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J.A. LOWDON
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Energy, Mines and Resources Canada
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CONTENTS

The present date list, GSC XIX, is the eighth 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 XIX

Abstract

This list includes 289 radiocarbon age determinations on 271 geological samples made by the Radiocarbon Dating Laboratory. They are on samples from various areas as follows: Mid-Atlantic Ridge (2); Labrador Sea (7); Newfoundland (1); Labrador (2); Nova Scotia (1); New Brunswick (3); Quebec (42); Ontario (12); Manitoba (9); Alberta (20); British Columbia (51); Yukon Territory (24); Northwest Territories, Mainland (31); Northwest Territories, Arctic Archipelago (70); Maine (9); New York (2); Wisconsin (1); Alaska (2). Age determinations on archeological samples are as follows: Yukon Territory (2). Details of background and standard for the 2 L and 5 L counters during the period from September 6, 1978 to October 3, 1979 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 289 datations effectuées sur 271 échantillons géologiques par le Laboratorie de datation au radiocarbone. Ces échantillons proviennent des régions suivantes: La dorsale médio-Atlantique (2); La mer du Labrador (7); Ile de Terre-Neuve (1); Labrador (2); Nouvelle-Ecosse (1); Nouveau-Brunswick (3); Québec (42); Ontario (12); Manitoba (9); Alberta (20); Colombie-Britannique (51); Yukon (24); Territoires du Nord-Ouest, continent (31); Territoires du Nord-Ouest, archipel Arctique (70); Maine (9); New York (2); Wisconsin (1); Alaska (2); Les datations effectuées sur échantillons archéologiques sont: Yukon (2). Les valeurs de mouvement propre et de l'étalonnage des compteurs 2 L et 5 L, pour la période allant du 6 septembre 1978 au 3 octobre 1979, 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 covered by this introduction (September 1978 through September 1979) both the 2 L counter (Dyck and Fyles, 1962) and the 5 L counter (Dyck et al., 1965) were operated for the entire 13 months. The 2 L counter was operated at 2 atm and the 5 L at 1 atm.

Average background and standard counting rates for the periods used for computerized age calculations are shown in Tables 1 and 2, respectively. On a period basis, all counting rates were within statistical limits. In early January all 23 cosmic ray guard tubes in the counter shielding system were replaced. A result of this can be seen (Table 1) in the lower backgrounds attained, especially in the 5 L counter.

Table 3 lists the number of daily counts used to determine the average background and standard counting rates that were utilized for age calculations during the periods listed. Table 4 lists the number of different background and standard gas preparations used for counting during the same periods.

Table 1

Background (c/m)* for Periods Used for Age Calculations
September 6, 1978 to October 3, 1979

PERIOD	2 L COUNTER (2 atm)	5 L COUNTER (1 atm)
September 1978	1.233 ± 0.020	2.375 ± 0.027
October	1.218 ± 0.019	2.465 ± 0.036
November	1.260 ± 0.023	2.547 ± 0.047
December	1.294 ± 0.020	2.659 ± 0.028
January 8 – February 14, 1979	1.251 ± 0.044	2.282 ± 0.032
February 14 – March 27	1.253 ± 0.026	2.308 ± 0.022
April	1.219 ± 0.021	2.307 ± 0.046
May	1.267 ± 0.033	2.272 ± 0.039
June	1.243 ± 0.047	2.307 ± 0.027
July	1.246 ± 0.021	2.255 ± 0.025
August	1.269 ± 0.030	2.280 ± 0.026
September	1.270 ± 0.023	2.264 ± 0.043

*c/m = counts per minute

Table 2

Standard, N_o*, (c/m) for Periods Used for Age Calculations
September 6, 1978 to October 3, 1979

PERIOD	2 L COUNTER (2 atm)	5 L COUNTER (1 atm)
September 1978	18.028 ± 0.094	28.003 ± 0.118
October	17.925 ± 0.094	27.968 ± 0.122
November	18.044 ± 0.149	27.972 ± 0.129
December	17.820 ± 0.098	27.953 ± 0.154
January 8 – February 14, 1979	17.701 ± 0.122	27.918 ± 0.125
February 14 – March 27	17.723 ± 0.095	27.886 ± 0.118
April	17.725 ± 0.096	28.078 ± 0.127
May	17.629 ± 0.097	27.782 ± 0.121
June	17.661 ± 0.105	27.759 ± 0.122
July	17.609 ± 0.098	27.965 ± 0.116
August	17.627 ± 0.098	27.903 ± 0.118
September	17.437 ± 0.120	27.901 ± 0.188

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

[1] Prepared by J.A. Lowdon who operates the laboratory. 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 Counts Used to Determine Average Background and Standard Counting Rates for Periods Listed

PERIOD	2 L BACKGROUND	5 L BACKGROUND	2 L STANDARD	5 L STANDARD
September 1978	4	4	3	3
October	4	4	3	3
November	4	4	3	3
December	4	4	3	3
January 8 – February 14, 1979	5	5	3	3
February 14 – March 27	5	5	3	3
April	4	4	3	3
May	4	4	3	3
June	4	4	3	3
July	4	4	3	3
August	4	5	3	3
September	3	4	3	3

Table 4

Number of Different Background and Standard Gas Preparations Used for Counting for Periods Listed

PERIOD	2 L BACKGROUND	5 L BACKGROUND	2 L STANDARD	5 L STANDARD
September 1978	2	2	2	2
October	2	2	2	2
November	2	2	2	2
December	2	2	2	2
January 8 – February 14, 1979	2	2	2	2
February 14 – March 27	3	3	2	2
April	2	2	2	2
May	3	2	2	2
June	2	2	2	2
July	2	3	2	2
August	3	3	2	2
September	2	2	2	2

Age calculations are carried out by 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).

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

Where $^{13}C/^{12}C$ ratios are available, a correction for isotopic fractionation has been applied to the date, and the $\delta^{13}C$ value has been reported. Related to the PDB standard, the "normal" values used for correction are $\delta^{13}C = -25.0$ ‰ for wood, other terrestrial organic materials, and bones (terrestrial and marine), and 0.0 ‰ for marine shells. All determinations were made on aliquots of the same sample gas used for age determination. Since 1975 all $^{13}C/^{12}C$ ratios have been determined at the Department of Earth Sciences, University of Waterloo, Ontario (under a series of contracts supervised by Professor P. Fritz and R.J. Drimmie). Prior to the establishment of the laboratory at Waterloo, samples GSC-1195, -1195-2, and -1207 were determined by Teledyne Isotopes, Westwood, New Jersey (also under contract), and the following samples were determined by the GSC Geochronology Section (Head, R.K. Wanless): GSC-1175, -1243, -1301, -1305, -1317, -1339, -1404, -1419, -1441, -1451, -1459, -1468, -1496-A, -1496-B, -1496-C, -1496-2, -1497, -1508, -1649, -1657, -1687, -1712, -1754, -1775, -1799, -1802, -1807, -1813, -1814, -1815, -1894, -1895, -1907, -1908, -1929, -1932, -1954.

Acknowledgments

Thanks are extended to I.M. Robertson and J.E. Tremblay for the preparation, purification, and counting of samples in the Laboratory, to K. Santowski for the GSC $\delta^{13}C$ determinations, and to R.J. Drimmie, Department of Earth Sciences, University of Waterloo for his expeditious handling of samples sent to him for $\delta^{13}C$ determinations. Identification of materials used for dating or associated with the material being dated has been carried out mainly by the following specialists, to whom we express our gratitude: wood and pollen (R.J. Mott and L.D. Farley-Gill); plant macrofossils (J.V. Mathews, Jr.); mosses (M. Kuc, formerly GSC, and J.A.P. Janssens, University of Alberta, Edmonton, Alberta); freshwater molluscs (M.F.I. Smith, National Museum of Natural Sciences, Ottawa, and A.H. Clarke, Jr., formerly NMNS, now Smithsonian Institution, Washington, D.C.); marine molluscs (F.J.E. Wagner, Atlantic Geoscience Centre, Dartmouth, Nova Scotia); mammal bones (C.R. Harington, National Museum of Natural Sciences, Ottawa; C.S. Churcher, University of Toronto, Toronto; and D.M. Shackleton, now at University of British Columbia, Vancouver); and fish bones (D.E. McAllister, National Museum of Natural Sciences, Ottawa). A.C. Roberts, Mineralogy Section, made the X-ray diffracton determinations on all shell samples, and R.J. Richardson, Paleoecology and Geochronology Section, assisted in the processing and examination of samples prior to their submission to the laboratory.

GEOLOGICAL SAMPLES

Mid-Atlantic Ridge

Mid-Atlantic Ridge Series

Coralline limestone samples drilled from the top of Olympus Mountain, Mid-Atlantic Ridge (45°28.4'N, 27°43.3'W), in a water depth of 827 m. The samples were collected in 1969 on **CSS Hudson** cruise 69-025 by C.T. Schafer[1] using a self-contained hydrostatic pressure-driven corer developed at the Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography (Schafer and Brooke, 1970). Two determinations were made on core 160:

GSC-1317. Olympus Mountain, 1-4 cm — 31 200 ± 1480; $\delta^{13}C$ = +3.1‰

Coralline limestone (sample 160-1; 9.6 g) from 1 to 3 cm depth in the longest unbroken core (34 cm) obtained on Olympus Mountain. The moderately porous coralline limestone is overlain by living coral in addition to coral detritus. The lower 1 to 1.5 cm of the submitted sample contained pebbles; this portion was split off and was not used in the age determination.

GSC-1271. Olympus Mountain, 12-15 cm — >32 000

Coralline limestone (sample 160-2; 9.2 g) from 12 to 15 cm depth in the same core.

Comment (C.T. Schafer): The general environment includes dense growths of coral associated with pebble substrate or minor amounts of fine calcareous sediment underlain by coralline limestone. The geology and sedimentology of the area have been described by Schafer (1969).

Comment (W. Blake, Jr): Radiocarbon age determinations, on both globigerina ooze (on Crestal Mountains) and on coralline limestone from other cores (on Confederation Peak, Citadel Peak, and Wegener Mountain) have been reported by Ogden and Hart (1976). In addition to the dates done at Dalhousie University and the two reported here, others were obtained commercially at Teledyne Isotopes. The submitter concluded (Schafer, 1974, p. 1157) on the basis of all the dates, that "Absolute dates (^{14}C) of coralline limestone, which underlies coarse unconsolidated sediment at most drilling sites, suggest deposition and initial lithification of these deposits during a middle Wisconsin interstadial period". These samples were given no pretreatment but simply were dissolved in H_3PO_4 in the shell apparatus. Both samples mixed with dead gas for counting. GSC-1271 based on two 1-day counts in the 2 L counter; GSC-1317 based on one 4-day count in the 2 L counter.

Labrador Sea

Labrador Sea Series

Samples of foraminifera from cores collected along the Northwest Atlantic Mid-Ocean Channel (NAMOC) on cruises of **CSS Hudson** HU-74-026 (Phase IV) and HU-75-009 (Phase IV).

GSC-2205. Labrador Sea (I) — 5160 ± 150; $\delta^{13}C$ = +1.0 ‰

Foraminifera (core H74-65; core depth 70 to 76 cm; 6.9 g) from the base of the top pelagic unit (average thickness 30 cm) in a core from the right (west) levee of the Northwest Atlantic Mid-Ocean Channel (59°58'N, 56°15'W), water depth 3120 m. The foraminifera were hand picked from samples that were wet sieved through a 63 µm screen and dried. The total length of the core was 1.58 m. Collected 1974 by R. Hesse, McGill University, Montreal, and S.K. Chough, then McGill University, now Seoul National University, Seoul, Korea.

GSC-2208. Labrador Sea (II) — 17 200 ± 600; $\delta^{13}C$ = -0.4‰

Foraminifera (core H74-68; core depth, 157 to 179 cm; 4.6 g) from the base of the lower pelagic unit (average thickness 40 cm) in a core from the right (west) levee of the Northwest Atlantic Mid-Ocean Channel (59°33'N, 54°30'W), water depth 3387 m. The total length of the core was 8.5 m. Collected 1974 by S.K. Chough and R. Hesse.

Comment (S.K. Chough): In the lower pelagic unit disseminated sand-sized tephra particles are correlated among the cores from the levee of the Northwest Atlantic Mid-Ocean Channel (Chough, 1978).

GSC-2451. Labrador Sea (III) — 6910 ± 200; $\delta^{13}C$ = -0.8 ‰

Foraminifera (core H75-25; core depth 17 to 26 cm; 5.6 g) from the base of the upper pelagic unit, on the floor of the Northwest Atlantic Mid-Ocean Channel (57°30'N, 50°57'W), in a water depth of 3646 m. The total length of the core was 2.26 m. Collected 1975 by S.K. Chough and R. Hesse.

Comment (S.K. Chough): The date records the termination of turbidity current activity in the Northwest Atlantic Mid-Ocean Channel (cf. GSC-2444, 8630 ± 320 years, this series; Chough, 1978).

GSC-2444. Labrador Sea (IV) — 8630 ± 320; $\delta^{13}C$ = +0.5‰

Foraminifera (core H75-24; core depth 13 to 19 cm; 5.6 g) from the base of the upper pelagic unit in a core from the right (west) levee of the Northwest Atlantic Mid-Ocean Channel (57°27'N, 51°05'W), water depth 3507 m. The total length of the core was 8.15 m. Collected 1975 by S.K. Chough and R. Hesse.

Comment (S.K. Chough): This date, from the same core as GSC-2430, gives the termination of turbidity current activity in the Northwest Atlantic Mid-Ocean Channel (cf. also GSC-2451, 6910 ± 200 years, in core H75-25, this series; Chough, 1978).

[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-2430. Labrador Sea (V) 22 700 ± 540
$\delta^{13}C = +0.5‰$

Foraminifera (core H75-24; core depth 140 to 155 cm; 9.3 g) from the base of the lower pelagic unit in a core from the right (west) levee of the Northwest Atlantic Mid-Ocean Channel (57°27'N, 51°05'W), in a water depth of 3507 m. The total length of the core was 8.15 m. Collected 1975 by S.K. Chough and R. Hesse.

Comment (S.K. Chough): The dated horizon can be correlated with others (e.g., GSC-2332, >23 000 years, in core H75-22, this series; Chough, 1978).

GSC-2356. Labrador Sea (VI) >25 000

Foraminifera (core H75-20; core depth 330 to 345 cm; 4.35 g) from the base of the lower pelagic unit in a core from the left (east) levee of the Northwest Atlantic Mid-Ocean Channel (56°59'N, 50°16'W). The total length of the core was 5.53 cm; water depth 3635 m. Collected 1975 by S.K. Chough and R. Hesse.

Comment (S.K. Chough): The horizon containing foraminifera dated at >25 000 years can be correlated on the basis of lithology with others for the same horizon (cf. GSC-2332, >23 000 years, core H75-22; and GSC-2430, 22 700 ± 540 years, core H75-24; both in this series).

GSC-2332. Labrador Sea (VII) >23 000

Foraminifera (core H75-22; core depth 175 to 180 cm; 4.78 g) from the base of the lower pelagic unit in a core from the right (west) levee of the Northwest Atlantic Mid-Ocean Channel (56°57'N, 50°27'W), water depth 3553 m. The total length of the core was 2.9 m. Collected 1975 by S.K. Chough and R. Hesse.

Comment (S.K. Chough): In the lower pelagic unit disseminated sand-sized tephra particles are correlated among the cores from the levee of the Northwest Atlantic Mid-Ocean Channel. Layer-by-layer matching is possible between this core and core H75-24, 70 km apart. The same horizon dated in core H75-24 yielded an age of 22 700 ± 540 years (GSC-2430, this series; Chough, 1978).

Comment (W. Blake, Jr.): Because of the small size of all seven samples, the HCl leach was omitted throughout. Each sample was mixed with dead gas for counting. GSC-2205, -2208, -2444, and -2451 were each based on two 1-day counts; GSC-2332 and -2430 were each based on one 3-day count, and GSC-2356 was based on one 4-day count; all were counted in the 2 L counter.

Eastern Canada

Newfoundland

GSC-2483. "Comb Pond" 7770 ± 190
$\delta^{13}C = -22.6‰$

Silty gyttja (79.0 g wet; 16.7 g dry) from the base of a core in lake sediment 495 to 500 cm below lake level and 95 to 100 cm below the sediment/water interface in Gros Morne National Park, Newfoundland (49°41.5'N, 57°42.5'W), at an elevation of 678 m. Collected 1976 with a 5 cm diameter Livingstone sampler by J.G. McAndrews, Royal Ontario Museum, Toronto, and I.A. Brookes, York University, Toronto.

Comment (J.H. McAndrews): The pond occupies a rock basin on "Big Level" weathering zone B of Grant (1977a). The date represents a minimum for deglaciation or cessation of mass weathering. A pollen diagram from the overlying sediment is complacent and indicates a local shrub tundra with an influx of ca. 4000 pollen/cm^2/yr. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Labrador

GSC-2825. Pinware 10 900 ± 140
$\delta^{13}C = +1.5‰$

Marine pelecypod shells (sample 77-1292; 20.1 g; **Mya truncata**; identified by W. Blake, Jr.) from the eroded base of a 2.5 to 3 m high estuarine sediment exposure on a small tributary stream to Pinware River, approximately 2.4 km northeast of Pinware, Labrador, Newfoundland (51°31.53'N, 56°43.80'W), at an elevation of ca. 9 m. Dispersed shells and fragments occurred throughout a 2 m exposure of sandy silt beneath a peat cover (up to 0.5 m thick) in a terrace whose surface is at 15 m. The dated sample consisted of the larger shell fragments collected from the base of the actively eroding embankment. Collected 1977 by D.G. Vanderveer, Department of Mines and Energy, Government of Newfoundland and Labrador, St. John's; submitted by D.R. Grant.

Comment (D.G. Vanderveer): The date is a minimum for deglaciation and incursion of the sea up the Pinware River estuary and is correlative in time with the marine incursion on the Northern Peninsula of Newfoundland and the Ten Mile Lake readvance moraine (GSC-1324, 11 000 ± 160 years, GSC XI, 1971, p. 260; Grant, 1972, 1977b).

Comment (W. Blake, Jr.): The dated sample comprised 9 valves (5 left and 4 right), all of which exhibited at least part of the truncated posterior end. The largest valve was >3.5 cm long, >3.0 cm high, and up to 2 mm thick. Only a few traces of periostracum remained, and the exterior surfaces of the shells were chalky; some internal lustre was still visible. The in situ portion of the sample, not used for dating, was smaller and in general contained thinner shells; species present include **Macoma calcarea**. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-2896. Mud Lake 5640 ± 60

A wood sample (sample 76-264(a), 11.4 g; **Abies** sp.; identified by L.D. Farley-Gill) from silt and sand 3.5 m above present river level and below 4.2 m of fluvial and estuarine sediments on the south bank of Churchill River, 2.5 km north of Mud Lake and 16 km east of Goose Bay, Labrador, Newfoundland (53°20'N, 60°10'W), at an elevation of 3 to 4 m. River level is not more than 1 m a.s.l. Collected 1976 by D.G. Vanderveer.

