GSC-2860 minus the number of annual rings between the bark and the mid-ring position of the dated portion of the stump). Each date based on two 1-day counts in the 5 L counter.

GSC-2575. Kluane Lake 260 ± 50
$\delta^{13}C = -23.8$ ‰

Wood (sample 307-R0A; 11.3 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 81-42 by R.J. Mott) from a stump protruding from beach gravel on the north edge of Kluane Lake about 6.5 km east of Destruction Bay, Yukon Territory (61°14.8'N, 138°39.8'W), at an elevation of 780 m. Only outer rings of the stump were collected for dating. Collected 1977 by V.N. Rampton, Terrain Analysis and Mapping Services Ltd., Carp, Ontario.

Comment (V.N. Rampton): Although Kluane Lake initially drained northwestward on a course parallel to the present Kluane River during the late Wisconsin, it appears to have drained to the south through Slims River valley during much of postglacial time (Bostock, 1969; Terrain Analysis and Mapping Services Ltd., 1978). The latter drainage appears to have been established by 10 000 years ago, as plant fragments and organic silt in an ice-wedge cast developed in gravels, which are exposed at the south edge of the Alaska Highway along the south bank of Kluane River (61°32.5'N, 139°19.5'W), and which presumably were deposited during the early northward drainage of Kluane Lake, have been dated at 8390 ± 135 years B.P. (I-10 524, unpublished).

Seismic records and subbottom stratigraphy indicate that Kluane Lake was more than 50 m below its present level for much of the time during which it drained to the south, as organic layers characteristic of peaty terrestrial or shallow lacustrine environments were encountered between 46 and 50 m depth in two adjacent cores in the west part of Kluane Lake. The organic material in one core (46 m depth) contained wood fragments, a few spruce needles, rare seeds of plants characteristic of shallow water (**Potamogeton** sp., **Hippuris** sp., and **Chara** sp.; identified by J.V. Matthews, Jr.) and many mosses: one level contained **Bryum pseudotriquetrum** (Hedw.) Gaertn., Meyer & Schreb., **Calliergon giganteum** (Schimp.) Kindb., **Catoscopium nigritum** (Hedw.) Brid., **Distichium capillaceum** (Hedw.) B.S.G., **Drepanocladus aduncus** (Hedw.) Warnst., **D. aduncus** var. **kneiffii** (B.S.G.) Monk., **D. crassicostatus** Janssens (new species to be validated and described), **D. exannulatus** (B.S.G.) Warnst **D. lycopodioides** var. **brevifolius** (Lindb.) Monk., **Hygroamblystegium tenax** (Hedw.) Jenn., **Hylocomium splendens** (Hedw.) B.S.G., **Philonotis fontana** (Hedw.) Brid., **Scorpidium scorpioides** (Hedw.) Limpr., and **Tomenthypnum nitens** (Hedw.) Loeske; a second level contained **Aulacomnium palustre** (Hedw.) Schwaegr., **Calliergon richardsonii** (Mitt.) Kindb. **ex** Warnst., **Ditrichum flexicaule** (Schwaegr.) Hampe, **Drepanocladus aduncus, D. exannulatus, D. fluitans** (Hedw.) Warnst., **Hylocomium splendens**, and **Oncophorus** sp. and **Pohlia** sp.; identified by J.A. Janssens, University of Minnesota, Minneapolis, Minnesota). Alluviation along the southern outlet, possibly caused by initial Neoglacial advances of Kaskawulsh Glacier, probably caused Kluane Lake to begin to rise above its lowest level about 2200 years ago because the upper part of the organic layer in the core taken at 50 m depth was dated at 2215 ± 80 years B.P. (I-10 525, unpublished). The organic layer was overlain by lacustrine clays containing the 1220 year-old White River ash, and no interruptions in sedimentation showed.

The possible age range in calendar years for GSC-2575, considering statistical errors, corrections for half-life, and fluctuations in atmospheric ^{14}C content (based on Figure 1 in Stuiver and Suess, 1966), of 290 to 440 calendar years confirms the previously held belief that Kluane Lake rose to its maximum level at this time (Hughes et al., 1972). Other dates on drowned trees near lake level of 340 ± 130 years (GSC-867; GSC IX, 1970, p. 75) and 490 ± 50 years (GSC-2860; Clague, 1981) give similarly derived age ranges of 290 to 515 and of 490 to 540 calendar years, respectively. The latter date (GSC-2860) related to the inner 30 to 50 rings of a 210 year-old tree. Thus the tree probably was drowned between 300 to 350 calendar years ago, if one assumed the tree died 190 years after the dated wood interval was alive. Driftwood on the highest Neoglacial beach dated at 120 ± 130 years B.P. (GSC-1569; Hughes et al., 1972; GSC XIII, 1973, p. 29) gives a derived age between modern and 320 calendar years. A readvance of Kaskawulsh Glacier to its maximum Neoglacial position occurred between 300 and 420 calendar years ago. (Denton and Stuiver, 1966). This readvance completely dammed the Slims River outlet of Kluane Lake and raised it to its maximum Neoglacial elevation. The present outlet, Kluane River, was then established and the lake was lowered as the river eroded downward to its present thalweg. A synthesis of the derived ages of the above events indicates that Kaskawulsh Glacier probably reached its maximum Neoglacial position and Kluane Lake was at its maximum Neoglacial elevation between 300 and 320 calendar years ago. Date based on two 1-day counts in the 5 L counter.