Comment (D.G. Vanderveer): The date obtained is in conflict with GSC-1135 which indicates that sea level 5320 ± 170 years ago was at 33^{+}m (GSC XI, 1971, p. 263). Either GSC-1135 is too young a date or the wood sample has been eroded from an older deposit upstream and does not represent age of the enclosing sediments.

Comment (W. Blake, Jr.): A third alternative is that the wood was deposited in deeper water than was expected to be the case by the submitter. There was nothing in the determination of GSC-1135 from a laboratory point of view to suggest that the validity of the date should be questioned, and that sample, fragmented **Mytilus edulis** shells, was collected from a horizon that had stratified sand and gravel both above and below. GSC-2896 was a single piece of wood, dry when received by the laboratory but wet when collected. Date based on one 4-day count in the 5 L counter.

Nova Scotia

GSC-2833. Joggins 160 ± 50
$\delta^{13}C = +0.3‰$

A single pelecypod valve (sample 20708/89; 43.6 g; **Mercenaria mercenaria**; identified by W. Blake, Jr.) from pinkish red clayey till exposed in a sea cliff ca. 0.8 km

southwest of Joggins, Nova Scotia (45°41.9'N, 64°27.2'W), at 1.4 m above high tide level. This intact right quahaug valve was protruding from the lowest till of a three-till sequence, totalling ca. 21 m in thickness. Collected 1978 by R.H. MacNeill, Acadia University, Wolfville, Nova Scotia; submitted by V.K. Prest.

Comment (W. Blake, Jr.): This aragonitic shell was first examined for its amino acid content at the University of Delaware; J. Wehmiller's comment (personal communication, 1979) was that "the D/L leucine value of .03... makes your sample look very young... could probably be as young as 10 000 years." The testing for amino acids prior to dating was to see if the age of the shell was in the ^{14}C dating range (<40 000 years). It is clear that the shell is not related to the age of the till from which it was collected. Perhaps a modern shell was incorporated into slump debris which was later sculptured by the sea, or the shell was shoved into in situ till in some way. Not only did the amino acid data suggest that the shell was younger than would be expected from its position in the third till, but the shell was extremely well preserved and fresh appearing. The valve measured 7.9 cm wide, 6.5 cm high, and 1.9 cm deep. No pitting or incrustations were present, nor was the exterior chalky; a dull internal lustre remained. Date based on one 3-day count in the 5 L counter.

New Brunswick

Mispec Bay Series

Marine pelecypod shells from the shore of Mispec Bay, ca. 10 km east of Saint John, New Brunswick (45°13.5'N, 65°57.2'W), at an elevation of ca. 35 to 40 m. The shells were collected in a sand and gravel pit, ca. 150 m from the road and ca. 10 m below the surface. Collected 1976 by J.R. Bélanger.

GSC-2573. Mispec Bay (I) 14 400 ± 530
$\delta^{13}C = +1.1$ ‰

A single pelecypod valve (sample BTA-76-3; 3.0 g; **Hiatella arctica;** identified by W. Blake, Jr.). Because of the small sample size, the HCl leach was omitted. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2640. Mispec Bay (II) 12 800 ± 120

Pelecypod shell fragments (sample BTA-76-3(A); 25.5 g; **Mya** sp., identified by W. Blake, Jr.). Only outer 10 per cent removed by HCl leach. Date based on one 3-day count in the 2 L counter.

Comment (N.R. Gadd): GSC-2640 and GSC-2566 (13 100 ± 130 years, this list) are compatible with I(GSC)-7, 13 325 ± 500 years (Isotopes I, 1961, p. 50) and GSC-965, 13 000 ± 200 years (GSC IX, 1970, p. 55) from offshore sediments at Saint John, lying at present sea level midway between the two new sites reported here. Also, shells at Sheldon Point, west of Saint John at 9 m from a bar or spit developed on a submerged moraine, are 13 000 ± 170 years old (GSC-1340, GSC XI, 1971, p. 267). A fourth comparable date is that at Pennfield, about 50 km west of Saint John, where marine shells (at ca. 40 m) near the upper limit of submergence for the Fundy coast are 13 000 ± 340 years old (GSC-882; GSC IX, 1970, p. 55-56; cf. Gadd, 1973).

Comment (W. Blake, Jr.): The Mispec Bay sample also contained **Portlandia arctica** (paired valves), **Clinocardium ciliatum,** and barnacle fragments. GSC-2640 included **Mya arenaria** but perhaps other **Mya** species as well. Both types of dated shells were aragonitic. The single **Hiatella arctica** valve dated first (GSC-2573) was to test the age of the collection; the date does not overlap with GSC-2640 and seems anomalously old when compared with other determinations on marine shells from the New Brunswick coast. No ready explanation for the discrepancy in ages is available.

GSC-2566. Lorneville 13 100 ± 130
$\delta^{13}C = +1.3$ ‰

Barnacle fragments (sample BTA-77-1; 26.6 g; **Balanus** sp.; identified by W. Blake, Jr.) from sand exposed ca. 20 m below the surface in a gravel pit on Highway 810, 3 km southwest of Lorneville, New Brunswick (45°10.1'N, 66°10.9'W), at an elevation of ca. 30 m. Collected 1977 by J.R. Bélanger.

Comment (W. Blake, Jr.): The site is close to the sea, and the deposit is interpreted as a beach constructed from reworked morainic debris. The comment made by N.R. Gadd with reference to GSC-2640 (12 800 ± 120 years, this list) applies here also. Only calcitic barnacle fragments were used for dating; other species present in the sample included **Mya truncata, Hiatella arctica, Clinocardium ciliatum,** and **Macoma** sp. The shells were cleaned in a sonic bath with distilled water to remove adhering red silt and clay. Date based on two 1-day counts in the 2 L counter.

Quebec

GSC-1799. Lac Côté, Gaspé 9810 ± 360
$\delta^{13}C = -22.0$ ‰

Basal organic lake sediment (sample C-2-75; 131.5 g wet) from 247 to 254 cm below the water/mud interface, overlying sand and silt in a large lake in a granite bedrock basin (48°58'N, 65°57'W), in the McGerrigle Mountains, at an elevation of ca. 915 m, ca. 2.3 km south of Mont Jacques-Cartier, Gaspé, Quebec (elevation 1268 m). Water depth 10.9 m. Collected 1972 with a Livingstone corer by J. Lebuis, Ministère des richesses naturelles, Québec, and P.P. David, Université de Montréal, Montréal.

Comment (J. Lebuis and P.P. David): The date is a minimum for the deglaciation of the highest area in Gaspé, although Mont Jacques-Cartier, now covered by felsenmeer and devoid of any glacial erratics, may have been a nunatak above the last major ice sheet (Lebuis and David, 1977). The date is also the youngest thus far obtained for the deglaciation of Gaspé. Sample mixed with dead gas for counting. Date based on three 1-day counts in the 2 L counter.

GSC-2494. Nouvelle 12 400 ± 150
$\delta^{13}C = +2.0$ ‰

Marine pelecypod shells (sample PC-4/76; 12.5 g; **Hiatella arctica;** identified by R.J. Richardson) from a new extension to a gravel pit on the north side of the railway and of Highway 132, 1.6 km southeast of Nouvelle, Quebec (48°08'N, 66°17.5'W), at an elevation of ca. 43 to 46 m. The sparse shells were collected at 1.5 to 3.0 m depth from dry sandy gravels which dipped down the hillside and terrace face; these marine gravels were underlain by cemented, irregularly bedded ice-contact cobble gravels. Collected 1976 by V.K. Prest, C. Gauthier, now University of Western Ontario, London, and V. Cormier.

Comment (W. Blake, Jr.): According to the submitter, this date relates closely to the limit of postglacial marine submergence; this limit rises to the east to approximately 55 m near New Carlisle, then decreases again to the northeast toward Percé. The date is similar to one of 12 200 ± 180 years (GSC-1018; GSC XI, 1971, p. 267) from clay <1 m a.s.l. on the shore of Chaleur Bay near New Richmond, but Lebuis and David (1977) reported a date of 13 890 ± 160 years (QU-275) on shell fragments at 45 m nearby. Although **Mya truncata** and **Macoma** sp. were also included in the sample submitted, only aragonitic **Hiatella**

arctica valves were used for the age determination. The shells were chalky on the exterior and some were lightly encrusted on the interior (including cemented calcareous bits). The largest whole valves were <3 cm long. Only the outer 10 per cent was removed by HCl leach. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-1908. Ruisseau Castor, Gaspé — 13 800 ± 160; $\delta^{13}C$ = -26.4‰

Basal peaty lake sediment (sample C-3-72; 36 g) from 664 to 668 cm depth below the water/mud interface, overlying silt in a small unnamed lake in a sandstone bedrock basin above coastal cliffs 0.7 km south of Ruisseau Castor, Gaspé, Quebec (49°10'00"N, 66°19'40"W), at an elevation of ca. 167 m. The sample contains well preserved moss remains identified as perhaps being **Scorpidium turgescens** or one of several species of **Hygrohypnum** (unpublished GSC Bryological Report No. 254 by M. Kuc). Collected 1972 with a Livingstone corer by P.P. David, Université de Montréal, Montréal, and J. Lebuis, Ministère des richesses naturelles, Québec.

Comment (J. Lebuis and P.P. David): The date is a minimum for the deglaciation of the north-central part of Gaspé bordering the St. Lawrence estuary. This result agrees closely with QU-85 (13 540 ± 300 years; Lebuis, 1973); see also the comment for GSC-1886 (12 700 ± 100 years, this list). Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-1807. Lac Saint-Ignace, Gaspé — 15 300 ± 450; $\delta^{13}C$ = -26.6‰

Basal organic lake sediment (sample C-1-72; 160 g wet) containing traces of marl, 312 to 319 cm below the water/mud interface, overlying calcareous sand and silt in a small lake in a calcareous bedrock basin on the dissected plateau north of the Shick-Shock Mountains, 1.5 km southwest from Saint-Bernard-des-Lacs, Gaspé, Quebec (49°01'30"N, 66°22'15"W), at an elevation of ca. 275 m. Water depth 11.4 m. A thin marl deposit on the surface of the sediment is visible in shallow water. Collected 1972 with a Livingstone corer by J. Lebuis.

Comment (J. Lebuis and P.P. David): The date appears to be 1000 to 2000 years too old when compared with other dates from the area (GSC-1908, 13 800 ± 160 years; this list; and QU-85, 13 540 ± 300 years, Lebuis, 1973; cf. also Quebec I, 1977, p. 99), which give minimum ages for the deglaciation of this part of Gaspé. This discrepancy may be because of the hard-water effect (Donner et al., 1971; Mott, 1975; Karrow and Anderson, 1975). 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 (W. Blake, Jr.): A similar age determination was obtained from the basal gyttja in a lake at 415^{+} m in calcareous bedrock at Saint-Joachim-de-Tourelle; 15 330 ± 1350 years (QU-47; Quebec I, 1977 p. 99).

GSC-1886. Sainte-Anne-des-Monts Hospital road, Gaspé — 12 700 ± 100

Marine pelecypods (sample C-12-72; 46.4 g; numerous whole valves and fragments of **Macoma calcarea,** some with bits of ligaments intact; identified by W. Blake, Jr.) from a fresh excavation along the road to Sainte-Anne-des-Monts, Gaspé, Quebec (49°07'10"N, 66°29'20"W), at an elevation of ca. 12 m. The sample is from 4 to 5 m below the surface in calcareous marine silts and clays overlain by 2 m of littoral sand and gravel and underlain at 6 m depth by schist bedrock. Collected 1972 by R. Brinsmead and J. Lebuis, Ministère des richesses naturelles, Québec, and P.P. David, Université de Montréal, Montréal.

Comment (J. Lebuis and P.P. David): The date corresponds closely to GSC-1186 (12 600 ± 160 years; GSC XI, 1971, p. 268) collected to the east and with GSC-102 (12 720 ± 170 years; GSC II, 1963, p. 42) collected to the west; all three dates relate to sedimentation in the Goldthwait Sea. The date is younger than QU-85 (13 540 ± 300 years; Lebuis, 1973; Quebec I, 1977, p. 99) obtained on shells from stony marine clays 30 km to the west; the latter date is one of the oldest obtained thus far for the beginning of the marine transgression in the St. Lawrence estuary (Lebuis and David, 1977; GSC-1908, 13 800 ± 160 years, this list). Date based on one 3-day count in the 5 L counter.

Comment (W. Blake, Jr.): The sample also contained a few fragments of **Mya truncata,** although none were included knowingly in the sample submitted to the laboratory.

Lac Colin Series

Organic sediment (sample MS-73-20) from a small semicircular lake (long dimension of about 320 m) in a bedrock basin surrounded by rugged bedrock hills, 13 km northwest of Saint-Fabien-de-Panet, Quebec (46°43'00"N, 70°17'37"W), at an elevation of 658 m. The core was obtained with a Livingstone sampler in 1.5 m of water; 672 cm of brown algal gyttja overlies, in turn, 4 cm of black laminated gyttja, 11 cm of dark grey and black, banded, silty gyttja and 7 cm of black and grey, banded, organic clay. Below the 694 cm level is a layered light grey clay with minor organic content near the contact with the overlying sediments. Collected 1973 by R.J. Mott.

GSC-2420. Lac Colin, 88-92 cm — 2530 ± 80; $\delta^{13}C$ = -27.3‰

Algal gyttja (78 g wet) from 88 to 92 cm below the sediment/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-2337. Lac Colin, 147.5-152.5 cm — 3310 ± 100; $\delta^{13}C$ = -28.0‰

Algal gyttja (65 g wet) from 147.5 to 152.5 cm below the sediment/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-2333. Lac Colin, 296-300 cm — 4850 ± 90; $\delta^{13}C$ = -27.9‰

Algal gyttja (77 g wet) from 296 to 300 cm below the sediment/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-2329. Lac Colin, 468-472 cm — 6310 ± 110; $\delta^{13}C$ = -28.0‰

Algal gyttja (71 g wet) from 468 to 472 cm below the sediment/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-2412. Lac Colin, 568-572 cm — 7290 ± 160; $\delta^{13}C$ = -27.5‰

Algal gyttja (84 g wet) from 568 to 572 cm below the sediment/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-2325. Lac Colin, 664-668 cm — 8990 ± 100; $\delta^{13}C$ = -27.0‰

Algal gyttja (77 g wet) from 664 to 668 cm below the sediment/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-2406. Lac Colin, 676-680 cm — 9760 ± 180; $\delta^{13}C$ = -28.8‰

Dark brown laminated gyttja (85 g wet) from 676 to 680 cm below the sediment/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-2282. Lac Colin, 688-694 cm — 11 100 ± 180

Basal organic sediment (147 g wet) from 688 to 694 cm below the sediment/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.

Comment (R.J. Mott): These eight radiocarbon age determinations date prominent features of the pollen profile from this lake in the Notre Dame Mountains of southeastern Quebec. GSC-2282 dates the shrub/herb pollen assemblage at the base of the profile; GSC-2406 the spruce **(Picea)** pollen maximum; GSC-2325 the boundary between the spruce and balsam fir **(Abies balsamea)** pollen zones; GSC-2412 the white pine **(Pinus strobus)** pollen maximum; GSC-2329 the end of the pine pollen zone; GSC-2333 the end of the hemlock **(Tsuga canadensis)** pollen zone; GSC-2337 the beginning of the upper hemlock pollen zone; and GSC-2420 the resurgence of spruce pollen. Details of the palynology and vegetational history are outlined in Mott (1977).

Lac Dufresne Series

Lac Dufresne (sample MS-69-13), a small lake in a bedrock basin close to the drainage divide, is located 13 km southeast of Armstrong, Quebec, 0.8 km west of the Maine border (45°51'N, 70°21'W), at an elevation of 650 m. Cores were taken with a Livingstone sampler in 6 m of water; 366 cm of algal gyttja overlies massive grey clay and laminated clay. Collected 1969 by R.J. Mott.

GSC-2442. Lac Dufresne, 40-45 cm — 1560 ± 90; $\delta^{13}C$ = -28.5‰

Silty organic lake sediment (42 g wet) from 40 to 45 cm below the sediment/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date is based on two 1-day counts in the 2 L counter.

GSC-2427. Lac Dufresne, 108-113 cm — 2860 ± 90; $\delta^{13}C$ = -29.1‰

Silty organic sediment (53 g wet) from 108 to 113 cm below the sediment/ 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-2359. Lac Dufresne, 214-219 cm — 5030 ± 130; $\delta^{13}C$ = -29.7‰

Silty gyttja (53.5 g wet) from 214 to 219 cm below the sediment/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-2424. Lac Dufresne, 280-285 cm — 8420 ± 160; $\delta^{13}C$ = -28.7‰

Silty gyttja (61 g wet) from 280 to 285 cm below the sediment/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-2345. Lac Dufresne, 345-349 cm — 9600 ± 140; $\delta^{13}C$ = -28.7‰

Silty organic sediment (85 g wet) from interval 345 to 349 cm below the sediment/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-1294. Lac Dufresne, 357-362 cm — 11 200 ± 160

Basal gyttja (99.8 g wet) from 357 to 362 cm below the sediment/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 (R.J. Mott): Prominent pollen zones and pollen zone boundaries are dated which allow the chronology of the vegetational history of the Frontier Mountains of southeastern Quebec to be outlined. GSC-1294 dates the spruce **(Picea)** pollen indicative of spruce woodlands which displaced the earlier tundra vegetation of the area. GSC-2345 marks the change to closed forests of pine **(Pinus)**, balsam fir **(Abies balsamea)**, and birch **(Betula)**. The pine pollen maximum is dated by GSC-2424, the decline of hemlock **(Tsuga canadensis)** by GSC-2359, the beginning of the rise in beech **(Fagus grandifolia)** by GSC-2427, and the resurgence of spruce by GSC-2442. Palynological details and the history of vegetation have been described by Mott (1977), and a general outline of the pattern and chronology of deglaciation has been provided by Gadd et al. (1972).

GSC-1353. Lac aux Araignées, 913-924 cm — 10 700 ± 310

Basal organic sediment from Lac aux Araignées (sample MS-69-14), a large lake occupying a bedrock (granite) basin. The lake has several bays, the largest of which is West Bay, located 13 km east of the town of Lac-Mégantic, Quebec (45°28'N, 70°45'W), at an elevation of 406 m. Cores were collected in 11 m of water with a Livingstone sampler. Fine detritus algal gyttja overlies grey, stiff inorganic clay; no sharp contact occurs between the two units. Organic content decreases gradually until it is less than 0.5 per cent at a depth of 950 cm. The dated increment (121 g wet) was in the basal organic sediment at a depth of 913 to 924 cm below the sediment/water interface. Collected in 1969 by R.J. Mott and W.W. Shilts.