Natazhat Glacier Series

Wood from a hand-excavated exposure on the west bank of Little Boundary Creek, 0.5 km from its source (61°36'N, 140°55'W) and 48 km southwest of Koidern, Yukon Territory. The wood was contained in a 1.2 m-thick unit consisting of organic sediment and wood (presumably all spruce). This unit was overlain by 14.6 m of till and underlain by 1.8 m of till; the base of the lower till was covered by colluvium. The exposure, at an elevation of 1370 m, lies within the maximum Neoglacial position of Natazhat Glacier. Collected 1970 by G.H. Denton, University of Maine, Orono, Maine.

GSC-1702. Natazhat Glacier (IV) 3440 ± 140

Wood (sample 70-4; 12.7 g; **Picea** sp.; unpublished GSC Wood Identification Report No. 72-14 by L.D. Farley-Gill) from near the base of woody organic sediment.

GSC-1726. Natazhat Glacier (V) 3380 ± 130

Wood (sample 70-7; 12.15 g; **Picea** sp.; unpublished GSC Wood Identification Report. No. 72-14 by L.D. Farley-Gill) from a woody horizon 0.83 to 1.2 m above the base of woody organic sediment.

Comment (V.N. Rampton): Numerous dates between 3400 and 300 years B.P. have been obtained from wood at this site (cf. Lowdon and Blake, 1970; Rampton, 1970, 1971; Denton and Karlén, 1977), and they indicate that treeline was then at a higher elevation than at present in this area. Rampton (1970) had suggested that Natazhat Glacier advanced over this site about 3300 years ago, on the basis of dates on two logs (3280 ± 130 years B.P., GSC-933, and 3300 ± 130 years B.P., GSC-1003, both in GSC IX, 1970, p. 81), but Denton and Karlén (1977) indicated that Natazhat Glacier advanced over this site subsequent to 3050 years ago, possibly after 2675 years ago, on the basis of the above dates and subsequent dates (3050 ± 55 years B.P., SI-1100; 2675 ± 85 years B.P., SI-1101; 3060 ± 50 years B.P., SI-1102; and 3225 ± 90 years B.P., I-6871) obtained from the woody organic sediments at this site.

The chronology of all the dated wood fragments are not in harmony with their stratigraphic positions, i.e., some of the younger dates are on wood from sediments underlying sediments with wood giving older dates. In addition, the youngest date of 2675 ± 85 years B.P. (SI-1101) was obtained on organic silt near the base of the woody organic sediment. This phenomenon could be due to sediment mixing during glacier overriding or due to the vagaries of the radiocarbon dating technique. Each date based on two 1-day counts in the 5 L counter.

'Lateral Pond' Series

A series of pond sediment samples from a 300 cm-long core taken in 'Lateral Pond' (informal name), a small pond between lateral moraine ridges in Doll Creek valley, Yukon Territory (65°57'N, 135°31'W), at an elevation of 650 m. The site is situated to the north-northwest of Bonnet Plume Basin. Collected 1978 with a modified Livingstone piston corer by J.C. Ritchie, University of Toronto, Toronto, and L.C. Cwynar, then University of Toronto, Toronto, now University of Washington, Seattle, Washington.

GSC-2854. Lateral Pond, 69-72 cm — 6800 ± 80; $\delta^{13}C = -27.1$ ‰

Organic mud (sample Lta 1; 17.0 g dry) from 69 to 72 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Date based on two 1-day counts in the 5 L counter.

GSC-2852. Lateral Pond, 102-105 cm — 7510 ± 170; $\delta^{13}C = -26.7$ ‰

Organic mud (sample Lta 2; 8.5 g dry) from 102 to 105 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Date based on three 1-day counts in the 2 L counter.

GSC-2808. Lateral Pond, 148-152 cm — 12 100 ± 130; $\delta^{13}C = -25.9$ ‰

Organic mud (sample Lta 3; 35.8 g) from 148 to 152 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Date based on three 1-day counts in the 2 L counter.

GSC-2785. Lateral Pond, 185-190 cm — 14 800 ± 260; $\delta^{13}C = -27.9$ ‰

Organic mud (sample Lta 4; 115.9 g) from 185 to 190 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-2758. Lateral Pond, 230-235 cm — 15 200 ± 230; $\delta^{13}C = -24.0$ ‰

Organic mud (sample Lta 5; 119.2 g) from 230 to 235 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Comment (J.C. Ritchie): Relative and influx pollen data show that sparse herb tundra occupied the lower slopes, and sedge meadows grew in lowlands during the interval between 16 000 and 12 500 years ago. An abrupt change to shrub vegetation and then spruce forest vegetation began 12 500 years ago, and the modern configuration was in place by 7000 years ago (Ritchie, in press).

Comment (W. Blake, Jr.): The two lowermost samples, GSC-2758 and -2785, show that the area was free of glacier ice by 15 000 years ago, and the dates are in the same general age range as the basal organic material from another moraine-dammed lake in Doll Creek valley, (GSC-2690, 16 000 ± 420 years, this list; Ritchie, in press). The importance of these age determinations on basal pond sediments is summarized by Hughes et al. (1981, p. 360).

"The late Wisconsinan age assignment fits better than an early Wisconsinan or older age with our evolving reinterpretation of the stratigraphy and chronology of Old Crow and Bluefish basins. As will be documented in subsequent reports of this series, both basins contain glaciolacustrine sediments that began to accumulate about 30 000 years ago when meltwater was diverted into the Porcupine drainage by ice in the Bonnet Plume basin and ice blocking McDougall Pass. Since we believe that the Hungry Creek Glaciation was responsible for this diversion, that glaciation cannot be older than late Wisconsinan in age. Dates on cores from lakes held in by moraines presumed to have been constructed by the Hungry Creek glacier when it stood at its maximum limit suggest that it was retreating by 16 000 years ago."

Unnamed Lake Series

A series of lake sediments from a 360 cm-long core taken in 22 m of water in an unnamed, moraine-dammed lake in Doll Creek valley, southern Richardson Mountains, Yukon Territory (66°03'N, 135°39'W), at an elevation of 700 m. Collected 1977 with a modified Livingstone sampler by J.C. Ritchie and J.G. Westgate, both at University of Toronto, Toronto, and L.C. Cwynar, then University of Toronto, now University of Washington, Seattle, Washington.

GSC-2593. Unnamed Lake, 99-101 cm — 5790 ± 250; $\delta^{13}C = -27.7$ ‰

Silty organic lake mud (sample X-A; 22.9 g) from 99 to 101 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-2549. Unnamed Lake, 169-171 cm — 8860 ± 270; $\delta^{13}C = -26.8$ ‰

Silty organic lake mud (sample X-B; 42.8 g) from 169 to 171 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-2540. Unnamed Lake, 244-254 cm — 11 100 ± 500; $\delta^{13}C = -29.3$ ‰

Silty organic lake mud (sample X-C; 17.7 g) from 198 to 202 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2606. Unnamed Lake, 244-254 cm — 9350 ± 240; $\delta^{13}C = -27.6$ ‰

Silty lake mud (sample X-D; 34.4 g) from 244 to 254 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2607. Unnamed Lake, 344-354 cm — 10 200 ± 240; $\delta^{13}C = -27.6$ ‰

Silty lake mud (sample X-E; 35.1 g) from 344 to 354 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Comment (J.C. Ritchie): The discrepancies in the age/depth relations of GSC-2606 and -2607 are reflected also in inconsistent pollen stratigraphy, a result of coring difficulties in a relatively deep lake when stiff sediments are encountered. However, the upper unit, from 0 to 205 cm, shows consistent stratigraphy in terms of both age and pollen stratigraphy (Ritchie, in press).

GSC-2690. Doll Creek 16 000 ± 420
$\delta^{13}C$ = -27.1 ‰

Silty lake mud (sample CW 1; 58.4 g dry) at 393 to 408 cm below the mud/water interface of a small, unnamed moraine-dammed lake in Doll Creek valley, southern Richardson Mountains, Yukon Territory, (66°02'N, 135°42'W), at an elevation of 600 m. The site is situated to the north-northwest of Bonnet Plume Basin. Collected 1978 with a modified Livingstone sampler by J.C. Ritchie and L.C. Cwynar.

Comment (J.C. Ritchie): A core length of 522 cm of lake sediment yielded a sequence of pollen zones in part consistent with the regional pattern established at the 'Lateral Pond' site (GSC-2854, -2852, -2808, -2785, and -2758; this list; Ritchie, in press). However, a duplicated segment of core, indicated by the anomalous pollen stratigraphy between 220 and 300 cm, suggests that this highly promising site should be re-cored in future. The basal date of 16 000 years gives a minimum age for the beginning of organic sedimentation in this moraine-dammed lake and suggests that the valley glaciation in this area, formerly ascribed by Hughes (1972) to an early Wisconsin maximum glaciation, was in fact coeval with the latest glacial advance. These questions are discussed in detail, along with the pollen stratigraphy, in Ritchie (in press). Also, Hughes et al. (1981) have confirmed this reinterpretation from independent data obtained in the Bonnet Plume Basin to the south (cf. comment for the 'Lateral Pond' series, this list). NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 4-day count in the 2 L counter.