Comment (R.J. Mott): With retreat of the ice west of the drainage divide, a glacial lake occupied the valley in which Lac aux Araignées is presently situated, and inorganic clay was probably deposited in the basin (cf. Gadd et al., 1972). Further retreat of the ice front caused the glacial lake to drain and allowed organic accumulation to begin. The date is a minimum for the draining of the lake. No pollen analyses were conducted on this core. NaOH leach omitted because of the low organic content. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-1289 Lac à la Truite, 623-630 cm — 11 000 ± 240

Basal organic sediment (sample MS-69-11; 83 g wet) from Lac à la Truite (on Mont Sainte-Cécile), a small lake in a bedrock basin located 15.3 km north-northwest of

Lac Mégantic, Quebec (45°42.5'N, 70°57'W), at an elevation of 567 m. Cores were collected in 1.5 m of water with a Livingstone sampler; 630 cm of algal gyttja and silty algal gyttja overlay grey clay. The basal silty gyttja (83 g wet) from 623 to 630 cm below the sediment/water interface was dated. Collected 1969 by R.J. Mott and W.W. Shilts.

Comment (R.J. Mott): This high altitude basin became exposed when a deep reentrant in the ice front developed around Mont Sainte-Cécile and Mont Sainte-Sébastien; this occurred during construction of the Mégantic Moraine Complex (Shilts, 1970, in press; Gadd et al., 1972). The date is a minimum for deglaciation and for the beginning of organic accumulation in the lake. NaOH leach omitted because of the low organic content. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 l counter.

Saint-Nicholas Series

This rich fossil locality was frequented by J.W. Dawson who listed some 20 species (Wagner, 1967). The shells were collected in sand from a raised beach located east of the village of Saint-Nicholas, Lévis County, Quebec (46°41'45"N, 71°22'45"W), at an elevation of ca. 64 m. Collected 1970 by N.R. Gadd. Three determinations were made:

GSC-1451. Saint-Nicholas (I) 10 000 ± 150
$\delta^{13}C = +2.4$ ‰

Whole valves and fragments (sample GB-70-5(A); 48 g) of the brachiopod **Hemithyris psittacea** (identified by W. Blake Jr.). Although some of the brachiopods showed secondary carbonate encrustation, the individuals used were least affected and numerous individuals were intact and still articulated. Date based on two 1-day counts in the 5 L counter.

GSC-1508. Saint-Nicholas (II) 9950 ± 150
$\delta^{13}C = -0.8$ ‰

Fragments (sample GB-70-5(C); 46 g) of the mussel **Mytilus edulis** (identified by W. Blake, Jr.). Date based on one 2-day count in the 5 L counter.

GSC-1712. Saint-Nicholas (III) 11 100 ± 150
$\delta^{13}C = +2.2$ ‰

Fragments (sample GB-70-5(B); 47 g) of the barnacle **Balanus hameri** (identified by N.R. Gadd). Date based on one 4-day count in the 5 L counter.

Comment (N.R. Gadd): Because of the great variety of species available from this site it was thought worthwhile to test possible age variations from one species to another. The results of determinations GSC-1451 and GSC-1508 are in close agreement, but GSC-1712 shows an obvious discrepancy. The greater age of GSC-1712 is, however, compatible with the fact that **Balanus hameri** is most commonly a deep water species and that in the sampled section it is found at the contact with, or within, the grey till that underlies the beach deposit. Probably **Balanus hameri** was picked up by ice advancing into Champlain Sea during a late surge of Laurentide ice. The age is therefore more compatible with an age obtained on the core of St. Narcisse Moraine (GSC-1526, 11 600 ± 630 years; GSC XV, 1975, p. 10-11), with dated shells from glaciofluvial deposits associated with the moraine (GSC-1729, 11 300 ± 160 years and GSC-2045, 11 100 ± 90 years; Occhietti, 1977), and with a date on ice-contact drift west of Saint-Nicholas (GSC-1476, 11 200 ± 170 years; Gadd et al., 1972; this list). The ages of sessile **Mytilus edulis** and **Hemithyris psittacea**, both shallow water species, are logically more compatible with that of beach modification of the St. Narcisse Moraine (cf. GSC-1444, 10 000 ± 150; GSC XV, 1975, p. 11) in the late phase of the Champlain Sea. The occurrence of abundant fossils of great variety at low level (64 m a.s.l.) seems to support a concept of increasing temperature and salinity in the late stages of Champlain Sea.

GSC-1476. Saint-Nicholas 11 200 ± 170

Barnacle shells (Quebec series No. 8; 46 g); **Balanus hameri;** (identified by P. LaSalle) from a deposit interpreted as being ice-contact drift (till) in a gravel pit 3.2 km west of Saint-Nicholas, Quebec (46°41.8'N, 71°27.3'W), at an elevation of ca. 61 m. The shell-bearing unit underlies 3 m of gravel. Collected 1970 by P. LaSalle, Ministère des richesses naturelles, Québec.

Comment (P. LaSalle): Of the three samples of dated **Balanus** collected in glaciomarine drift in the Quebec City area, GSC-1476 is the only one that suggests the presence of glacier ice across the St. Lawrence at the time the shells were being deposited. The date also is a maximum for the time of emplacement of the St. Narcisse Moraine (LaSalle and Elson, 1975; cf. GSC-1232, 11 100 ± 160 years, and GSC-1295, 11 200 ± 160 years, both in GSC XVI, 1976, p. 6; and GSC-1712, 11 100 ± 150 years, this list). Date based on one 3-day count in the 5 L counter.

GSC-1855. Saint-Louis-de-Champlain 340 ± 80

Rostrum of a swordfish (sample NMC-12456 (Fish Collection Catalog No. NMC-67-172); 402 g; **Xiphias gladius;** identified by D.E. McAllister, National Museum of Natural Sciences, Ottawa) collected from clay during excavation of a reservoir 2.25 km west-northwest of Saint-Louis-de-Champlain, Quebec (46°25.7'N, 72°37.5'W), at an elevation of ca. 53 m. The clay underlies an estimated 4 m of peat. Collected by an unknown farmer and submitted 1966 via R. Ribes, Museé d'Archéologie, Trois-Rivières, Quebec, by C.R. Harington, National Museum of Natural Sciences, Ottawa.

Comment (C.R. Harington): Although originally considered to have been derived from deposits possibly of Champlain Sea age, the date certainly indicates that this swordfish sword was transported to the area by early settlers or native people. The swordfish is a warm water species which, at present, only sporadically reaches the Gulf of St. Lawrence. It is unlikely to have been an occupant of the relatively cold Champlain Sea.

Comment (W. Blake, Jr.): This well preserved and solid rostrum had been transformed into a sword by the farmer's son, i.e., sawn, varnished, and helved. The outside was sanded clean by J.G. Fyles and family. The sample showed no reaction with HCl or H_3PO_4 and so was treated with acetic acid in order to obtain the bone apatite fraction for dating. Sample mixed with dead gas for counting. Date based on one 1-day count in the 2 L counter.

Saint-Césaire Series

Marine pelecypod shells and wood from the same bed of marine clay exposed in a large borrow pit near Saint-Césaire, Quebec (45°24'N, 73°02.5'W), at an elevation of ca. 48 m. The exposure revealed 1 to 2 m of sandy gravel overlying, in downward succession, 2 to 3 m of marine clay (with shells and wood), 1 m of well banded freshwater(?) clay, and proglacial crossbedded sandy gravel. Nearby, an exposure revealed marine clay lying on till over gravel. Presumably the till lies stratigraphically below the freshwater(?) clay.

GSC-2586. Saint-Césaire, shells 10 300 ± 90
$\delta^{13}C = +1.1$ ‰

Shells (sample PC-6/77; 46.7 g; **Hiatella arctica;** identified by R.J. Richardson). Many paired shells were noted while the collection was being made. Collected 1977 by V.K. Prest. Uncorrected age: 10 300 ± 90 years.

GSC-2861. Saint-Césaire, wood 10 500 ± 90
$\delta^{13}C = -26.7‰$

Wood (sample PC-6/77(A); 11.2 g; **Picea** sp., identified by L.D. Farley-Gill and R.J. Mott) from a 'bush', the total length of which was approximately 1 m; maximum diameter was up to 3.0 cm at the thick end, 1.3 cm at the small end. Collected 1977 by F. Mayr, Université du Québec à Montréal; submitted by V.K. Prest. Uncorrected age: 10 600 ± 90 years.

Comment (V.K. Prest): The small 'bush' was found in an inclined position, spanning some 35 cm of horizontal clay beds. The shells were collected a few weeks later from within a metre of the site and near the middle of the section 'spanned' by the wood. The determinations on shell and wood are in close agreement, but in view of the accuracy of the ages, the wood may be interpreted as being slightly older than the shells. These comparative datings contrast with those from Mont Saint-Hilaire, 17 km to the north-northwest, where the shells were between 450 and 950 years older than accompanying woody debris (cf. GSC-2195 and -2200, this list).

Comment (W. Blake, Jr.): The 'bush' in reality appears to be part of a spruce root (cf. unpublished GSC Wood Identification Report 79-25, by L.D. Farley-Gill, and 79-52, by R.J. Mott); the firm wood was dry and hard when received by the laboratory, and it had a sulphurous odour when cut. All outside wood, plus adhering bark, was cut away. The aragonitic shells (all <3 cm in length) were thin and fragile, with chalky exteriors and no periostracum remaining; the internal lustre remained. Both GSC-2586 and -2861 were based on one 3-day count in the 5 L counter. The fact that this pair differs in age relationship from the results obtained on the Mont Saint-Hilaire series indicates that additional collections are needed to investigate the problem further. Arbitrarily assigning a correction factor based on the data from Mont Saint-Hilaire would have the effect in this case of making the shells even younger with respect to the associated wood.

Mont Saint-Hilaire Series

Marine pelecypod shells and wood collected from a borrow pit on the south side of Mont Saint-Hilaire, Quebec (45°31.8'N, 73°08.5'W), at an elevation of ca. 43 ± 2 m (determined by interpolation from the topographic map). Collected 1975 by F. Mayr, Université du Québec à Montréal; submitted by V.K. Prest.

GSC-2195. Mont Saint-Hilaire (I) 10 800 ± 100
$\delta^{13}C = -3.0‰$

Marine pelecypod shells (sample PC11b/75; 76.4 g; **Macoma balthica**, identified by W. Blake, Jr.) from an organic detritus layer overlying, in turn, marine clay with shells, and sand with shells. The organic detritus band was overlain by alluvial clay containing wood. Many shells were paired, with intact periostracum, and many were in growth position. **Portlandia arctica, Mya** sp., and **Balanus** sp. were also present, together with an unidentified pelecypod and gastropod. Two determinations were made:

GSC-2195. Outer fraction 11 000 ± 100

This fraction represents 11 to 55 per cent of shell material after the outermost 10 per cent was removed by HCl leach.

GSC-2195. Inner fraction 10 800 ± 100

This fraction represents 56 to 100 per cent of shell material. Uncorrected age: 10 900 ± 100 years.

Comment (V.K. Prest): These shells should date the closing phase of the Champlain Sea in this location, but they appear somewhat old. Wood from the same detritus layer, however, gave an uncorrected date of 10 100 ± 150 years (GSC-2200, this series); this date appears to be a better approximation for the close of the Champlain Sea here, and it suggests that the marine shells are "too old" by some 700 years.

Comment (W. Blake, Jr.): This sample was a large and well preserved collection of aragonitic shells, and many valves retained their internal lustre. Some portions of the sample were cleaned of adhering clay by washing in tap water. The largest valves in the sample were 2.3 cm long by 1.8 cm high. Depending on how the error terms are applied, the difference in age between the inner fraction of shells (GSC-2195) and the wood from the same detritus band may be as little as 450 years or as much as 950 years. For another comparison, where a larger piece of wood was available, the reader is referred to the Saint-Césaire series, GSC-2586 (10 300 ± 90 years, shells) and GSC-2861 (10 500 ± 90 years, wood), both in this list.

GSC-2200. Mont Saint-Hilaire (II) 10 100 ± 150

Wood (twig) from an organic detritus layer (sample PC11a/75; 2.0 g; unidentified) containing shells, overlying marine clay with shells, and overlain by alluvial clay with some wood.

Comment (V.K. Prest): The wood from the wood/shell horizon should date the closing phase of Champlain Sea on Mont Saint-Hilaire (see Prest and Hode-Keyser, 1977). The date of 10 100 ± 150 years appears to be in order although the date is uncorrected. Wood from the overlying alluvial clay was dated at 8840 ± 100 years (GSC-2216, uncorrected, this series).

Comment (W. Blake, Jr.): The first piece of wood submitted to the laboratory (6.3 cm long and 1.8 cm in diameter; weight 1.6 g) was identified as **Abies balsamea** (unpublished GSC Wood Identification Report No. 75-51, by L.D. Farley-Gill), but the CO_2 derived from burning this sample was lost, hence a new sample was prepared. The second sample was also a single piece of wood, 4.0 cm long and 1.5 x 1.0 cm in cross-section. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter. For further details on plant and insect fossils in the detritus layer, as well as pollen, the reader is referred to Mott et al. (in press).

GSC-2216. Mont Saint-Hilaire (III) 8840 ± 100

Wood (twigs) from a 50 cm thick alluvial clay layer (sample PC11d/75; 5.5 g; **Populus** sp.; identified by R.J. Mott) overlying the detritus from which GSC-2195 and -2200 (this series) were collected.

Comment (V.K. Prest): This date is also uncorrected for isotopic fractionation, but it appears in order for a post-Champlain Sea alluvial event.

Comment (W. Blake, Jr.): It is unlikely that the correction for isotopic fractionation would affect any of the age determinations by more than ± 100 years. This correction was not made because the aliquots of gas from GSC-2200 and from the outer fraction of shells (GSC-2195) were inadvertently lost en route to the University of Waterloo. For GSC-2216 only the single largest piece of wood (9.7 cm long and with a maximum diameter of 1.8 cm) was used for the age determination. Other species present in the sample include **Larix laricina** and **Picea** sp. (unpublished GSC Wood Identification Report No. 75-68 by R.J. Mott). Date based on one 2-day count in the 2 L counter.

GSC-2414. Saint-Stanislas-de-Kostka 9750 ± 150

Freshwater bivalve shells (sample RAB-76-28; 33.2 g; **Lampsilis siliquoidea**, identified by A.H. Clarke, Jr., formerly National Museum of Natural Sciences, Ottawa, now Smithsonian Institution, Washington, D.C.) from a drainage ditch cut into yellowish sand overlying a marine silty clay 3.5 km southeast of Saint-Stanislas-de-Kostka, Beauharnois County, Quebec (45°09'30"N, 74°05'45"W), at an elevation of ca. 47 m. Collected 1976 by S.H. Richard.

Comment (S.H. Richard): The dated aragonitic shells were recovered from lacustrine sand deposited in Lampsilis Lake 5 to 6 m below the lowest shoreline of the Champlain Sea (cf. GSC-2423, 10 600 ± 140 years; this list). Lampsilis Lake succeeded Champlain Sea in this area to the south and west of Valleyfield and in St. Lawrence Lowland south of Montreal (Elson, 1962, 1969; Elson and Elson, 1959). The date is the first obtained on fossil shells of the freshwater mollusc **Lampsilis siliquoidea** from estuarine-lacustrine sands overlying Champlain Sea sediments within the Lampsilis Lake basin limits as identified and mapped by Elson, Prest, and Terasmae (cf. Richard, 1977), although Gadd collected shells identified as **Lampsilis** sp. southwest of Bourget, Ontario (GSC-1968, 10 200 ± 90 years; GSC XVI, 1976, p. 6). The date is somewhat older than the age of 9500 years estimated by Terasmae (1965) or of 9300 years estimated by Elson (1968) to mark the end of the Champlain Sea episode. Date based on one 4-day count in the 2 L counter.

GSC-2265. Saint-Lazare-de-Vaudreuil 10 600 ± 130
$\delta^{13}C = +1.1$ ‰

Pelecypod shells (sample RAB-75-55F; 27 g; **Hiatella arctica**, identified by W. Blake, Jr.) from the upper part of a lens of dark grey stony diamicton (containing striated clasts) underlying fossiliferous sand and gravel in a gravel pit located 3.5 km southwest of Saint-Vaudreuil, Vaudreuil County, Quebec (45°23'00"N, 74°11'10"W), at an elevation of ca. 84 m. This site is near the distal end of an ice marginal delta. Collected 1975 by S.H. Richard, R.J. Fulton, and E.B. Owen.

Comment (S.H. Richard): The shell-bearing diamicton is interpreted as being a till derived from fossiliferous marine beds and emplaced by a late readvance or fluctuation of the margin of the Laurentide Ice Sheet into the Ottawa-St. Lawrence lowland.

Comment (W. Blake, Jr.): The reader is referred to comments following GSC-2108 (11 200 ± 100 years, Newington, Ontario) and GSC-2391 (10 500 ± 110 years, Sainte-Justine-de-Newton, Quebec; both in this list). Sample GSC-2265 was composed of intact valves for the most part, including at least six pairs; the exterior surfaces of these aragonitic shells were chalky but the internal lustre was preserved. The shells showed no evidence of being worn by transport, and a few bits of periostracum remained intact; they varied in length from 1.3 to 2.6 cm, in height from 0.7 to 3.1 cm. Sample mixed with dead gas for counting. Date based on one 3-day count in the 5 L counter.

GSC-2296. Rigaud 11 200 ± 90
$\delta^{13}C = +1.7$ ‰

Pelecypod shells (sample RAB-75-33; 50.0 g; **Hiatella arctica**, identified by W. Blake, Jr.) from a sand pit in a beach deposit of the Champlain Sea on Rigaud Mountain 3.2 km south of Rigaud, Vaudreuil County, Quebec (45°26'45"N, 74°19'40"W), at an elevation of 160 m. Collected 1975 by S.H. Richard.

Comment (S.H. Richard): GSC-2296 provides a minimum age for deglaciation of the top and southern flank of Rigaud Mountain. Gravel and sand near the top of Rigaud Mountain, at an elevation of ca. 192 m, did not yield any marine fossils, but these materials are believed to represent beaches formed at the marine limit in the area. A beach deposit 1.0 km east of the dated deposit, at an elevation of ca. 180 m, contained fragments of **Hiatella arctica** and **Macoma balthica** but not enough was recovered for radiocarbon dating (Richard, 1976). This date on Rigaud Mountain corresponds with GrN-1697, 11 490 ± 110 years, on shells collected by Elson from 172 m "at or near marine limit" on Mont Royal, 50 km to the east (Elson, 1969).