Northwest Territories

"M Lake" Series

A series of lake sediment samples from a 300 cm-long core taken in "M Lake" (unofficial name), a small lake in the Campbell-Dolomite hills near Inuvik, District of Mackenzie, Northwest Territories (68°16'N, 133°28'W), at an elevation of 75 m. Collected April 1974 with a modified Livingstone piston corer in the deepest part of the lake (24 m) by J.C. Ritchie and others.

GSC-2087. M Lake, 98-103 cm 2860 ± 80

Organic lake mud (sample M 98/103; 9.1 g dry) from 98 to 103 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-2221. M Lake, 122-128 cm 6410 ± 90

Organic lake mud (sample M 122/128; 15.0 g dry) from 122 to 128 cm below the mud/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 5 L counter.

GSC-2187. M Lake, 164-169 cm 8590 ± 80
$\delta^{13}C$ = -32.4 ‰

Organic lake mud (sample M 164/169; 16.0 g dry) from 164 to 169 cm below the mud/water interface. Uncorrected age: 8710 ± 80 years. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 5 L counter.

GSC-2172. M Lake, 213-218 cm 10 000 ± 110
$\delta^{13}C$ = -30.2 ‰

Silty organic lake mud (sample M 213/218; 12.5 g dry) from 213 to 218 cm below mud/water interface. Uncorrected age: 10 100 ± 110 years. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 4-day count in the 2 L counter.

GSC-2075. M Lake, 229-235 cm 11 100 ± 90
$\delta^{13}C$ = -34.1 ‰

Silty organic lake mud (sample M 229/235; 57 g dry) from 229 to 235 cm below the mud/water interface. Uncorrected age: 11 300 ± 90 years. This sample contained one stem of **Drepanocladus exannulatus** (unpublished GSC Bryological Report No. 291 by M. Kuc), and the sample is from before the rise in **Betula** in the pollen diagram. NaOH leach omitted from sample pretreatment. Date based on one 3-day count in the 5 L counter.

Comment (J.C. Ritchie): A detailed percentage and influx pollen analysis yielded six distinct pollen zones. The dates provide a secure chronology for several notable changes in vegetation and migration. The sequence is (1) a willow-grass-herb zone from 13 000 to 11 300 years; (2) a dwarf-birch - willow - grass-herb zone from 11 300 to 10 300 years; (3) a birch-poplar zone from 10 300 to 9700 years; (4) a birch-poplar-juniper zone from 9700 to 8900 years; (5) a spruce-birch-juniper zone from 8900 to 6500 years, and (6) a spruce - tree-birch - alder zone from 6500 years B.P. to the present (Ritchie, 1977).

Eskimo Lakes Pingo Series

A series of pingo sediments exposed in a wave-cut, eroded face on the south shore of Eskimo Lakes, District of Mackenzie, Northwest Territories, (69°25'N, 131'40'W), at an elevation of 6 m. Collected 1971 from an exposed vertical surface by J.C. Ritchie and K.G Ritchie, University of Toronto, Toronto, Ontario.

GSC-1669. Eskimo Lakes Pingo, 15 cm 2920 ± 130
$\delta^{13}C$ = -25.6 ‰

Terrestrial peat (sample T-E; 89 g dry) at 15 cm below the surface. NaOH leach omitted from sample pretreatment. Date based on two 1-day counts in the 5 L counter.

GSC-1724. Eskimo Lakes Pingo, 70 cm 4530 ± 140
$\delta^{13}C$ = -26.2 ‰

Moss detritus unit (sample T-D; 55 g dry; **Drepanocladus exannulatus;** unpublished GSC Bryological Report No. 179 by M. Kuc) in pond sediments. NaOH leach omitted from sample pretreatment. Date based on two 1-day counts in the 5 L counter.

GSC-1737. Eskimo Lakes Pingo, 80 cm 6770 ± 140
$\delta^{13}C$ = -22.7 ‰

Moss detritus unit (sample T-C; 52.0 g dry) in pond sediments. NaOH leach omitted from sample pretreatment. Date based on one 3-day count in the 5 L counter.

GSC-1717. Eskimo Lakes Pingo, 105 cm — 9500 ± 170; $\delta^{13}C = -22.3$ ‰

Gyttja sediment (sample T-B; 71.5 g dry) with shells, NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-1671. Eskimo Lakes Pingo, 190 cm — 9690 ± 250; $\delta^{13}C = -26.0$ ‰

Pond clay unit (sample T-A; 8.8 g burned) at the base of the exposed section. NaOH leach omitted from sample pretreatment. Date based on one 3-day count in the 1 L counter.

Comment (J.C. Ritchie and H. Hyvärinen, University of Helsinki, Helsinki, Finland): A collapsed, eroded closed-system pingo yielded a pollen diagram (relative) with three zones correlative with similar zones found elsewhere in the Mackenzie Delta region: "Zone I dominated by **Betula glandulosa** associated with low frequencies of **Salix** and **Artemisia**, Zone II dominated by **Picea** (20 to 40%) and **Betula** (50%), and Zone III showing roughly equal representation of **Alnus**, **Betula**, and **Picea**" (Hyvärinen and Ritchie, 1975).

Comment (W. Blake, Jr.): Much of the section below the level of sample T-C (80 cm depth) is characterized by the presence of freshwater molluscs and ostracods. Both T-C and T-B contain **Valvata sincera**, and the former contains **Gyraulus deflectus** and is dominated by Sphaeriids. T-A is dominated by **Gyraulus deflectus** and in addition contains **Lymnaea modicella**, **Physa** sp., **Promenetus exacuous**, **Helisoma** sp., and **Pisidium** cf. **casertaurum** (M.F.I. Smith, personal communications, 1972).

Northern Canada, Arctic Archipelago

Ellesmere Island

Jakeman Glacier Series (I)

Willow wood and peat collected around the margins of Jakeman Glacier, Ellesmere Island, Northwest Territories.

GSC-1866. Jakeman Glacier, southeast — modern; $\delta^{13}C = -26.9$ ‰

Wood (sample BS-48-68; 10.7 g; **Salix** sp. (root wood); unpublished GSC Wood Identification Report No. 71-45 by R.J. Mott) on the outer face of the innermost moraine, southeast margin of Jakeman Glacier (76°25.5'N, 80°48.5'W), at an elevation of 70 m. Collected 1968 by R.A. Souchez, Université Libre de Bruxelles, Belgium for W. Blake, Jr.

GSC-1562. Jakeman Glacier, northwest (I) — 1470 ± 80; $\delta^{13}C = -26.3$ ‰

Peat (sample BS-62-68; 40.0 g dry) from a discontinuous 2.5 cm-thick band, 50 cm below the ground surface in a gully leading to a river exposure along the northwest margin of Jakeman Glacier (76°30.5'N, 80°55'W), at an approximate elevation of 45 m. Collected 1968 by W. Blake, Jr.

GSC-1159. Jakeman Glacier, northwest (II) — 3540 ± 60; $\delta^{13}C = -28.6$ ‰

Peat (sample BS-61-68; 24.2 g dry) from a 5 cm-thick peat layer, 75 cm below the ground surface at the same location as described for GSC-1562. Collected 1968 by W. Blake, Jr.

Comment (W. Blake, Jr.): The age of the younger of the two peat beds provides a limiting date for an advance of Jakeman Glacier. This advance resulted in a lateral shift of the river adjacent to the ice margin and the commencement of gullying (Blake, 1981). The lower peat layer contains an assemblage of mosses (unpublished GSC Bryological Report No. 32 by M. Kuc) and remains of predaceous diving beetles (unpublished GSC Fossil Arthropod Report No. 81-7 by J.V. Matthews, Jr.), indicating that the overlying colluvium buried material adjacent to a tundra pool. The modern willow sample was imbedded in till and is believed to have been displaced from the site where it grew by a slight push forward of the glacier (Blake, 1981). NaOH leach omitted from the pretreatment of GSC-1159. GSC-1562 mixed with dead gas for counting. GSC-1159 based on two 1-day counts in the 5 L counter. GSC-1562 based on two 1-day counts in the 2 L counter; GSC-1866 based on one 1-day count in the 5 L counter.

Clarence Head Series

Marine pelecypod shells from two sites near Clarence Head, Ellesmere Island, Northwest Territories.

GSC-1572-2. Clarence Head (I) — 8980 ± 160

Seventeen umbonal fragments and 19 posterior fragments (sample CB-60-3-45/S; 26.6 g; **Mya truncata**; identified by W. Blake, Jr.) from reddish sand and mud on a bench approximately 1.5 km southwest of Clarence Head (76°48'N, 77°48'W), at an elevation of approximately 30 m. Collected 1960 by R.L. Christie; submitted 1974 by W. Blake, Jr.

GSC-2531. Clarence Head (II) — 9220 ± 90; $\delta^{13}C = +2.2$ ‰

Three left valves and five right valves (sample BS-77-393; 26.8 g; **Mya truncata**; identified by W. Blake, Jr.) from reddish mud on the surface and within 30 cm of the surface on a talus slope 1.5 km southwest of the tip of Clarence Head (76°47.6'N, 77°48'W), at an elevation of 50 to 52 m.

GSC-3183. Clarence Head (III) — 9330 ± 110; $\delta^{13}C = +2.2$ ‰

Whole valves and fragments (sample BS-77-393; 27.2 g; **Hiatella arctica**; identified by W. Blake, Jr.) from the same site from which GSC-2531 came. This sample, another species from the same collection, comprised three whole right valves plus three fragments and nine whole left valves plus one fragment. the largest valve was 3.9 by 2.1 cm, with a maximum thickness of 6 mm (most valves were only 1 to 2 mm thick).