Comment (W. Blake, Jr.): In addition to the pelecypod species named above the sample contained fragments of **Mytilus edulis** and **Balanus** sp. Only aragonitic whole shells of **Hiatella arctica** were utilized for dating; all valves were between 2.0 and 3.5 cm in length, without periostracum or internal lustre. Most shells were thin and fragile (the thickest valves attain 3 mm), with chalky exteriors, commonly pitted. Date based on one 3-day count in the 5 L counter.

GSC-2453. Beaver Crossing 10 500 ± 80
$\delta^{13}C = +1.6$ ‰

Pelecypod shells (sample RAB-76-25 B+C; 39.0 g; **Hiatella arctica**, identified by S.H. Richard) from a sand and gravel pit in the Beaver Crossing end moraine. Shells lie within coarse sand and fine gravel in the core of an end moraine ridge (11 to 12 m below ground surface) 1.2 km northeast of Beaver Crossing, Huntingdon County, Quebec (45°01'25"N, 74°21'10"W), at an elevation of ca. 67 m. The site is 3.4 km north of the New York State border. Collected 1976 by S.H. Richard.

Comment (S.H. Richard): The dated shells were extracted from deep inside the core of a well developed end moraine that is composed mainly of outwash and deltaic materials (Richard, 1977). The unit containing the dated material is overlain by fossiliferous diamicton and undisturbed fossiliferous beach deposits.

Comment (W. Blake, Jr.): The sample utilized for dating was composed of 57 right valves, 61 left valves, and 70 fragments (all identifiable as **Hiatella arctica** and aragonitic). All valves were less than 2.6 cm in length, and most exhibited minor pitting and encrustations on their surfaces. The HCl leach was reduced to 10 per cent. Date based on one 3-day count in the 5 L counter.

GSC-2423. Cazaville 10 600 ± 140

Pelecypod shells (sample RAB-76-54; 17.6 g; **Macoma balthica**, identified by S.H. Richard) from a borrow pit cut into sand of the lowest beach of the Champlain Sea 2.3 km northwest of Cazaville, Huntingdon County, Quebec (45°06'15"N, 74°23'25"W), at an elevation of ca. 55 m. Collected 1976 by S.H. Richard.

Comment (S.H. Richard): GSC-2423 was determined on shells recovered from a shallow water/shoreline sand forming the lowest beach of the Champlain Sea in the area south of the St. Lawrence River between Valleyfield and Fort Covington and south and west of Montreal Island (Richard, 1977). The date agrees with a date of 10 600 ± 200 years (L-604C) obtained for shells from the lowest Champlain Sea beach, elevation 61 m, near Summerstown some 14 km to the west of Cazaville (GSC I, 1962, p. 17; Terasmae, 1965; Mott, 1968). After the sea fell below 55 m a change from marine to freshwater environment took place, and Lampsilis Lake came into existence (Elson and Elson, 1959; Elson, 1962). A radiocarbon date of 9750 ± 150 years (GSC-2414; this list) has been obtained for shells of **Lampsilis siliquoidea** recovered in a shallow water sand lying over a Champlain Sea silty clay at an elevation of ca. 47 m at Saint-Stainislas-de-Kostka, some 23 km east of Cazaville.

Comment (W. Blake, Jr.): It is worth noting that younger marine shells have been found to the west, at Russell, Ontario; there, **Macoma balthica** and **Macoma calcarea** at 70 m were dated at 10 000 ± 320 years (GSC-1553; GSC XIII, 1973, p. 19). The shells in GSC-2423, though chalky, pitted, and in general presenting a soiled and weathered appearance, were intact valves for the most part. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Sainte-Justine-de-Newton Series

Pelecypod shells collected from a drainage ditch exposing marine sediments 3.2 km southwest of Sainte-Justine-Station, Quebec (45°20'25"N, 74°27'00"W).

GSC-2261. Sainte-Justine-de-Newton (I) — 10 300 ± 100; $\delta^{13}C = +1.5‰$

Pelecypod shells (sample BS-29.10.75-Stop 2; 26.5 g; **Mya truncata** L., identified by W. Blake, Jr.) from fossiliferous sand overlying compact, silty to clayey diamicton at an elevation of ca. 75 m. Collected 1975 by W. Blake, Jr. and E.B. Owen.

GSC-2391. Sainte-Justine-de-Newton (II) — 10 500 ± 110; $\delta^{13}C = +1.5‰$

Pelecypod shells (sample RAB-76-6; 22.8 g; **Hiatella arctica,** identified by R.J. Richardson) from the top of a compact silty diamicton (containing striated clasts) overlain by fossiliferous sand, at an elevation of 74 m. Collected 1976 by S.H. Richard and R.J. Richardson.

Comment (S.H. Richard): GSC-2261 is from a shallow water, low level beach sand deposit of the Champlain Sea (Richard, 1976). The sample consisted of articulated valves found upright in living position at the base of the sand with the lower part of the specimens anchored in the underlying diamicton. Specimens of other macrofaunal species found in situ in the marine beach deposit include **Mya arenaria, Mytilus edulis,** and **Macoma balthica.** This macrofaunal marine assemblage reflects cold temperate marine water conditions, and the age indicates deposition near the end of the Champlain Sea episode. This phase of the sea lasted from between 10 900 to 10 600 years to approximately 10 000 to 9800 years ago in the central part of the basin around Montreal and has been called the **Mya arenaria** phase of the Champlain Sea (Elson and Elson, 1959; Elson, 1964; 1969; Cronin, 1977). This is the farthest west reported occurrence of **Mya truncata** in Champlain Sea sediments (cf. Wagner, 1970). The shell-bearing diamicton (GSC-2391, 10 500 ± 110 years) underlying the sand is interpreted as a till derived from fossiliferous marine beds and emplaced by a late readvance or fluctuation of the margin of the Laurentide Ice Sheet into the Ottawa-St. Lawrence lowland.

Comment (W. Blake, Jr.): The estimated age of the shells comprising GSC-2391 was 11 200 to 11 100 years, because the submitter believed the shell-bearing diamicton to be correlative with the deposit at Newington, Ontario (GSC-2108, 11 200 ± 100 years, this list), which was interpreted as a till (Richard, 1975a,b). The younger age obtained makes it imperative that alternative explanations for these till-like deposits be considered (cf. Richard, 1977) because: (1) none of the older Champlain Sea deposits to the north and northwest show evidence of having been overridden and (2) pulses of an ice front on at least two occasions would be required to create shell-bearing tills whose contained fauna are of distinctly different ages. GSC-2391 mixed with dead gas for counting. Each date based on one 3-day count in the 2 L counter.

GSC-2189. Deschênes — 10 100 ± 130; $\delta^{13}C = +1.3‰$

Pelecypod shells (sample SK-73-10; 22.5 g; **Hiatella arctica,** identified by W. Blake, Jr.) from a freshly dug drainage ditch in pebbly sand 3.2 km north of Deschênes, Gatineau County, Quebec (45°24'40"N, 75°48'00"W), at an elevation of ca. 94 m. Collected 1973 by S.H. Richard.

Comment (S.H. Richard): The shells were recovered from a shallow water or shoreline pebbly sand that forms the lowest raised beach of the Champlain Sea in the Ottawa-Hull area (Richard, 1974; 1976; Richard et al., 1977). This date agrees with GSC-1553 (10 000 ± 320 years; GSC XIII, 1973, p. 19) obtained for marine pelecypod shells **(Macoma balthica** and **Macoma calcarea)** recovered from a Champlain Sea beach at an elevation of ca. 70 m near Russell, Ontario, some 45 km southeast of Deschênes. These two late marine phase dates appear to be in conflict with GSC-1968 (10 200 ± 90 years) on **Lampsilis** sp. shells at Bourget, Ontario, elevation ca. 53 m (Gadd, 1976; GSC XVI, 1976, p. 6).

Comment (W. Blake, Jr.): In considering the series of dates in the Ottawa and St. Lawrence River valleys, attention must be paid to differential postglacial rebound. For example, GSC-2189 at Deschênes (10 100 ± 130 years; 94 m) overlaps, age-wise, with GSC-2261 (10 300 ± 140 years; 75 m) at Sainte-Justine-de-Newton, more than 105 km to the east, as well as with GSC-1553 (10 000 ± 320 years; 70 m) as Richard has mentioned above. GSC-2189 also overlaps with GrN-2035 (10 330 ± 100 years, 97.6 ± 1.5 m) at Sainte-Joseph-du-Lac, more than 130 km to the east (Elson, 1969). Another pertinent date re this discussion is BGS-258 (9910 ± 150 years; Sharpe, 1979) on **Hiatella arctica** shells near Alexandria, Ontario (45°19'N, 74°42'W), some 38 km to the east-southeast of Bourget and at an elevation of ca. 99 to 107 m. The Brock University age determination is quoted with a 1σ error term. Using the 2σ criterion, as practised by the Geological Survey of Canada, the error term of approximately ±300 years results in the age overlapping with the age of the **Lampsilis** shells near Bourget, yet the marine sample is 45 m or more above the level of the freshwater sample.

Even if Richard's elevations are not precise (they are derived from the 1:50 000 contour maps with a contour interval of 50 feet, ~15 m), or even if the shells at Deschênes have been reworked by Ottawa River (cf. Gadd, 1963), it is clear that the sea level of ca. 10 000 to 10 300 years ago would be well above 70 m (that being the approximate elevation of the lowest site, near Russell). Thus GSC-1968 (10 200 ± 90 years) on **Lampsilis** sp. at only 53 m, is indeed difficult to accommodate; it would be easier to understand if a date closer to the age of the **Lampsilis** at Saint-Stanislas-de-Kostka (GSC-2414, 9750 ± 150 years; 47 m) had been obtained.

To my knowledge the only age determination thus far on wood from the western part of the Champlain Sea basin is one of 9860 ± 330 years (BGS-257) on material derived from gravel above silty marine gravel near Hawkesbury, Ontario (45°36'N, 74°34.5'W), at an elevation of ca. 61 m; the deposit enclosing the wood was interpreted by the collector (Q.H.J. Gwyn) as a channel deposit of the ancestral Ottawa River (cf. Sharpe, 1979).

The whole problem of the history of the Champlain Sea needs further attention. Resampling should be undertaken to obtain other material, for example additional wood samples, to check the ages of both freshwater and marine molluscs. In addition, the elevations of all samples should be carefully determined by instrumental levelling from bench marks.

GSC-2239. La Grand Rivière 7290 ± 90

Shells (sample Diques Duncan; 26.0 g; **Hiatella arctica;** identified by W. Blake, Jr.) collected in living position, with joined valves, in a thick gravel deposit situated at Mile 363 on the access road to La Grande Rivière, 13 km east of the Sakami Moraine and 20 km south of La Grande Rivière, Québec (53°35'N, 77°30'W), at an elevation of 175 m. The aragonitic shells were extracted from the base of a 60 cm thick clayey silt layer interstratified within a 30 m thick fluvioglacial delta. Collected 1975 by L. Hardy, then at Laboratoires Ville-Marie, Inc., Laval, Quebec; now at Les Consultants SOGEAM, Lachine, Quebec.

Comment (V.K. Prest): As the Sakami Moraine dates from about 7800 years ago (QU-122, 7880 ± 160 years; QU-124, 7750 ± 180 years; both in Hardy, 1977; cf. also Quebec II, 1977, p. 446), and the rate of ice retreat was approximately 220 m per year (Vincent, 1977), it may be that the ice stood at the Sakami position for some 400 years or more (Hardy, 1977). This moraine is composed mainly of stratified ice-contact deposits and extends north-northeast from Lac Mistassini to Poste-de-la-Baleine. Sample mixed with dead gas for counting. Date based on one 3-day count in the 5 L counter.

GSC-2244. Matagami-LG2 road 6810 ± 80
$\delta^{13}C = +2.1$ ‰

Shells (sample Mi365; 26.0 g; **Hiatella arctica;** identified by W. Blake, Jr.) collected in a gravel deposit situated 500 m east of the Matagami-LG2 road at Mile 365, Quebec (53°37'N, 77°43'W), at an elevation of 168 m. The aragonitic shells were very fragile, and many valves were unattached. The sample was extracted from a 30 cm thick silty sand layer covered by a 14 m thick coarse gravel unit situated on the eastern (proximal) slope of the Sakami Moraine. Collected 1975 by L. Hardy, then at Laboratoires Ville-Marie, Inc., Laval, Quebec; now at Les Consultants SOGEAM, Lachine, Quebec.

Comment (L. Hardy): The initial interpretation was that this date would give a minimum age for the formation of the Sakami Moraine (Hardy, 1976). The result of the age determination of these shells, as well as the stratigraphy of the gravel deposit, indicates that the sample gives the age of the 170 m shoreline of the regressing Tyrrell Sea. Sample mixed with dead gas for counting. Date based on one 3-day count in the 5 L counter.

Comment (J-S. Vincent): The shoreline dated by this sample must be above 170 m, as **Mytilus edulis** shells at an elevation of 175 m from a roadcut at Mile 363 are 6500 ± 90 years old (GSC-1959; GSC XVII, 1977, p. 7; Vincent, 1977).

Comment (V.K. Prest): As the shells were overlain by 14 m of coarse gravel considered to be ice contact in origin and to relate to the formation of the Sakami Moraine itself, this date is about 1000 years too young with respect to other dates on the moraine (QU-122, 7880 ± 160 years, QU-124, 7750 ± 180 years; both in Hardy, 1977; cf. also Quebec II, 1977, p. 446).

Ontario

GSC-2108. Newington 11 200 ± 100

Pelecypod shells (sample RAB-74-24; 34.8 g; **Hiatella arctica,** identified by W. Blake, Jr.) from grey, compact silty to sandy diamicton underlying fossiliferous marine gravel and sand in a gravel pit exposure 1.7 km south of Newington, Stormont County, Ontario (45°06'15"N, 75°01'00"W), at an elevation of ca. 100 m. The diamicton contains striated limestone clasts. Collected 1974 by S.H. Richard.

Comment (S.H. Richard): The shell-bearing diamicton is interpreted as being a till derived from fossiliferous marine beds and emplaced by a late readvance or fluctuation of the margin of the Laurentide Ice Sheet into the Ottawa-St. Lawrence lowland.

Comment (W. Blake, Jr.): The comments made with regard to the shell-bearing diamicton at Sainte-Justine-de-Newton (GSC-2391; 10 500 ± 110 years; this list) apply to GSC-2108 as well. It is also worth noting that material 11 100 to 11 300 years old corresponds precisely to the time when the St. Narcisse Moraine was forming along the north side of the St. Lawrence and Ottawa rivers (cf. Parry and Macpherson, 1964; LaSalle et al., 1972; LaSalle and Elson, 1975; Occhietti, 1977), and the position of the St. Narcisse Moraine is ca. 90 km north of Newington. The sample was composed of whole shells (up to 2.8 cm in length) and fragments; some valves were chalky on the exterior, but most retained their internal lustre. HCl leach reduced to 10 per cent. Date based on one 3-day count in the 5 L counter.

GSC-2448. Stittsville 11 300 ± 120

Marine pelecypod shells (sample GB-76-Rump 2; 19.2 g; probably **Hiatella arctica**) from distorted sand and silt in a fresh exposure in Rump's Sand Pit on Huntby Township Boundary Road, 1.6 km north of Stittsville, Ontario (45°17'N, 75°58'W), at an elevation of ca. 130 m (determination from topographic map). The horizon sampled, mainly a single circular structure about 0.9 m in diameter, included coarse and fine sand and clay bands and was ca. 3 m below ground surface. Collected 1976 by N.R. Gadd, R.J. Fulton, and colleagues.

Comment (N.R. Gadd): Convoluted structures of the sediments in the Rump gravel pit were used as "diagnostic criteria for subaqueous outwash" (Rust, 1977). Marine shells within the same convolutions gave a maximum age of 11 300 ± 120 years (GSC-2448; Gadd, 1978) for the formation of the structures. Because these structures are near a locality within the Champlain Sea basin where shorelines >12 000 years in age (Richard, 1975b) are preserved, it was deemed impossible for glacial readvance into Champlain Sea to have occurred at the time of the distortion of the sediments (Gadd, 1977). Therefore it has been concluded that the convolutions most probably are load-cast phenomena produced in the absence of glacier ice.

Comment (W. Blake, Jr.): The submitter recorded the presence of many juvenile shells in the collection, which was made up entirely of thin-walled shells. Unfortunately, a record does not seem to have been retained of which species was used for dating; judging by the fragments in the remainder of the sample, **Hiatella arctica** would seem to be the best possibility (including numerous juvenile shells). The other main species present, retaining internal lustre, is **Portlandia arctica;** in addition a few fragments of **Balanus** sp., **Mytilus edulis,** and **Macoma** sp. are represented. It is also of interest to note that **Macoma balthica** shells 2.4 km northeast of Almonte and ca. 18 km west of Rump's Sand Pit are 11 200 ± 160 years old (GSC-1172; GSC XIII, 1973, p. 19; elevation ca. 155 m), and a humerus of the bowhead whale, **Balaena mysticetus,** 2.1 km west of the town of White Lake and ca. 45 km west-northwest of Rump's Pit is 11 500 ± 90 years old (GSC-2269; this list; elevation ca. 170 m), are of similar ages. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2418. Pakenham 10 400 ± 80
$\delta^{13}C$= -13.6 ‰

Four cervical vertebrae of a white whale (sample NMC 21336; 44.5 g; **Delphinapterus leucas;** identified by C.R. Harington, National Museum of Natural Sciences, Ottawa), from a water well excavation 6 km northwest of Pakenham, Ontario (46°22.24'N, 76°20.42'W), at an elevation of ca. 107 m. The bones were found in wet blue clay with **Macoma balthica** shells, 4.3 m below the surface. Collected 1906 by P. Cannon, stored in J.A. Herrick's barn loft for many years, and submitted 1976 by C.R. Harington.

Comment (C.R. Harington): This date on bones from a rather young white whale, deposited in situ with marine pelecypods, corresponds closely with a date of 10 420 ± 150 years (GSC-454) on bone from another young white whale found in the Foster sand pit, Ottawa (Whiteaves, 1907; Harington 1972, 1977a). It seems reasonable that these small, gregarious whales that are well-adapted to inshore and freshwater conditions would be relatively common as fossils in the western part of the Champlain Sea during its later stages. Collagen fraction utilized. Date based on one 3-day count in the 5 L counter.

GSC-2402. Lanark Township 290 ± 40
$\delta^{13}C$ = -23.6 ‰

Antler (sample APM no. 1; 750 g) from a former cedar swamp in the east half of Lot 15, Concession 5, Lanark Township, Ontario (approximate co-ordinates 45°05'N, 76°23'W). The sample was stored for 75 years before dating. Indian artifacts were found in the vicinity, but are not necessarily related to the antler fragments collected in 1900 by J.W. Borrowman; submitted by D. Strickland, Ontario Ministry of Natural Resources, Whitney, Ontario.

Comment (C.R. Harington, National Museum of Natural Sciences, Ottawa): Antler fragments of at least two, and probably three adult male wapiti **(Cervus elaphus)** are represented in the collection. Probably the animals were present in Lanark Township during February to April, when the antlers are usually shed. Presumably the specimens represent the eastern subspecies **(C.e. canadensis)** that became extinct in Canada about 1850, and which is now completely extinct. This is the first radiocarbon date on wapiti from Ontario. It is not unusual to discover that wapiti lived east of Ottawa nearly 300 years ago. Other wapiti specimens from Ontario have been recorded from near Hamilton, Waterford, Kingston, Sydenham, Strathroy, and Lambton County (Spencer, 1883; Bell, 1898; Smith, 1901; Hay, 1923; Harington, 1977a). Other records not substantiated by specimens are noted by Peterson (1966). Collagen fraction utilized for dating. Date based on two 1-day counts in the 5 L counter.

GSC-2269. White Lake 11 500 ± 90
$\delta^{13}C$ = -13.5‰

Core samples from the centre of a complete whale humerus (sample CR-75-55; 1007 g) found in a fresh exposure of dry oxidized sand on the south side of Hanson's gravel pit, 2.1 km west of the western edge of the town of White Lake, Ontario (45°22'20"N, 76°31'40"W), at an elevation of ca. 170 m. The bone was overlain by about 3 m of sand and 2.5 m of gravel. Collected 1975 by A. Jones, White Lake; submitted by C.R. Harington, National Museum of Natural Sciences, Ottawa.

Comment (C.R. Harington): This date on solid bone from the humerus of a large, arctic-adapted bowhead whale **(Balaena mysticetus)** found on a high shoreline appears to be reasonable, marking the early, deep cold water phase of the Champlain Sea. The date is in accordance with Prest's (1970) views on the chronology of the Champlain Sea, but it does not correspond closely to the date of 12 800 ± 220 years (GSC-1859; Richard, 1974) on marine mollusc shells from a similar elevation at nearby Clayton, Ontario. Several other bones, probably from the same whale, have been recovered from Hanson's gravel pit (Harington, 1977a).

Comment (W. Blake, Jr.): After this fresh-appearing bone was cut up and crushed, approximately 800 g were utilized for dating of the collagen fraction. Date based on one 3-day count in the 5 L counter.

GSC-1664. Westmeath 11 000 ± 160
$\delta^{13}C$ = -1.6 ‰

Marine pelecypod shells (sample ONT-001; 27.0 g; **Macoma balthica;** identified by A.H. Clarke, Jr., formerly National Museum of Natural Sciences, Ottawa, now Smithsonian Institution, Washington, D.C.) from a clayey sand layer exposed in the freshly cut face of a gravel pit, 3.5 km west of Ottawa River (Sullivan Island) and 8.5 km southeast (along the road) of the town of Westmeath, Ontario (45°45'N, 76°50'W), at an elevation of 158 m. The 38 cm thick clayey sand unit, at the top of which the shells occur, together with the underlying band of reddish clay, was interpreted as being deeper water deposits than the sand and pebble units above. The sands and gravels beneath the clay were interpreted as being of fluvioglacial origin. Collected 1970 by P.J. Howarth, McMaster University, Hamilton; submitted by P.J. Howarth and S.B. McCann of the same institution.

Comment (W. Blake, Jr.): This age determination is similar to one of 10 870 ± 130 years (GSC-90; GSC II, 1963, p. 44) on marine pelecypod shells at 137 m elevation southeast of Pembroke. At that site the shell bearing sand and silty clay occurred as a lens above fluvioglacial gravel and sand and was overlain by laminated alluvial silty sand and Ottawa River gravel. As noted in Lowdon and Blake (1975, p. 13) the dates are also in agreement with the ages of basal gyttja: GSC-1516 (9830 ± 250 years) from Perch Lake at ca. 165 m northeast of Chalk River and GSC-177 (9540 ± 250 years) from a bog at ca. 152 m in a river channel on the Petawawa Sand Plain. Date based on one 3-day count in the 2 L counter.

Boulter Lake Series

Boulter Lake (sample MS-69-19) is a small kettle lake in an esker complex about 27 km east-northeast of Powassan, Ontario (46°19'15"N, 79°02'W), elevation ca. 340 to 345 m, with a maximum water depth of 8.2 m. A total of 760 m of algal gyttja overlies 4 cm of sand which in turn overlies a 5 cm thick layer of algal gyttja overlying the basal sand. Samples were taken with a Livingstone piston corer. Collected 1969 by R.J. Mott and J.E. Harrison, then with Geological Survey of Canada, now Ministry of State for Science and Technology, Ottawa (Harrison, 1972).

GSC-1429. Boulter Lake, 755-760 cm 11 500 ± 180

Algal gyttja (81 g wet) from 755 to 760 cm below the sediment/water interface. NaOH leach omitted from sample pretreatment. Date based on one 3-day count in the 2 L counter.

GSC-1363. Boulter Lake, 762-769 cm 11 800 ± 400

Basal algal gyttja (19 g burned) from 762 to 769 cm below the sediment/water interface. NaOH leach omitted from sample pretreatment. Date based on one 3-day count in the 1 L counter.

Comment (R.J. Mott): GSC-1363 was originally submitted to obtain a minimum date for the end of Main Lake Algonquin and initiation of drainage east through Ottawa Valley (cf. Karrow et al., 1975). The date obtained was much older than expected, and GSC-1429 was run to corroborate the first date. Despite the agreement between the two dates, pollen analysis shows that the pollen assemblages present in Boulter Lake are correlative with those obtained from a nearby lake, Morel Lake, which provided a basal date of 10 100 ± 240 years (GSC-1275, GSC XV, 1975, p. 13). The Boulter Lake dates, therefore, appear to be anomalously old, probably due to contamination by older carbonates.

Comment (W. Blake, Jr.): The gas used for GSC-1429 was also counted for 3 days in the 1 L counter, and a value of 11 400 ± 280 years was obtained. The result from the 2 L counter is preferred, however, because of the smaller error term.

GSC-2259. Hamilton 1770 ± 50

Wood (sample MPA 74003(03); 11.2 g; **Quercus** sp.; identified by R.J. Mott) from a borehole site behind the pool at Coronation Park, Hamilton, Ontario (43°15'53"N, 79°53'51"W), at an elevation of 82.3 m. The wood is from 5.5 m below the surface in medium grey silt and fine sand and is about 6.7 m above Lake Ontario and Cootes' Paradise. The site is behind the glacial Lake Iroquois beach. Collected 1974 by F.M. Morin, then Geological Survey of Canada, now Canadian International Development Agency, Senegal.

Comment (T.W. Anderson): Although the submitter expected the date to relate to the age of lagoonal material behind the Lake Iroquois beach, the wood was presumably washed in and buried by materials derived from slope erosion. The date provides an age for near-recent deposition behind the Iroquois beach rather than backshore deposition by glacial Lake Iroquois itself. Date based on one 3-day count in the 5 L counter.

GSC-2706. Dundas 3690 ± 50

Wood (sample BM2 SA6; 11.8 g; **Platanus occidentalis** L.; identified by R.J. Mott) from a borehole site (no. 2) at Cootes Drive (Highway 102) bridge on the south side of Spencer Creek, Dundas, Ontario (43°16'15"N, 79°55'30"W), at an elevation of 65 to 66 m. The wood occurred from 9.14 to 10.21 m below the surface in and at the base of organic silty clay. It is overlain by silty clay and silt and underlain by sand and sandy gravel, which, in turn, overlies laminated silty clay and silty till. Sample obtained in 1974 by D. Belshaw of Peto MacCallum Ltd., Concord, Ontario, by driving in steel BX casing; submitted by M.J. Pullen, Concord, Ontario, and T.W. Anderson.

Comment (T.W. Anderson): The sand and sandy gravel sequence is believed to be an alluvial deposit which is correlative with the low-water (Admiralty?) stage of Lake Ontario. The wood and enclosing organic silty clay presumably originated in a lagoonal habitat which developed on the exposed floodplain well after Lake Ontario fell to the low stage. The overlying silt is probably a recent floodplain soil development. The date thus provides an age for lagoonal initiation only, as the wood and organic sequence bear no relation to the late Holocene lake level changes in Lake Ontario proper. Date based on one 3-day count in the 5 L counter.

GSC-2148. Matheson >37 000

Moss peat (sample Hole 78; 30.0 g) in fine lacustrine sand at 12.0 to 13.1 m depth in a borehole 6.4 km south of Highway 101 and 12.0 km southwest of Matheson, Ontario (48°28'33"N, 80°36'42"W), at an elevation of ca. 274 ± 5 m (interpolated from the topographic map). The organic-bearing horizon is underlain by clay, a lower glacial unit consisting of gravel and tills, and bedrock, and is overlain by clay, gravel of the upper glacial unit, and varved clay. Collected 1975 by W.E. Brereton, then with Driftex, Ltd., Ottawa, now with MPH Consulting, Ltd., Toronto.

Comment (W. Blake, Jr.): The most common constituent of the peat is **Drepanocladus revolvens;** other mosses present include **D. exannulatus** (rare), **Calliergon giganteum** (rare), **C. sarmentosum** (rather frequent), **Meesea triquetra** (frequent), and **M. uliginosa** (one fragment). Brereton and Elson (1979) suggested a tentative correlation of the deposit with the Missinaibi Formation in the Moose River basin of the James Bay Lowland (cf. Skinner, 1973). Pebbles and more clayey lumps were removed from the sample, after oven drying, before it was sent to the laboratory. Sample mixed with dead gas for counting. Date based on one 4-day count in the 2 L counter.

GSC-1633. Kidd Creek Mine >28 000

Wood chips (sample T.G.S.(4-71-5); 2.1 g; **Picea** sp.; identified by R.J. Mott) from a hole drilled during a drift prospecting program of Texas Gulf Sulphur south of Kidd Creek Mine, in Kidd Township, 32 km north of Timmins, Ontario (48°45'N, 81°25'W), at an elevation of ca. 275 m. The wood chips, which appeared in the slurry, derived from a horizon of silt and fine sand lenses at 27 to 33 m depth; the wood-bearing horizon is underlain by clay, silt, and till bedrock at 44 m depth and is overlain by varved clay (of Lake Barlow-Ojibway), Cochrane till, and oxidized surface clay. Collected 1971 by R. Wiens, Texas Gulf Sulphur; submitted by R.G. Skinner, then Geological Survey of Canada, now Environmental Affairs Advisor, Department of Energy, Mines and Resources, Ottawa.

Comment (W. Blake Jr.): The material was expected to date the Barlow-Ojibway sediments, but it is derived from older material; cf. GSC-2148 (>37 000 years, this list) from Currie Township and GSC-1299 (>42 000 years; GSC XI, 1971, p. 276) from the site of Lower Notch Dam on Montreal River. The dated sample comprised 15 pieces, all <3.5 cm in length and <1 cm in diameter. All were light brown, were worn and rounded, and some had adhering silt. The identification was based on one of the larger fragments, but a cone present in the sample was **Picea mariana** (unpublished GSC Wood Identification Report No. 71-67 by R.J. Mott). Sample mixed with dead gas for counting. Date based on one 3 day count in the 2 L counter.

Western Canada

Manitoba

Elk Island Series

Fine fibrous sedge peat from a Shelby tube core 31 cm long, between elevations 214.3 m and 214.6 m (Geodetic), ca. 3.2 km north of Victoria Beach, Manitoba (50°44'N, 90°33'W). The peat layer is overlain by 2.9 m of wind- and water-sorted sand and gravel and underlain by clay. Collected 1978 by A. Swedlo, and submitted by F. Penner, Water Resources Division, Manitoba Department of Mines, Natural Resources and Environment, Winnipeg.

GSC-1980. Elk Island (I) 1060 ± 210

Peat (sample, Lake Winnipeg-1973-1 (top); 14.0 g dry) from the top 1.5 cm of the 31 cm long core.

GSC-1977. Elk Island (II) 1660 ± 60

Peat (sample, Lake Winnipeg-1973-1 (bottom); 6.0 g dry) from the bottom 1 cm of the 31 cm long core.

Comment (F. Penner): The deposit of peat is believed to be in situ. GSC-1977 and -1980 may date, respectively, the earliest and the latest periods when the level of Lake Winnipeg was ca. 3 m lower than at present due to lesser rebound of its northern outlet (cf. Penner and Swedlo, 1974).

Mean lake level for the period 1920 to 1966 is 217.4 m (Geodetic). GSC-1977 mixed with dead gas for counting; date based on two 1-day counts in the 5 L counter. GSC-1980 based on one 3-day count in the 1 L counter.

York Factory Series

Wood samples from exposures along Hayes River and Hayes River estuary, Manitoba.

GSC-1305. York Factory (I) 1930 ± 130
$\delta^{13}C = -25.3‰$

Wood (sample Site (2) no. 1; 16 g; **Picea** sp.; identified by R.J. Mott) from 2.4 km southwest of York Factory on the left bank of Hayes River (56°59'N, 93°39'W), at an elevation of 5.2 to 5.5 m above Hayes River, which is tidal at this point. Collected 1969 by S.J. Simpson, then at University of Manitoba, Winnipeg, now Ballymena, County Antrim, Northern Ireland.

GSC-1468. York Factory (II) 660 ± 190
$\delta^{13}C = -26.5‰$

Wood (sample Site (13) no. 1; 2.4 g) from the northwest bank of Hayes River estuary, ca. 3 km southwest of Marsh Point (57°03'N, 92°14'W), at an elevation of ca. 2.4 m. Collected 1970 by S.J. Simpson.

Comment (W. Blake, Jr.): These two age determinations are part of a series used by Simpson (1972) to construct a postglacial uplift model for the lower Hayes River area. GSC-1305 and GSC-1468 are based on two 1-day counts in the 5 L counter and the 1 L counter, respectively.

GSC-2820. Chaucer 980 ± 60

Wood (sample AR-12; 11.9 g; **Fraxinus** sp.; identified by R.J. Mott) from blue-grey fossiliferous clay, with minor pebbles, in a river-cut exposure, 4.8 km west of Chaucer, Manitoba, in SE sec. 31, tp. 7, rge. 15, west of principal meridian (49°38'N, 99°30'W), at an elevation of ca. 320 m. The shell-bearing clay, extending to ca. 2 m above the level of Assiniboine River, was 6^{+} m below the ground surface. The strata immediately above the clay are obscured by slumping; above, in succession, are clay with sand, or paleosol, coarse sand and horizontally bedded pebble gravel, clay, medium sand, and gravel. Collected 1978 by S. Ringrose, Manitoba Department of Mines, Resources, and Environmental Management, Winnipeg.

Comment (W. Blake, Jr.): The age expected by the submitter was 13 000 to 14 000 years, as the sample was thought to complement the Thornhill Terrace series (cf. GSC XVI, 1976, p. 8) with respect to the inception of Lake Agassiz I in Manitoba. The pollen assemblage, however, suggested an age of <10 000 years (unpublished GSC Palynological Report No. 79-1 by R.J. Mott). The wood must relate to the slumped materials rather than to a horizon below the paleosol. The wood, which was charred on the surface, was cleaned in distilled water using a sonic bath. Date based on one 1-day count in the 5 L counter.

GSC-2761. Sclater 840 ± 50

An organic detritus layer (sample E.N.-1978; 64.4 gm) ca. 5 cm thick from 1.7 m depth in a 4.5 m high alluvial fan section at Sclater, Manitoba (51°55.7'N, 100°34.0'W), at an elevation of 340 m. The sample was collected from a peaty horizon 0.3 m below the base of a horizon of tree stumps buried in the alluvium. Both the peaty horizon and the overlying "tree stump" horizon are exposed for a distance of about 1 km along the length of the fan. Collected 1978 by E. Nielsen, Manitoba Department of Mines, Natural Resources and Environment, Winnipeg.

Comment (E. Nielsen): Assuming that the fan is built on a nearly horizontal till surface, calculations based on the slope of the surface and the approximate extent of the fan indicate that the deposit is at most 6 m thick at the sampling site. Extrapolation based on the sedimentation rate indicates the fan is therefore not more than 3000 years old. The initiation of the formation of the fan is tentatively correlated with the increase in precipitation in the area at between 2500 and 3500 years ago (Bryson and Wendland, 1967; Ritchie 1969). The organic-rich horizon marks a pronounced disconformity in the alluvial fan sequence and probably represents a period of reduced precipitation in the area. The date and its paleoclimatic implications do not substantiate the conclusion by David (1971) that paleosols in the Brandon Sand Hills, 235 km south of Sclater, dated at 920 ± 140 years and 890 ± 130 years, (GSC-954 and GSC-976, respectively; GSC XI, 1971, p. 283-284) represent a time of increased precipitation.

Comment (W. Blake, Jr.): The age determinations on humus-rich sands reported by David (1971, p. 297) represent "the mean residence times (M.R.T.) of the total soil humus of the sampled soil layers at the time of burial of the soils... all the radiocarbon ages should be treated as maximum ages for the time of burial of the soils". Thus there may not be a conflict in interpretation, especially when the error term on the ages is taken into account. It is also worth noting that plant remains present in the organic detritus included achenes of **Carex** sp., a fragment of achene of **Rubus** sp., and an achene of **Ranunculus** sp., cf. **R. sceleratus** L. – the latter plant "usually grows on the seasonably flooded, muddy margins of small ponds"; the presence of water is also suggested by fragments of an unidentified hydrophilid beetle (unpublished GSC Plant Macrofossil Report No. 78-8 by J.V. Matthews, Jr.). Date based on two 1-day counts in the 5 L counter.

Moorby Lake Series

Peat from a uraniferous bog near Kasmere Lake, Manitoba (59°28'20"N, 101°12'30"W) at an elevation of ca. 390 m. Collected 1978 with a frozen ground corer by W.B. Coker and R.N.W. DiLabio

GSC-2798. Moorby Lake, 30-41 cm 1040 ± 50
$\delta^{13}C = -26.9‰$

Moderately fresh **Sphagnum** peat (sample 64N 781058, 15.7 g, one 11 cm long core increment) collected just below permafrost table. Sample contained 0.5 ppm uranium on a dry weight basis, 27.4 ppm uranium on an ashed weight basis, and 2.6 ppb uranium in interstitial waters after thawing.