Comment (W. Blake, Jr.): Originally only a single valve was dated (GSC-1572) because the thick nature of the shells in Christie's collection suggested that the shells might be transported. Determination GSC-1572-2 was done in order to reduce the size of the error term accompanying GSC-1572 (9810 ± 330 years; published in uncorrected form, 9770 ± 330 years, in Blake, 1972 and GSC XIII, 1973, p. 42). The divergent results suggest that GSC-1572, assuming it is correct, relates to a time when the level of the sea was well above the collection site. The new collection from 1977 shows clearly that the limit of Holocene marine submergence, which has not been determined with certainty because of the steepness of the coast (although there is a bench at approximately 80 m), is more than 9000 years in age (Blake, 1981). GSC-1572-2 based on two 1-day counts in the 2 L counter; GSC-2531 and -3183 each based on one 3-day count in the 2 L counter.

Hook Glacier Series

Marine shells and willow wood from the margins of the south arm of Hook Glacier, Makinson Inlet, Ellesmere Island, Northwest Territories. Collected 1977 by W. Blake, Jr.

GSC-3180. Hook Glacier (I) 9270 ± 110
$\delta^{13}C$ = +0.3 ‰

Marine shells (sample BS-77-5; 23.0 g; **Portlandia arctica**; identified by W. Blake, Jr.) from a 4 to 5 cm-thick band and approximately 2 m below the surface of a terrace on the northwest side of Hook Glacier (77°32.2'N, 81°32'W), at an elevation of 64 m.

GSC-2643. Hook Glacier (II) 1110 ± 60
$\delta^{13}C$ = -27.3 ‰

Wood (sample BS-77-12; 6.3 g dry; **Salix** sp.; unpublished GSC Wood Identification Report No. 78-15 by R.J. Mott) imbedded in till of a lateral moraine ridge on the northwest side of Hook Glacier (77°32.8'N, 81°30.5'W), at an elevation of approximately 160 m.

GSC-2903. Hook Glacier (III) 1230 ± 200
$\delta^{13}C$ = -27.3 ‰

Wood (sample BS-77-10; 0.9 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 79-24 by R.J. Mott), from the same site as GSC-2643.

Comment (W. Blake, Jr.): The date (GSC-3180) on marine shells shows that much of Makinson Inlet became free of glacier ice in a short time, for shells on the outer east coast of Ellesmere Island near Clarence Head (GSC-253 and -3183, this list) are close to the same age; two of the dates overlap with GSC-3180. The two age determinations on willow branches from a lateral moraine show that the advance which incorporated the wood occurred more recently than 1050 to 1170 radiocarbon years ago (Blake, 1981). Because of the small sample size used for GSC-3180, only the outer 10 per cent of shell was removed by HCl leach. GSC-2903 mixed with dead gas for counting; this determination and GSC-2643 each based on two 1-day counts in the 2 L counter. GSC-3180 based on one 3-day count in the 2 L counter. The $^{13}C/^{12}C$ value used for correcting GSC-2903 is the average value determined for seven other willow samples in the vicinity, including GSC-2643.

GSC-2893. Split Lake 1040 ± 40
$\delta^{13}C$ = -29.2 ‰

Wood (sample BS-77-347; 11.5 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 79-23 by R.J. Mott) from lacustrine silt and sand exposed on the west side of the valley north of Split Lake, approximately 16.5 km north of head of the Makinson Inlet (north arm), Ellesmere Island, Northwest Territories (77°50.2'N, 81°48'W), at an elevation of 45 m. The pieces of willow dated were from 4 to 5 m above the level of the valley floor, thus near the base of the 27 m of this unit that is exposed. Collected 1977 by W. Blake, Jr.

Comment (W. Blake, Jr.): The date indicates that approximately 1100 to 1000 radiocarbon years ago, Split Lake Glacier had pushed farther across the valley than at present, so that a larger and deeper lake was dammed upvalley (Blake, 1981). The timing of the advance may have correlated with that of Hook Glacier to the south (see GSC-2643, 1110 ± 60 years, this list). The dated pieces of willow had mostly intact bark. Eighteen pieces (some of which may originally have been from the same stem) were used; the largest was 16 cm long and the maximum diameter of the thickest piece was 1.5 cm. Date based on one 3-day count in the 2 L counter.

Glacier 7A-45 Series

Samples of wood and peat collected close to the south side of Glacier 7A-45 (designation following the Glacier Atlas of Canada, department of the Environment; Area 46427A, unpublished), approximately 16 km north of the head of Makinson Inlet (north arm). Ellesmere Island, Northwest Territories (77°49.8'N, 81°45'W). Collected 1977 by W. Blake, Jr.

GSC-2622. Glacier 7A-45 (I) 70 ± 60
$\delta^{13}C$ = -26.9 ‰

Wood (sample BS-77-345; 13.8 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 78-13 by L.D. Farley-Gill) from a well preserved and intact willow "tree" (3.5 cm maximum thickness) on the ground surface. This sample, from one of many occurring on the surface of the extensive peat deposit on the south side of the glacier snout, had bark intact on much of the exposed wood, although the thin ends of the branches were broken off.