GSC-2803. Moorby Lake, 128-141 cm 4450 ± 60
$\delta^{13}C = -32.7‰$

Humified peat (sample 64N 781067, 18.5 g, one 13 cm long core increment) collected from 98 to 111 cm below permafrost table. Sample contained 27.0 ppm uranium on a dry weight basis, 700.0 ppm uranium on an ashed weight basis, and 5.4 ppb uranium in interstitial waters after thawing.

GSC-2759. Moorby Lake, 240-254 cm 5990 ± 80
$\delta^{13}C = -27.7‰$

Humified basal peat (sample 64N 781076, 31.7 g, one 14 cm long core increment) collected from 210 to 224 cm below permafrost table. Sample overlies sand. Sample contained 786.0 ppm uranium on a dry weight basis, 1054.0 ppm uranium on an ashed weight basis, and 200.0 ppb uranium in interstitial waters after thawing.

Comment (R.N.W. DiLabio): Date GSC-2759 provides an estimate for the onset of uranium enrichment of the peat. Based on GSC-2759 and GSC-2803, the uranium-rich, most humified lower portion of the peat section dates from a warmer episode than at present (Nichols, 1974). Peat diagenesis and uranium enrichment could proceed only when the peat was unfrozen. Geochemical results on this bog and an adjacent one are discussed in Coker and DiLabio (1979). Each date is based on two 1-day counts in the 5-L counter.

Alberta

GSC-1195-2. Bellis — 2800 ± 140
$\delta^{13}C = -18.5$ ‰

Bison sp. bones (sample SV-68-27; 500 g; vertebrae, sacrum, and ribs; identified by C.S. Churcher, University of Toronto, Toronto) recovered at ca. 1.5 m depth below the surface in a natural exposure (cutbank) of sandy silt alluvium. The site is in a postglacial river terrace along the lower part of the north valley side of North Saskatchewan River, 10 km south-southwest of Bellis and 18 km east-southeast of Smoky Lake, Alberta (54°03'N, 112°14'W), at an elevation of ca. 565 m. Collected 1968 by S.H. Richard; submitted by D.A. St-Onge, then Geological Survey of Canada, now Université d'Ottawa, Ottawa.

Comment (S.H. Richard): The bones date a well developed abandoned terrace level (the lower of two) on the northern wall of North Saskatchewan Valley; the enclosing sediments were deposited when the river floodplain was ca. 12 m above present river level (cf. St-Onge, 1970, 1972). The date correlates well with both GSC-1205, 10 200 ± 160 years (this list) on **Bison** sp. bones in gravel alluvium of a high level (550 m) river terrace at Athabasca which approximates the beginning of postglacial river valley development in this area and with GSC-1207, 6040 ± 140 years (this list) on **Bison** sp. bones from sandy silty alluvium of a middle level river terrace on North Saskatchewan River 7 km upstream from this site; the latter date relates to a phase in the history of North Saskatchewan River when its floodplain was ca. 20 m above present river level.

Comment (W. Blake, Jr.): Two determinations were made:

GSC-1195. — 2980 ± 130
$\delta^{13}C = -17.6$ ‰

Sample pretreatment included a one hour leach with 0.1 N NaOH. Date based on one 3-day count in the 2 L counter.

GSC-1195-2. — 2800 ± 140
$\delta^{13}C = -18.5$ ‰

Sample pretreatment included an overnight leach with 0.1N NaOH. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 5 L counter. This date, under the designation of GSC-1195, was published in uncorrected form as 2700 ± 140 years (St-Onge, 1970) before the $^{13}C/^{12}C$ determination was made.

GSC-1207. Pakan — 6040 ± 140
$\delta^{13}C = -16.9$ ‰

Bison sp. bones (sample SV-68-26; 300 g; 1 tibia plus 1 rib; identified by C.S. Churcher, University of Toronto, Toronto) recovered from 1.8 m depth below the surface in a natural exposure (cutbank) of sandy silty alluvium. The site is in an abandoned postglacial river terrace halfway up the north valley side of North Saskatchewan River, 6 km northeast of Pakan and 12 km southeast of Smoky Lake, Alberta (54°02'N, 112°20'W), at an elevation of 570 m. Collected 1968 by S.H. Richard; submitted by D.A. St-Onge, then Geological Survey of Canada, now Université d'Ottawa, Ottawa.

Comment (S.H. Richard): This sample dates a well developed abandoned terrace (the middle of a set of three) on the northern wall of North Saskatchewan Valley; it records the time when the river floodplain was at an elevation of ca. 570 m, i.e. ca. 20 m above present river level (cf. St-Onge, 1972).

Comment (W. Blake, Jr.): The sample received an overnight treatment with 0.1N NaOH. Date based on one 2-day count in the 5 L counter. The date was published in uncorrected form (5900 ± 140 years; St-Onge, 1970) before the $^{13}C/^{12}C$ determination was made.

GSC-2404. Cooking Lake — 10 900 ± 190

Freshwater molluscs (sample 15575-DE; 15.0 g; gastropods – **Stagnicola elodes** and **Lymnaea stagnalis appressa**; pelecypods – **Pisidium ferrugineum** and **P. castertanum**; identified by D. Emerson) from calcareous lacustrine silt at a depth of 3 m from the surface in a road section ca. 27 km due east of Edmonton, Alberta and 7 km north of Cooking Lake; tp. 52, rge. 20 (53°31'N, 113°00'W), at an elevation of ca. 735 m. The shell-bearing silt overlies till. Collected 1976 by D. Emerson, University of Alberta, Edmonton.

Comment (W. Blake, Jr.): The dated sample provides an approximation for the time of deglaciation (Emerson, 1977). A summary of the glacial lake sequence in this area, together with radiocarbon age determinations to the northeast, north, and northwest of Edmonton is provided in St-Onge (1972). Other age determinations on mollusc shells some 10 to 14.5 km north of Cooking Lake are reported by Westgate et al. (1976): 9050 ± 150 years (I-4552) and 10 800 ± 155 years (I-8484). Because of the small sample size of GSC-2404 only the outer 10 per cent was removed by HCl leach. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-1894. Three Hills — 9720 ± 300
$\delta^{13}C = -18.9$ ‰

Bison ribs (sample Milan Bison site (1); 921 g, **Bison occidentalis**; identified by D.M. Shackleton, then National Museum of Natural Sciences, Ottawa; now University of British Columbia, Vancouver from sand, clay, and diamicton exposed in a specially dug excavation on the farm of S. Milan, 11.3 km east and 3.2 km south of Three Hills, Alberta in NE sec. 20, tp. 31, rge. 22, W 4th meridian (51°41'30"N, 113°04'30"W), at an elevation in the range of 808 to 814 m. The sand was underlain by coarse gravel; above the 5^{+} m thick sand unit was 0.2 to 0.5 m of grey to yellow clay, 0.2 to 0.5 m of a yellow-weathering sandy to bouldery diamicton, and ca. 2 m of grey weathering bouldery diamicton. Collected 1971 by L.V. Hills, University of Calgary, Calgary.

Comment (W. Blake, Jr.): As Shackleton and Hills (1977) pointed out, the overlying diamicton first was interpreted as being a till, and an age of 22 000 to 23 000 years was expected. However, the postglacial age, reinforced by a nearly identical date of 9670 ± 160 years (I-8579), also on bison rib fragments, suggests that the diamicton has another origin. The bison remains were accompanied by a skeleton of wapiti **(Cervus elaphus nelsoni)**, and freshwater gastropods. The value for GSC-1894 (9630 ± 300 years) published by Shackleton and Hills (1977) is the age prior to the correction being made for isotopic fractionation. All ribs were sawed open longitudinally to check for crystallization; pieces with crystals present were not used. The exterior surfaces of these solid and well preserved bones were scraped clean on a band saw.

Pretreatment included leaches in 3N HCl and for one hour in 0.1N NaOH. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Athabasca Series

Freshwater shells and **Bison** sp. bones from the vicinity of Athabasca, Alberta.

GSC-1380. Athabasca, shells 10 200 ± 280

High-spired freshwater gastropod shells (sample SV-69, R-7; 10.1 g; unidentified as to species) recovered ca. 1.7 m below ground surface from the wall of a fresh 18 m high man-made exposure in a silt and silty clay deposit of glacial Lake Athabasca. The site is in Tawatinaw Valley 3.1 km south-southeast of Athabasca, Alberta (54°42'N, 113°15'30"W), at an elevation of ca. 557 m. Collected 1969 by S.H. Richard; submitted by D.A. St-Onge, then Geological Survey of Canada, now Université d'Ottawa, Ottawa.

Comment (S.H. Richard): The shells date a late phase of lacustrine sedimentation in glacial Lake Athabasca. At this time the front of the retreating Laurentide Ice Sheet was at Pleasant View, Alberta, 20 km north-northeast of Athabasca, and the northward draining waters from the deglaciated areas to the south were dammed in Athabasca and Tawatinaw valleys (up to an elevation of ca. 576 m). The date was one of the first obtained for freshwater fossils of an ice marginal lake in the Athabasca area; it overlaps with GSC-1205, 10 200 ± 160 years (this series), on bone of **Bison** sp., in a high-level (elevation of sample ca. 550 m) postglacial river terrace at Athabasca. The latter sample dates the next event in the glacial history of the Athabasca area, i.e., the beginning of the development of Athabasca Valley following the draining of glacial Lake Athabasca.

Comment (W. Blake, Jr.): The sample was composed for the most part of clean, whole individuals. After washing in distilled water all the spires of the gastropods were broken off and any silt remaining was scraped out. Date based on one 3-day count in the 1 L counter.

GSC-1205. Athabasca, bone 10 200 ± 160
$\delta^{13}C = -17.6$ ‰

Bison sp. bones (sample SV-68-25; 300 g; two tibias; identified by C.S. Churcher, University of Toronto, Toronto) recovered at an unknown depth below the surface but 38 to 46 m above present river level in a gravel pit in high-level river terrace alluvium 0.6 km north of Athabasca, Alberta, across the river from the townsite (54°43'N, 113°17'W), at an elevation of ca. 550 m. The gravels from which the bones were collected comprise the upper terrace on the north side of Athabasca River at this site. Collected 1968 by S.H. Richard; submitted by D.S. St-Onge, then Geological Survey of Canada, now Université d'Ottawa, Ottawa.

Comment (S.H. Richard): The bones date the initial period of postglacial sedimentation by Athabasca River at Athabasca townsite following the draining of glacial Lake Athabasca; at this time the river floodplain was at an elevation of ca. 550 m, i.e. ca. 40 m above present river water level (cf. St-Onge, 1970). The date is in general agreement with GSC-1380, 10 200 ± 280 years (this series) on freshwater gastropod shells, at approximately 557 m in silt and silty clay, deposited on the floor of glacial Lake Athabasca which had occupied the same site immediately prior to the establishment of the postglacial drainage network.

Comment (W. Blake, Jr.): The exact depth below the surface at which these particular **Bison** bones were collected is unknown because the bones were unearthed by the operators of the gravel pit, but most bones appear to derive from a bed some 4 to 5 m below the surface. The sample received an overnight treatment with 0.1N NaOH. Date based on two 1-day counts in the 5 L counter. The date was published in uncorrected form 10 000 ± 160 years (St-Onge, 1970) before the $^{13}C/^{12}C$ determination was made.

Chalmer's Bog Series

A series of dates from a 10.6 m long core taken from a peat bog 14.5 km southeast of Turner Valley, Alberta (50°39'30"N, 114°33'30"W), at an elevation of ca. 1360 m. Mazama tephra occurs at 600 cm depth. Collected 1978 by L.E. Jackson, Jr., using a Livingstone corer.

GSC-2851. Chalmer's Bog, 640 cm 8220 ± 80
$\delta^{13}C = -28.8$ ‰

Well decomposed peat (sample PL-78-37(JJCDA-5); 9.8 g dry) taken 640 cm below the surface and 40 cm below the Mazama ash. The sample dates the beginning of peat accumulation in what was formerly an open pond.

GSC-2668. Chalmer's Bog, 830 cm 18 300 ± 380
$\delta^{13}C = -32.6$ ‰

Well preserved aquatic moss (sample JJCDA-4; 3.7 g dry; **Drepanocladus trichophyllus** (Warnst.) Mikut; identified by J.A.P. Janssens, University of Alberta, Edmonton) which was found for the first time as a fossil in North America at this site. The moss formed a horizon encased in marly clay 830 cm below the surface.

GSC-2670. Chalmer's Bog, 930 cm 18 400 ± 1090
$\delta^{13}C = -32.4$ ‰

Well preserved band of aquatic moss (sample JJDCA-3; 2.3 g dry; **Drepanocladus trichophyllus** (Warnst.) Mikut; identified by J.A.P. Janssens) encased in marly clay 930 cm below the surface.

Comment (L.E. Jackson, Jr.): The two lower dates provide evidence for the existence of an ice free corridor in the southern foothills of the Rocky Mountains during the height of the Late Wisconsinan Glaciation (Jackson, 1978, 1979; Rutter, 1978). Pollen taken from the horizon immediately overlying GSC-2668 was found to be dominated by **Artemisia** with secondary **Cyperaceae, Salix, Graminae,** and other herbs generally indicative of open or arctic environments (unpublished GSC Palynological Report No. 78-9 by R.J. Mott). Because of small sample size, the NaOH leach was omitted for GSC-2668 and GSC-2670; both samples were mixed with dead gas for counting. GSC-2668 based on one 3-day count in the 2 L counter, GSC-2670 based on one 4-day count in the 2 L counter, and GSC-2851 based on one 3-day count in the 5 L counter.

GSC-2589. Sunwapta Pass 8150 ± 100
$\delta^{13}C = -21.9$ ‰

Wood (sample BL-77-1; 11.5 g; **Picea** sp; identified by L.D. Farley-Gill) from a log exposed in a stream bank section in Wilcox Creek, Sunwapta Pass, Jasper National Park, Alberta (52°13'N, 117°12'W), at an elevation of 2200 m. Collected 1977 by B.H. Luckman, University of Western Ontario, London; submitted by T. Pierce, Parks Canada.

Comment (B.H. Luckman): The log, approximately 1.25 m long and 13.5 cm in diameter, was embedded in the streambed and extended back into the adjacent bank. The log occurs within a grey, probably lacustrine, clay in a small valley floor depression ponded by an alluvial fan. The clay is overlain by peats and tephras (Luckman et al., 1979). A date of 7700 ± 110 years (BGS-450) was obtained on wood at the base of the peat, 20 m upstream (Luckman et al., 1977; see also Luckman and Osborn, 1978, 1979). The basin is presently

a willow meadow with trees only on the surrounding higher ground. The presence of the logs indicates standing trees at the margin of the basin prior to 8000 years ago and provides a minimum date for deglaciation. This site is approximately 1000 m from the Little Ice Age margin of Athabasca Glacier.

Comment (W. Blake, Jr.): The wood was fresh appearing and solid; although the tree rings could not be precisely counted, a large number appeared to be present, probably more than 150. Date based on two 1-day counts in the 5 L counter.

GSC-2806. Columbia Icefields 980 ± 50
$\delta^{13}C = -22.4‰$

Wood (sample SNAG2; 11.7 g; **Pinus** sp.; identified by L.D. Farley-Gill) from a large snag lying on the ground surface ca. 1 km south-southeast from the Icefields Information Centre, Jasper National Park, Alberta (52°13'N, 117°13'W), at an elevation of ca. 2130 m. Collected 1978 by B.H. Luckman.

Comment (B.H. Luckman): The present treeline vegetation on the slope above the Icefields Information Centre is stunted and sparse. However the slope surface is littered with the remains (trunks, rootstocks) of much larger trees, some more than 40 cm in diameter, which formerly grew close to the present treeline. The dated sample is from a hollow trunk fragment, 4 m long and 35 to 40 cm in basal diameter lying on the surface of a steep shale slope about 30 m below the highest living trees. It probably rolled to its present position. Although the dated sample was sound and highly resinous, the centre and parts of the outer trunk had rotted away and, in places, the trunk showed evidence of burning. At least 110 annual rings were visible, the dated sample comprising 7 annual rings from a series of exceptionally wide rings (4 to 6 mm) at the inner edge of the remaining trunk (probably about half the original trunk radius). The great width of the rings, and the position and size of the trunk, suggest that growth conditions for the tree were much more favourable about 1000 years ago and that large trees grew much higher on the slope than they do at present. The date also indicates that **P. albicaulis** snags may remain for considerable periods of time above treeline under present conditions.

Comment (W. Blake, Jr.): The wood was identified as "white pine type which includes **P. strobus, P. monticola, P. flexilis,** and **P. albicaulis** The wood of these species cannot be differentiated with certainty" (unpublished GSC Wood Identification Report No. 79-6 by L.D. Farley-Gill). Date based on two 1-day counts in the 5 L counter.

GSC-2865. Peace River 9880 ± 130
$\delta^{13}C = -20.2‰$

Two tibia (samples PR2-77 and PR3-77; 576 g total) from a large bison; the samples probably derive from **Bison** cf. **priscus** on the evidence of horn cores and smashed skulls obtained from Mrs. Vera Lane's gravel pit, adjacent to the north. The bones were collected from the municipal gravel pit on the west (left) side of Peace River in the town of Peace River, Alberta. The samples were combined in order to have enough material for dating. The municipal gravel pit is in the second terrace above the river in NE 1/4 sec. 30, tp. 83, rge. 21, W 5th mer. (56°13'40"N, 117°18'10"W). The pit was being worked at the time of collection. The bones were collected about 8 m below the terrace surface but may have originated 5 m higher where other bones have been found. The terrace surface is at about 345 m a.s.l., or some 35 m above Peace River and nearly 200 m below prairie level. Collected 1977 by C.S. Churcher, University of Toronto, Toronto, and M. Wilson, University of Calgary, Calgary; submitted by C.S. Churcher.

Comment (C.S. Churcher and A. MacS. Stalker): The age of the bones had been estimated as 4000 years. The determined age of 9880 ± 130 years is close to those for GSC-2895 (10 200 ± 100 years) and GSC-2902 (10 200 years; both in this list), which were collected from a similar stratigraphic position at another site. The date indicates that the river already had incised its valley to near the present depth by 9880 years ago and that the trunk drainage system in the Peace River country then was close to its present grade. This is a surprisingly fast rate of downcutting if the area had been covered by Classical Wisconsin ice only a few thousand (2000 to 5000) years before, and it raises the question of how important that glaciation was in the region. Most of the bones recovered from this gravel terrace derive from large bison **(Bison** cf. **priscus),** with only single specimens of wapiti antler **(Cervus canadensis)** or mammoth **(Mammuthus primigenius)** (Churcher and Wilson, 1979). A horse metapodial was recovered in 1979 (unpublished). This, as in the site of dates GSC-2895 and GSC-2902, is surprising, for at that time such animals undoubtedly were still extant, though perhaps greatly reduced in number. They may have been extinct locally. 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-2675. Maligne Icefields 100 ± 50

Wood (sample MI log 1; 11.5 g; **Picea** sp.; identified by L.D. Farley-Gill) from a tree toppled and overidden by a recent advance of the northeastern margin of Maligne Icefield, in an unnamed valley draining into the head of Maligne Lake, Jasper National Park, Alberta (53°35'N, 117°24'W), at an elevation of 2153 m. Collected 1977 by B.H. Luckman.