GSC-2898. Glacier 7A-45 (II) modern
$\delta^{13}C$ = -26.9 ‰

Wood (sample BS-77-330; 11.6 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 81-44 by R.J. Mott) from a second "tree" of the same site at which GSC-2622 was collected. The ends of the branches were somewhat worn and rounded, although the bark was intact at the bulbous part of the stump close to the ground.

GSC-3224. Glacier 7A-45 (III) 90 ± 70
$\delta^{13}C$ = -25.8 ‰

Wood (sample BS-77-334; 11.7 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 81-44 by R.J. Mott) from a third stump at the same site at which GSC-2622 and -2898 were collected. This piece was lying loose in a gully cut into the surface of the underlying peat and, as with the other samples, the ends of branches were abraded and rounded.

GSC-3191. Glacier 7A-45 (IV) 2590 ± 150
$\delta^{13}C$ = -27.3 ‰

Twigs (sample BS-77-344; 2.7 g dry; **Salix** sp.; unpublished GSC Plant Macrofossil Report No. 81-2 by J.V. Matthews, Jr.) extracted from the uppermost 10 cm of a peat deposit (approximately 9 m thick) at the same site. This peat underlies the surface on which the willows (GSC-2622, -2898, and -3224) grew. The twigs, which had intact bark and buds in most cases, were extracted by tweezers from the peat, and great care was taken to avoid the coal fragments that have been worked into the peat from nearby outcrops of Tertiary rocks.

GSC-2909. Glacier 7A-45 (V) 5180 ± 260
$\delta^{13}C$ = -32.1 ‰

Leaves and stems (sample BS-77-335; 2.8 g; **Dryas integrifolia**; identified by W. Blake, Jr.) extracted from the basal 10 cm of peat from the same site at which GSC-3191 was collected.

Comment (W. Blake, Jr.): The three dated willow stumps have been covered by ice in the very recent past, and this advance is probably responsible for the coarse bouldery outwash and ablation till which now cover the surface of the peat. The possibility, however, that more than one advance of the glacier has occurred in the last 2500 years cannot be excluded. The two dates on peat show that for a period of roughly 2500 years the glacier did not advance over the site and in fact was probably well behind its present position (Blake, 1981). GSC-2909 and -3191 mixed with dead gas for counting. GSC-2898 is based on one 1-day count in the 5 L counter; GSC-2622 and -3191 are each based on two 1-day counts in the 2 L counter; GSC-3224 is based on two 1-day counts in the 5 L counter; and GSC-2909 is based on one 3-day count in the 2 L counter. The $^{13}C/^{12}C$ value for GSC-3191 is based on the average value for seven other samples in the vicinity.

GSC-2699. Cape Faraday 2380 ± 140
$\delta^{13}C = +1.1$ ‰

Marine pelecypod valve (sample CB-61-3-10/3S; 6.1 g; **Astarte borealis**; identified by W. Blake, Jr.) from the surface of a moraine ridge on the southeast side of Glacier 7K-59 (designation following the Glacier Atlas of Canada, Department of the Environment, Area 46427K, unpublished), approximately 4.5 km northeast of Cape Faraday, Ellesmere Island, Northwest Territories (77°54.5'N, 76°48.5'W), at an elevation of 60 m. Collected 1961 by R.L. Christie; submitted 1978 by W. Blake, Jr.

Comment (W. Blake, Jr.): This age determination, the only one from the Talbot Inlet area, indicates that Glacier 7K-59 has advanced some time during the last 2500 radiocarbon years (Blake, 1981). The aragonitic valve utilized, the largest in the collection (4.1 cm long, 2.3 cm high) had no pitting or encrustations, and the periostracum was partially intact. Because of the small sample size, only the outer 5 per cent was removed by HCl leach. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Alfred Newton Glacier Series

Willow wood and marine shells collected adjacent to the snout of Alfred Newton Glacier, Ellesmere Island, Northwest Territories.

GSC-3201. Alfred Newton Glacier (I) modern
$\delta^{13}C = -28.1$ ‰

Wood (sample BS-79-67(A); 11.6 g; **Salix** sp.; unpublished GSC Wood Identification Report No. 81-5 by L.D. Farley-Gill) from within 1 m of the snout of Alfred Newton Glacier (78°35.0'N, 74°50.5'W), at an elevation of 10 m. Collected 1979 by W. Blake, Jr.

GSC-3103. Alfred Newton Glacier (II) 8930 ± 100
$\delta^{13}C = +1.5$ ‰

Marine shells (sample BS-80-5; 26.5 g; **Hiatella arctica**; identified by W. Blake, Jr.) from a stream gully close to the north side of the snout of Alfred Newton Glacier (78°35.2'N, 74°51.5'W), at an elevation of approximately 50 m. Collected 1980 by S. Funder, University of Copenhagen, Copenhagen, Denmark, and W. Blake, Jr.

Comment (W. Blake, Jr.): GSC-3103 shows that some 9000 to 8900 radiocarbon years ago Alfred Newton Glacier was less extensive than it is at present, for close to the site where this sample was collected the glacier is overriding undisturbed raised beaches. The position of the wood used for GSC-3201, now subject to ice falls and inundation by water pouring over the snout, indicates that when the tree was growing the ice was farther back. Together, the two dates show that this glacier is now as far advanced as it has been for a period of nearly 9000 radiocarbon years (Blake, 1981).

The aragonitic shells (some juvenile) comprising GSC-3103 were thin and had good internal lustre, and the largest whole valve measured 4.1 by 1.7 cm. The main stem of the willow used for GSC-3201 was more than 70 cm in length, with a maximum diameter of 1.5 cm. Bark and buds were intact. GSC-3103 based on one 3-day count in the 2 L counter. GSC-3201 based on two 1-day counts in the 5 L counter.

GSC-3200. Sverdrup Pass 150 ± 50
$\delta^{13}C = -28.8$ ‰

Stems and leaves (sample HCA-78-24/7-5; 18.0 g dry; **Dryas integrifolia**; identified by W. Blake, Jr.) from 1 to 2 m in front of the snout of Glacier 7C-11 (designation following the Glacier Atlas of Canada, Department of the Environment; 46427C, unpublished), 12 km east of the head of Irene Bay, Ellesmere Island, Northwest Territories (79°04.5'N, 80°56'W), at an elevation of 150 m. The vegetation (wet when collected, air dried in the office) was still attached to the rock surface in front of the glacier, which is the westernmost outlet glacier in Sverdrup Pass. Collected 1978 by D.A. Hodgson; submitted 1981 by W. Blake, Jr.

Comment (W. Blake, Jr.): The wedge-like glacier snout has covered the collection site in the recent past (a fair amount of rock flour had to be removed from the sample), and the lack of living plants indicates that retreat has taken place recently (D.A. Hodgson, personal communication, 1981; cf. Blake, 1981). Date based on two 1-day counts in the 5 L counter.

Lougheed Island

Lougheed Island Series

Whole marine pelecypod shells (**Hiatella arctica**; identified by D.A. Hodgson) from two strata 3 m apart vertically, in the backwall of a large and actively regressing nivation hollow. The site is 30 km south-southeast of Cape Ahnighito, northwestern Lougheed Island, Northwest Territories (77°30'N, 105°36'W). The top of the backwall is 44 m above sea level, as measured by altimetry, using extra high water as the datum. Collected 1979 by D.A. Hodgson.

GSC-2928. Lougheed Island (I) 10 400 ± 260
$\delta^{13}C = +2.5$ ‰

Thin, fragile, commonly paired valves, 2 to 4 cm in length, of **Hiatella arctica** (sample HCA-79-27/7-1AII: 15.7 g), within a 10 cm-thick lens of stratified clayey silt and sand, overlain by 50 cm of clayey silt to the ground surface. The shell lens was underlain by 3 m of massive marine pelite, free of macrofossils, but containing scattered stones, some striated.

GSC-2986. Lougheed Island (II) 10 500 ± 130

Valves of **Hiatella arctica** (sample HCA-79-27/7-1AI; 26.9 g), similar to GSC-2928, within a sandy silt stratum directly underlying the massive marine pelite described above. The shell-bearing stratum in places lies directly over a non-cemented sandstone, and elsewhere is separated from the rock by up to 10 cm of stratified sand.

Comment (D.A. Hodgson): Similar stratigraphy was traced for more than 100 m along the nivation hollow backwall, although shells were found in the lower stratum at only one point. The backwall is regressing into a 20 km-long ridge, drumlinoid in form and likely glacial in origin, though of undetermined age (Hodgson, 1981). In the field, it was believed that the stratigraphy might record a marine transgression, followed by a deepwater marine interval and a later regression; however, the similarity of the dates makes this hypothesis less appealing. Furthermore, GSC-356 (10 240 ± 280 years; 90 m elevation) on Edmund Walker Island 50 km to the southeast and GSC-320 (10 100 ± 150 years; 60 m elevation; both in GSC VI, 1967, p. 190-191) from near Cape Rondon 20 km to the southwest are both higher and younger (probably) than the uppermost shells from the section described here. What is certain is that the shells are nearly 1500 years older than any of the numerous finite-aged shell collections from the Sverdrup Islands directly east and northeast of Lougheed Island, despite similar field survey methods being used throughout the area.

Comment (W. Blake, Jr.): Both shell samples (aragonitic) showed reasonably good preservation. GSC-2928 (13 whole or partial left valves, 14 right valves) was composed of chalky, soft, and thin shells, although some bits of periostracum remained. The largest valve used measured 3.7 by 1.0 cm. In the case of GSC-2986, the shells were also chalky, but some internal lustre showed, and bits of both ligament and periostracum remained. The shells (11 left valves, 6 right, plus an intact pair) showed no wear on their exterior surfaces. The largest valve in this sample measured 4.6 by 2.2 cm, the smallest was 1.8 by 0.8 cm. Most shells were less than 1 mm thick, all were less than 2 mm. GSC-2928 mixed with dead gas for counting. Each date based on one 3-day count in the 2 L counter.

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