Comment (B.H. Luckman): This site is on the eastern margin of the Maligne Icefield between two outlet glaciers where the icefield margin overode an older rockslide deposit at approximately the 2153 m level. The log was horizontal and protruding from beneath a fresh moraine. The date provides a limiting age for the Little Ice Age maximum at this site.

Comment (W. Blake, Jr.): The sample submitted measured 29 x 4 x 3.5 cm. The outside, punky wood was cut away, and the section used for dating represented approximately 40 annual rings. Date based on two 1-day counts in the 5 L counter.

Watino Series

Bone samples from the Northern Alberta Railway Ballast Pit, on the left (west) side of Smoky River directly south of the town of Watino, Alberta, in NE 1/4 sec. 34, tp. 77, rge. 24, W 5th mer. (55°43'N, 117°37'30"W). The pit lay between Alberta highway 49 and the railway right of way but has since been recontoured and covered with topsoil. The bones came from near the base of the alluvial sand and gravel forming the second terrace above the river and were at an elevation of about 410 m, or about 40 m above the river and 130 m below prairie level. At this point most of the lowest terrace is destroyed. Collected 1977 by N. Boisvert of the Northern Alberta Railway, Fahler, Alberta, and C.S. Churcher, University of Toronto, Toronto; submitted by C.S. Churcher.

GSC-2895. Watino (I) 10 200 ± 100
$\delta^{13}C = -20.3‰$

Cervical vertebra, either 5 or 6, from a large bison (sample B-10-77; 424.5 g).

GSC-2902. Watino (II) 10 200 ± 100
$\delta^{13}C = -21.1‰$

Left tibia from a large bison (sample B-41-77; 742.5 g).

Comment (A. MacS. Stalker and C.S. Churcher): The dates are much older than the anticipated age of 4000 years, as was also the case with GSC-2865 (9880 ± 130 years; this list), which came from a similar stratigraphic position. They indicate that much of the main drainage system of the region had been developed by 10 000 years ago, and the river already had downcut to near its present grade. This, in turn, indicates that either downcutting was extremely rapid during and following retreat of Classical Wisconsin ice some 2000 to 5000 years earlier, or else illustrates the extremely limited effect the last phase of Classical Wisconsin glaciation had in the region. The area may have been covered solely by early Classical Wisconsin ice and been relatively unaffected by later readvances.

A skull of **Bison** cf. **Bison alaskensis**, now in the Provincial Museum of Alberta, Edmonton (no. P71.7), was obtained from this pit in 1970 by W. McGurran of the Northern Alberta Railway (Churcher and Wilson, 1979). This is a species of longhorned **Bison** similar to **B. priscus**, and the dated materials probably derived from this species. The lack of bones other than bison at this level suggests that other large mammals, such as horse, muskox, and mammoth were scarce in this region at the time, or perhaps locally extinct.

Other dates at Watino given by Westgate et al. (1972) include GX-1207, >38 000 years; GSC-1020, 43 500 ± 620 years; I-2516, 35 500 ± 2300 years; I-2615, 35 000 ± 3300 years; and I-4878, 27 400 ± 850 years. These dates are on wood and peat contained in oxbow-type lake deposits.

Comment (W. Blake, Jr.): The cervical vertebra used for GSC-2895 had several large rounded pebbles imbedded in openings in the bone, but in general both samples were well preserved. GSC-2895 and -2902 based on two 1-day counts and one 3-day count, respectively, in the 5 L counter.

GSC-2173. Surprise Valley (Maligne Valley) 310 ± 40

Wood (sample Hoodoo I; 7.2 g; **Picea** sp.; identified by R.J. Mott) embedded in the wall of a natural recess in a hoodoo (earth pillar, demoiselle) cut into Late(?) Wisconsin calcareous till on the eastern flank of Maligne Valley (52°48'30"N, 117°41'W) about 30 km southeast of Jasper, Alberta, and at an elevation of ca. 2000 m. Collected 1974 by B.H. Luckman, University of Western Ontario, London.

Comment (B.H. Luckman): The wood was part of a branch ca. 30 cm long embedded in a mixture of needles and animal droppings on a slight bench at the back of a large recess (3 to 5 m deep) in the flank of a 30 m high hoodoo. The site appeared to have been used as a goat or sheep den, and the fecal material had been carbonized due to a nearby forest fire in 1946. The hoodoo occurs in a lateral moraine of highly calcareous till about 500 m above the valley floor. The branch appeared to be wedged in the till, but obviously, from the date, it had been carried to its present position, probably by animals. The date indicates the stability of these hoodoo forms (the till is strongly cemented). The overhang is large and dry; it had attained its present dimensions more than 300 years ago and has been little modified since.

Comment (W. Blake, Jr.): This well preserved wood sample was highly aromatic; it was partly encased in melted pitch containing animal droppings (Rodentia) plus **Picea** needles (unpublished GSC Bryological Report No. 321 by M. Kuc). This adhering material was cut off before the wood was submitted for dating. Sample mixed with dead gas for counting. Date based on one 4-day count in the 5 L counter.

GSC-2615. Watchtower Basin 8080 ± 90
$\delta^{13}C = -23.6‰$

Wood (sample Log-1, Watchtower Basin; 11.5 g; **Picea** sp.; identified by L.D. Farley-Gill) from a log in a small alpine lake in the Watchtower Basin, Maligne Valley, Jasper National Park, Alberta (52°50'N, 117°50'W), at an elevation of 2153 m. Collected 1977 by M.S. Kearney, University of Western Ontario, London; submitted by B.H. Luckman of the same institution.

Comment (M.S. Kearney): The Watchtower site, approximately 20 km southeast of Jasper, is a small bedrock basin in a gently sloping alpine meadow. Although scattered krummholz trees occur nearby, the present treeline is approximately 1000 m downvalley (about 50 m vertically). The sample was taken from a log approximately 1.25 m long and 10 to 12 cm in diameter protruding from an underwater peat face in the basin. The size and topographic position indicate that the site was covered by standing trees some 8000 to 8100 years ago, i.e., treeline was higher than at present. The sample also provides a minimum date for deglaciation in the Watchtower Basin. Date based on two 1-day counts in the 5 L counter.

GSC-2682. Excelsior Basin 8450 ± 170

Peat (sample BP1ExB; 5.9 g) representing the basal 2.5 cm of a Hiller core from a small alpine bog in the Excelsior Basin, approximately 16 km south-southeast of Jasper, in the Maligne Valley, Jasper National Park, Alberta (52°48'50"N, 118°40'W), at an elevation of 2092 m. Collected 1977 by M.S. Kearney; submitted by B.H. Luckman.

Comment (M.S. Kearney): This site is from the base of a 105 cm long peat core (overlying clayey silt) in a small alpine bog occupying a bedrock basin above treeline in Excelsior Valley. The topographic situation is similar to that in Watchtower Basin (the next valley to the south; cf. GSC-2615, 8080 ± 90 years, this list). The date provides an age for the base of a pollen diagram and is a minimum date for deglaciation. Preliminary pollen data from the basal samples indicate a climate which was slightly warmer than at present. Sample mixed with dead gas for counting. Date based on one 4-day count in the 2 L counter.

GSC-2802. Grande Prairie 4540 ± 230

Charcoal (sample SF-78-8; 1.7 g, from Wapiti Gravel Supplies, Pit No. 1, about 13 km south-southeast of Grande Prairie, Alberta, in NW 1/4 sec. 20, tp. 70, rge. 5, W 6th mer. (55°05'N, 118°43'20"W). The charcoal came from the middle of three terraces found on the left (north) bank of Wapiti River, some 40 m above the river and 90 m below prairie level, at an elevation of 550 m. The charcoal is preserved as pieces up to 0.5 cm in diameter, some of which may be recognized as twigs or pieces of larger branches. It was collected from silt as close to the top of a 0.7 m thick soil as possible. This soil, which is three times as thick as the modern soil on top of the terrace, is thought to represent Climatic Optimum time. It overlies 10 m of coarse gravel, and is overlain by 3 m of generally stone-free sand and silt that is of alluvial origin for the most part. This upper material displays several thin soils, numerous firebands containing charcoal, and scattered gastropods. Collected 1978 by C.S. Churcher, University of Toronto, Toronto, and A. MacS. Stalker.

Comment (C.S. Churcher and A. MacS. Stalker): The material overlying the 0.7 m thick soil is thought to show a return to a damper and cooler climate, following the Climatic Optimum, with renewed deposition and growth of trees. Each thin soil above represents a short hiatus in deposition, and numerous forest fires left scraps of charcoal.

The age of 4540 ± 230 years was close to the estimated age of 4000 years and should mark a time shortly after the close of the Climatic Optimum. It is unlikely that the end of that episode in this region can be determined more closely. The sample has no connection with the level of Wapiti River at that time. NaOH 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.

British Columbia

GSC-2410. Columbia Lake 640 ± 40

Wood (sample Stn. 94; 11.4 g; **Picea** sp.; identified by L.D. Farley-Gill) from a depth of 1.5 m in a fresh drainage ditch cut in clayey, silty, sandy overbank deposits of Columbia River 4.8 km north of Columbia Lake, British Columbia (50°19'53"N, 115°52'24"W), at an elevation of ca. 805 m. Collected 1975 by K.E. Ricker, Karl E. Ricker, Ltd., Vancouver; submitted by R.J. Fulton.

Comment (K.E. Ricker): The presence of Mazama ash near the surface of the Columbia River floodplain sediments in the Mica Dam-Arrow Lakes section of the river indicates little aggradation over the past 6600 years. This tephra is not exposed in floodplain sediments near the river headwaters in the Rocky Mountain Trench so that it was hypothesized that significant aggradation was occurring in this area; GSC-2410 confirms that this is the case. Date based on one 3-day count in the 5 L counter.

GSC-1753. La Forme Creek 10 000 ± 160

Wood fragment (sample FI-14-72; 4.7 g; **Salix** sp.?; identified by R.J. Mott) from a landslide scar 1.5 km north of La Forme Creek on the Mica Dam Road and 25 km north of Revelstoke, British Columbia (51°13'55"N, 118°13'05"W), at an elevation of ca. 500 m. The sample was collected 8 m below the top of a laminated silt that is overlain by 11 m of gravel, sand and interbedded gravel, and silt. The silt containing the sample is interpreted as a glaciolacustrine deposit; overlying are Holocene colluvial and alluvial sediments. Collected 1972 by R.J. Fulton.

Comment (R.J. Fulton): This date is a minimum age for deglaciation of this section of the Columbia River valley. This occurrence extends the northern limit of the enlarged lake that occupied the Arrow Lakes basin at this time (Fulton, 1971, p. 17).

Comment (W. Blake, Jr.): The wood fragments comprising this sample were wet on receipt by the laboratory. The largest two were dried in an electric oven, but only a single piece, ca. 10 cm long, was used for the age determination. The sample was identified by R.J. Mott (unpublished GSC Wood Identification Report No. 24) as "deciduous wood highly compressed and humified. Features visible suggest **Salix** sp." Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Tonquin Pass Series

Wood samples from Tonquin Pass, British Columbia (52°44'N, 118°22'W), approximately 26 km southwest from Jasper, Alberta, and 1 km northwest of the Continental Divide, at an elevation of ca. 2000 m. Collected by B.H. Luckman and K. Cawker, University of Western Ontario, London.

GSC-2631. Tonquin Pass (I) 5090 ± 70

Wood (sample No. EZZ5; 11.9 g; **Picea** sp.; identified by L.D. Farley-Gill) from a streambank section along Tonquin Creek, Tonquin Pass.

Comment (B.H. Luckman): This branch was extracted from the basal peat/gravelly clay contact at river level, approximately 100 m west of the main Tonquin Creek section (Luckman and Osborn, 1979). It was anticipated that this sample would provide a limiting date for deglaciation. The sample section was a relatively low one (1 m) in an area of bank slumping. The dated material is interpreted as a branch derived from the higher part of the peat and incorporated in its present stratigraphic position by bank slumping. Other dates from these sections (GSC-2648, 6570 ± 70 years, this series; also BGS-465, 9660 ± 300 years) indicate that the basal peat is much older than indicated by GSC-2631.

Comment (W. Blake, Jr.): The single piece of wood was well preserved (especially the heart wood) and clean. Date based on one 3-day count in the 5 L counter.

GSC-2648. Tonquin Pass (II) 6570 ± 70

Wood (sample EZZ1-1; 11.5 g; **Picea** sp.; identified by L.D. Farley-Gill) recovered from a peat section on the floor of Tonquin Pass.

Comment (B.H. Luckman): This sample was from an intact log, approximately 7 m long (exposed length) and 20 to 30 cm in diameter, exposed in a wind deflated peat bog along a streambank section. Two tephras occur in the section, the lower one passing immediately beneath the log, and the upper one is draped over its upper surface. The date confirms that the lower tephra is Mazama (cf. GSC-2459; 6170 ± 100 years; GSC XVII, 1977, p. 13; Bowyer, 1977). Also, because the site is presently a treeless, wet, valley floor meadow, this log, plus other tree fragments and macrofossils at the site, indicates a drier/warmer climate at that time. Date based on one 3-day count in the 5 L counter.

GSC-1802-2. Boat Encampment 25 200 ± 260
$\delta^{13}C = -22.8‰$

Wood (sample FI-75-72-I; 12.0 g; **Picea** sp. identified by L.D. Farley-Gill) from Mica Dam till borrow pit (Wood River Burn), east side of the Rocky Mountain Trench, 3 km southeast of the confluence of Columbia, Canoe, and Wood rivers, British Columbia (52°07'N, 118°24'W), at an elevation of ca. 670 m. The sample is from a 20 cm diameter log (one of several) that lay near the top of a 7 m thick sand and silt unit underlying 30 m of till and overlying 8 m of till. The upper till dates from Fraser Glaciation (Late Wisconsin), and the sand and silt are floodplain deposits formed during the Olympia nonglacial period (20 000 years to before 43 800 years). Collected 1972 by R.J. Fulton.

Comment (R.J. Fulton): The date confirms that the wood-bearing sediments are of Olympia age and that they were deposited by a flowing stream. This contrasts with stratified silts from which materials were dated earlier (GSC-1258, 21 700 ± 240 years; GSC XI, 1971, p. 294 and GSC-173, 21 500 ± 300 years; GSC IV, 1965, p. 32). It appears that this sample dated a period when a major river occupied the Rocky Mountain Trench but that the sediment from which the younger dates have derived was deposited while a lake (dammed by advancing ice tongues?) occupied the area. The significance of this date, together with one of 26 800 ± 1000 years (GX-2032; Clague, 1975a) from farther south in the Rocky Mountain Trench is, according to Fulton (1977, p. 205), "that the southern part of the Trench was not occupied by Late Wisconsin ice until after 25 200 ± 260 years (GSC-1802-2) and was free of ice before 10 000 ± 140 years (GSC-1457)." This latter age determination (GSC-1457), on peat from Oldman Creek, is published in GSC XVI (1976, p. 9).

Comment (W. Blake, Jr.): Five determinations have been made on this log, wood from which has been supplied to several other laboratories for inter-laboratory checks:

GSC-1802. 25 800 ± 310
$\delta^{13}C = -22.5‰$

Standard pretreatment with 0.2N NaOH, 2N HCl, and distilled water rinses. Date based on one 3-day count in the 5 L counter. Sample weight 12.0 g, February 1973.

GSC-1802-2. 25 200 ± 260
$\delta^{13}C = -22.8‰$

For this determination the one hour treatment with 0.2N NaOH, 2N HCl, and distilled water rinses was carried out twice. Date based on one 5-day count in the 5 L counter. Sample weight 13.7 g, May 1976.

GSC-1802-3. 24 800 ± 280
$\delta^{13}C = -22.5‰$

Standard pretreatment as in GSC-1802. Date based on one 3-day count in the 5 L counter. Sample weight 11.5 g, August 1976.

GSC-1802-4. 25 000 ± 270
$\delta^{13}C = -22.5‰$

NaOH leach omitted from standard pretreatment. Date based on one 4-day count in the 5 L counter. Sample weight 13.1 g, August 1976.

GSC-1802-5. 24 900 ± 350
$\delta^{13}C = -21.8‰$

Standard pretreatment but a new purification method utilizing KOH (Lowdon and Blake, 1978) was tried. Date based on one 3-day count in the 5 L counter. Sample weight 11.8 g, March 1978.

The determinations, with the exception of the original one, GSC-1802, all overlap within the limits of error. It seems clear that the age of this log is close to 25 000 years. No ready explanation is available for the older age obtained on GSC-1802.

Determination GSC-1802-2 is considered to be the most reliable because of the extra pretreatment and the longer counting time, resulting in the smallest error term. This is also the value that has been used by Fulton (1977) in his report on the area from which the log was collected.

Determinations from the other laboratories are listed below. We are grateful for permission to publish these results prior to their appearance in lists of age determinations by the respective laboratories.

Brock University St. Catharines, Ontario	BGS-303	25 620 ± 300
Dalhousie University, Halifax, Nova Scotia	DAL-254	25 800 ± 1070
Ministère des richesses naturelles, Québec, Quebec	QU-153	24 980 ± 950
University of Waterloo, Waterloo, Ontario	WAT-199	25 320 ± 400 $\delta^{13}C = -22.5‰$

Riggins Road Series

The Riggins Road section is a stream cut on the south bank of Bessette Creek, 13 km east of Lumby, British Columbia, 100 m upstream from the bridge on Riggins Road (50°18'N, 118°52'W), surface elevation ca. 455 m. The dated material is from 22 m of organic-rich, interbedded, sandy silt, sand, and gravel, containing two tephra layers, that is overlain, in order, by 11 m of laminated silt, 10 m of pebbly sand, 11 m of cobbly gravel, and 1.5 m of massive gravel with 2.5 m of varved silt at the top. The varved silt is a late glacial lacustrine deposit, the massive gravel is Fraser Glaciation till, and the gravel, sand, and silt units are proglacial deposits laid down as the ice moved into the area. The organic-rich sediments are the stratotype for the Bessette Sediments (Fulton and Smith, 1978), and a date of 19 100 ± 240 years (GSC-913; GSC IX, 1970, p. 72; Fulton, 1971, p. 8) indicates the time at which their deposition ended.

GSC-1953. Riggins Road (I) 25 300 ± 320

Wood (sample FI-RR-D; 7.2 g; **Picea** sp.; identified by R.J. Mott) from 13.5 m below the top of the organic-rich unit, 2.27 m below the Cherryville tephra, and 2.1 m above the Riggins Road tephra (Westgate and Fulton, 1975). Collected 1973 by R.J. Fulton.

GSC-1945. Riggins Road (II) 25 400 ± 270

Detrital peat (sample 173 (g); 57.5 g) from 11.3 m below the top of the organic-rich unit and from 3 to 8 cm below the Cherryville tephra (Westgate and Fulton, 1975). Collected 1973 by N.F. Alley, then under contract to Geological Survey of Canada, now Soil Conservation Authority, Kew, Victoria, Australia; and J.A. Westgate, then University of Alberta, Edmonton, now University of Toronto, Toronto; submitted by R.J. Fulton.

GSC-1938. Riggins Road (III) 31 100 ± 480

Detrital peat (sample 173 (a); 30.7 g) from 15.9 m below the top of the organic-rich unit and 30 cm below the Riggins Road tephra (Westgate and Fulton, 1975). Collected 1973 by N.F. Alley and J.A. Westgate; submitted by R.J. Fulton.

GSC-2031. Riggins Road (IV) 31 200 ± 900

Wood fragments (sample FI-7a; one piece is coniferous wood lignified **Picea** or **Larix** sp., identified by R.J. Mott; three other samples were too poorly preserved to identify) from 17.9 m below the top of the organic-rich sediments and 2 m below Riggins Road tephra (Westgate and Fulton, 1975). Collected 1973 by N.F. Alley; submitted by R.J. Fulton.

Comment (R.J. Fulton): These samples set the framework for dating Bessette Sediments at the type locality and also provide a basis for estimating the ages of the Cherryville and Riggins Road tephras. GSC-1938 and GSC-1945 each based on one 3-day count in the 5 L counter; GSC-1953 based on one 3-day count in the 2 L counter; GSC-2031 mixed with dead gas for counting and date based on one 4-day count in the 5 L counter.

GSC-2232. Vedder Crossing 22 700 ± 320
$\delta^{13}C = -22.2‰$

A tusk (sample ECH-1974-tusk; 658 g) from sandy gravel exposed in a fresh face of the Bailey Gravel Pit, 3.2 km east-northeast of Vedder Crossing Bridge and 366 m east of the southeast corner of the Indian Reservation, Chilliwack Municipality, British Columbia (49°06'20"N, 121°55'20"W), at an elevation of ca. 60 m. Collected 1974 by E.C. Halstead, Environment Canada, Vancouver; submitted by C.R. Harington, National Museum of Natural Sciences, Ottawa.

Comment (C.R. Harington): This seems to be the first record of Quaternary elephant remains from the Fraser Lowland. The date on the tusk suggests that such elephants, possibly mammoths (Proboscidea cf. **Mammuthus** sp.), occupied Fraser Lowland prior to the peak of the late Wisconsin glaciation (Harington, 1977b). It is worth noting that several species of large Quaternary mammals, including

mammoths and mastodons, probably reached southeastern Vancouver Island from the mainland about this time (30 000 to 17 000 years B.P.) by crossing large, vegetated floodplains that filled the Strait of Georgia (Harington 1975, 1977b; Clague 1976).

Comment (W. Blake Jr.): Adhering sand, dirty bone, and a few fine rootlets were removed with a stiff steel brush and a knife. The tusk material was powdery and easily crushed. Crushed bone treated with 3N HCl until effervescing stopped. NaOH treatment omitted because of small sample size. Collagen fraction utilized. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2394-2. North Vancouver >54 000

Wood (sample FAB5-1960) from a fresh roadcut 30 m deep on the Upper Levels Highway immediately west of Lynn Creek, British Columbia (49°20'02"N, 123°01'02"W), at an elevation of 100 m. The sample is from a peat layer about 1 m thick overlain by white Quadra type sand and underlain by sand and silt. Vashon till occurs at the top of the section. Collected 1960 by J.E. Armstrong from a freshly excavated surface; dried in the office. Two determinations were made:

GSC-2394. >39 000

Date based on one 3-day count in the 5 L counter. Sample weight 24.8 g.

GSC-2394-2. >54 000

Pretreatment of new material included leaches for one hour in hot NaOH and hot HCl. Date based on one 5-day count in the 5 L counter at 4 atm; sample weight 46.3 g.

Comment (J.E. Armstrong): This peat layer is separated from two other peat layers by about 100 m of covered slope. The younger of the other two peat layers lies on Semiahmoo Drift and is overlain by White Quadra type sand; wood from it was dated at 32 200 ± 3300 years (I(GSC)-214; Isotopes II, 1962, p. 35-36), and it is correlated with the Cowichan Head Formation. The older peat layer is found in Highbury Sediments which at this site are overlain by Semiahmoo Drift and underlain by Westlynn Drift (stratotype section). Wood from this peat was dated at >52 300 years (GSC-555; GSC VI, 1967, p. 173). Neither of the two pre-Vashon drifts was exposed in the section from which the wood used for GSC-2394 and GSC-2394-2 was obtained, but the position of the wood-bearing unit immediately below Quadra type white sand suggests it should be correlated with the Cowichan Head Formation.

Comment (W. Blake, Jr.): This strongly lignified and distorted wood, at first only identifiable as confiferous, upon re-examination by R.J. Mott was found to have features most like those of **Abies** sp. (unpublished GSC Wood Identification Report No. 78-25).

Mill Bay Series

Wood samples collected from a 10 m high roadcut 4 km southeast of Mill Bay, Vancouver Island, British Columbia (48°37'18"N, 123°31'29"W). The exposure is on an actively sliding slope in a roadcut that is a few years old, but the samples were extracted from 10 to 20 cm below the surface. Collected 1976 by S.R. Hicock, then Geological Survey of Canada, now University of Western Ontario, London; submitted by J.E. Armstrong.

GSC-2434. Mill Bay (I) 23 800 ± 240

Wood (sample FAB-178-W; 11.6 g; **Abies** sp., identified by L.D. Farley-Gill) at 10 m a.s.l. from a horizontally bedded, wood-bearing silt and fine sand unit, 3 m thick, which is underlain by 1 to 2 m of rusty sandy pebble gravel (which contained GSC-518, 23 840 ± 300 years old; GSC VI, 1967, p. 173-174), up to 1 m of dark brown organic silt with stones and till clasts (from which GSC-2495, described below, was collected), and finally by blue-grey fissile stony lodgment till. The horizontally bedded sand unit is overlain by convoluted and flat bedded sand to the top of the section.

GSC-2495. Mill Bay (II) 24 000 ± 310

Wood (sample FAB-177-W; 11.5 g; **Salix** sp., identified by L.D. Farley-Gill) at 4 m a.s.l. from a dark brown organic silt to fine sand, up to 1 m thick, which contained wood, organic matter, and clasts of blue-green stony till. It is underlain by fissile, blue-grey stony lodgment till, and overlain by 1 to 2 m of rusty sandy gravel and 6 m of horizontally bedded to convoluted sand to the top of the exposed section.

Comment (S.R. Hicock): These two dates, plus GSC-2452 (25 200 ± 300 years, this list) further improve our knowledge of the extent and age of the diachronous proglacial Quadra Sand (early Fraser Glaciation, Late Wisconsinan) and the nonglacial Cowichan Head Formation (Olympia nonglacial interval, mid-Wisconsinan). At Mill Bay the top of the rusty gravel appears to mark the contact between Cowichan Head Formation and Quadra Sand. When plotted on Clague's (1977, p. 18) age relation diagram for these two formations, GSC-2434 (in sand above the rusty gravel) falls on the curve which marks the transition from fluvial (Cowichan Head) to glaciofluvial (Quadra) sedimentation, whereas GSC-2495 (below the rusty gravel) plots clearly in the Cowichan Head field. The above relationships suggest that GSC-2434 represents early Quadra Sand deposition, close to the time of transition from fluvial to glaciofluvial sedimentation, at this site. These two dates not only confirm GSC-518 (23 840 ± 300 years, in the rusty gravel; GSC VI, 1967, p. 173-174), but also provide another valuable section where the contact between Cowichan Head Formation and Quadra Sand (between the Olympia nonglacial interval and Fraser Glaciation) is well dated (at 23 800 years B.P.). Each date based on one 3-day count in the 5 L counter.

Comment (W. Blake, Jr.): With reference to Hicock's comment re the age of GSC-2434 and -2495 and the position of these samples when plotted on Clague's (1977) diagram, it is important to stress that the wood-bearing units are indistinguishable on the basis of age. The error terms must not be forgotten in such discussions, and a useful modification to Clague's (1977) diagram would be if the age-latitude line separating Quadra Sand from Cowichan Head Formation had a width representing at least 500 years. Assignment to a specific formation must be done on lithological, sedimentologcial, or paleontological grounds; age is not a valid criterion when the dates in different formations overlap one another.

GSC-2182. Lens Creek 12 200 ± 140

Basal peat (sample SJ14; 13.7 g) from 525 cm below the surface of a peat bog, 12.8 km due south of Lake Cowichan township, Vancouver Island, British Columbia (48°43'N, 124°02'W), at an elevation of ca. 700 m. The bog occurs near Lens Creek in the shallow col between Fleet and Robertson rivers on the gently rolling plateau south of Cowichan Lake. Collected 1973 with a Hiller peat corer by N.F. Alley, then under contract to Geological Survey of Canada, now with Soil Conservation Authority, Kew, Victoria, Australia.

Comment (N.F. Alley): The date provides a minimum age for deglaciation of the main Vashon ice from the uplands south of Cowichan Lake. A basal peat bog date of 10 280 ± 150 years (I-8450; Alley and Chatwin, 1979) from Cowichan Valley suggests that deglaciation of valley bottoms may have been complete prior to 10 000 years ago.

NaOH leach omitted because of small sample size. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2223. Harris Creek 13 100 ± 130

Basal peat (sample SJ12; 30.6 g) from 530 cm below the surface of a peat bog, 13 km southwest of Lake Cowichan, Vancouver Island, British Columbia (48°43'N, 124°11'W), at an elevation of ca. 396 m. The bog occupies the low col between Lens and Harris creeks on the dissected plateau south of Cowichan Lake. Collected 1973 by N.F. Alley.

Comment (N.F. Alley): The date provides a minimum age for deglaciation of the main Vashon ice from the uplands south of Cowichan Lake (cf. GSC-2182, 12 200 ± 140 years, this list; Alley and Chatwin, 1979). NaOH leach omitted. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2041. San Juan Ridge 11 200 ± 110

Basal peat (sample SJ36; 56.5 g) from 325 cm below the surface of a peat bog on top of San Juan Ridge, 17 km west-southwest of River Jordan township, Vancouver Island, British Columbia (48°32'N, 124°13'W), at an elevation of 762 m. The basal peat overlies blue fluid clays, and the bog is developed in a glacially scoured depression on the top of the ridge. Collected 1973 with a Hiller peat corer by N.F. Alley.

Comment (W. Blake, Jr.): The date provides a minimum for deglaciation of the main Vashon ice, although other basal peat dates in the area are significantly older; cf. GSC-2182 (12 200 ± 140 years) and GSC-2223 (13 100 ± 130 years; both in this list; also Alley and Chatwin, 1979). NaOH leach omitted. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2452. French Creek 25 200 ± 300

Wood (sample FAB-176-W; 22.5 g; **Abies** sp., identified by L.D. Farley-Gill) from 1 m above the base of the north-eastern bank of French Creek (exposed section 10 m high above the creek), 5 km west-northwest of Parksville, Vancouver Island, British Columbia (49°19.9'N, 124°23.0'W), at an elevation of 50 m. The sample is from a dark brown organic silt layer, up to 2 m thick, containing pebbles, wood, and clasts of blue-grey stony clayey silt. The organic silt layer is underlain by stony clayey silt and lodgment till, and it is overlain by a crossbedded to flat bedded sand unit, 6 m thick, which is capped by lodgment till and stony clayey silt. Collected 1976 by S.R. Hicock; then Geological Survey of Canada, now University of Western Ontario, London; submitted by J.E. Armstrong.

Comment (S.R. Hicock): At French Creek the organic silt layer containing GSC-2452 could be assigned on the basis of lithology to either the lower part of Quadra Sand or to the upper Cowichan Head Formation. However, when GSC-2452 is plotted on Clague's (1977, Fig. 15) curve it lies clearly in the Quadra field and is therefore assigned to Quadra Sand. This seems reasonable as Quadra Sand was being deposited at Point Grey, 90 km to the east-southeast, by 26 100 years ago (Clague, 1977).

Comment (W. Blake, Jr.): The log used for dating, part of a larger log, was 69 cm long and 12 cm in diameter. Date based on two 1-day counts in the 5 L counter.

GSC-2904. Conuma River 8300 ± 70

Wood (sample 2; 11.4 g; **Picea** sp.; identified by L.D. Farley-Gill) at an elevation of approximately -28 m in a drillhole in a large alluvial fan, Conuma Valley, near the head of Tlupana Inlet, Vancouver Island, British Columbia (49°48.2'N, 126°24.9'W). The sample is from coarse sand approximately 37 m below the surface of the alluvial fan. Sediments in the 46 m drillhole consist of interbedded sand, pebble to boulder gravel, and minor silt and clay. Wood and other plant detritus are common in several beds, and marine shells were recovered from sand and mud at an elevation of about -15 m. Collected 1979 by E. Livingston and D. Hansen Pacific Hydrology Consultants, Ltd., Vancouver; submitted by E.C. Halstead, Environment Canada, Vancouver and J.J. Clague.

Comment (J.J. Clague): The fan from which the dated material came has been built into Conuma Valley by a stream tributary to Conuma River during postglacial time. Most of the fan sediments, including the dated stratum, are below present sea level and were deposited in a high-energy deltaic environment on the margin of Tlupana fiord. As this delta grew and expanded above sea level, Conuma River prograded westward, infilling Tlupana fiord to beyond the date site. The present delta front of Conuma River is 2 km west of the date site, thus the river has prograded at least this far since 8300 years ago. Because the dated stratum is overlain by about 28 m of sediments, which are below present sea level, and which are presumably deltaic in origin, it is likely that the head of Tlupana fiord was east of the date site until well after 8300 years ago. This progradation by the river from the date locality to present tidewater probably occurred in much less than 8300 years. Date based on one 4-day count in the 5 L counter.

Hirsch Creek Series

GSC-2407. Hirsch Creek (I) 4660 ± 60
$\delta^{13}C = -24.5‰$

Wood (sample CIA-2301; 11.5 g; **Picea** sp.; identified by L.D. Farley-Gill) from a roadcut, 0.5 km north of Hirsch Creek and 4 km north of Kitimat, British Columbia (54°05.5'N, 128°36.7'W), at an elevation of ca. 36 m. The wood is from sandy silt (up to 1.9 m of silt exposed), which is overlain by up to 1.0 m of woody fibrous peat, the latter being the surface unit at this site. The dated sample was collected 0.9 m below the peat-silt contact in 1976 by J.J. Clague.

Comment (J.J. Clague): The organic-rich sandy silt overlies gravel which was deposited by Hirsch Creek prior to a final phase of downcutting and terracing. The silt is interpreted to be overbank material deposited by Hirsch Creek during the early stage of this episode of incision. The stream presently flows about 17 m below the terrace surface at the sample site. The woody peat began to accumulate after Hirsch Creek had incised its alluvial fill to the point where the terrace was no longer affected by flooding. Other dates from the Kitimat area providing chronologic control on postglacial geologic events include GSC-522 (GSC VI, 1967, p. 174), GSC-2425 and -2492 (this date list). Date based on two 1-day counts in the 5 L counter.

GSC-2492. Hirsch Creek (II) 10 100 ± 160
$\delta^{13} = +1.7‰$

Shell fragments and unpaired valves of marine molluscs (sample CIA-2426; 10.7 g; **Mya truncata**; identified by I. Lubinsky, University of Manitoba, Winnipeg) from a 36 m high roadcut, 0.2 km south of Hirsch Creek and 2 km north-east of Kitimat, British Columbia (54°03.8'N, 128°35.6'W), at an elevation of ca. 98 m. The shells were collected from the base of foreset-bedded sand and gravel overlying marine silty clay. Fossils are limited to a sand-filled channel in the clay. Collected 1976 by J.J. Clague and A. Wallingford.

Comment (J.J. Clague): The shells date the initial deposition at this site of marine deltaic deposits by Hirsch Creek. The foreset-bedded sediments overlying the dated sample are part of a delta, now largely eroded, graded to a sea level of ca 120 m. GSC-2492 thus provides chronologic

control on postglacial sea levels in the area. A sequence of higher, telescoped Hirsch Creek deltas which formed earlier than GSC-2492 have not been dated. However, other shell dates from the Terrace-Kitimat area (GSC-522, -523, -535; Armstrong, 1966; GSC VI, 1967, p. 174; GSC-2276, -2306, -2408, and -2425; this list) provide additional control points on the early postglacial emergence curve for the British Columbia's northern inner coast. Sample mixed with dead gas for counting. Determination based on two 1-day counts in the 2 L counter.

GSC-2425. Kitimat River 9300 ± 90
$\delta^{13}C$ = -26.5 ‰

Wood (sample CIA-2292-1; 6.5 g) from Kitimat River bluff (15 m high), 2 km east-northeast of the confluence of Hirsch Creek and Kitimat River, and 5 km north of Kitimat, British Columbia (54°06.0'N, 128°36.8'W), at an elevation of 28 m. The wood is from a 15 cm thick bed of sandy clayey silt and silty sand within a foreset-bedded deltaic sand unit. The deltaic sand is unconformably overlain by fluvial pebble-cobble gravel and is underlain by horizontally stratified marine sandy silt and silty clay containing abundant disseminated organic matter. Collected 1976 by J.J. Clague ca. 60 cm above the contact between deltaic sand and marine silt-clay.

Comment (J.J. Clague): The foreset-bedded sand is a late-stage marine deltaic deposit of Hirsch Creek, postdating the higher delta dated by GSC-2492 (10 100 ± 160 years, this list). GSC-2425 and other dates from marine, glaciomarine, and deltaic sediments from the Terrace-Kitimat area (GSC-522, -523, -535; Armstrong, 1966; GSC VI, 1967, p. 174; GSC-2276, -2306, -2408, and -2492; this list) provide chronologic control on postglacial emergence of inner coastal areas of northern British Columbia. Sea level in the Kitimat area ca. 9300 years ago was more than 28 m above present. Date based on one 3-day count in the 2 L counter.

Comment (W. Blake, Jr.): The single piece of wood used for dating was lignified and slightly compressed, and it was not possible to obtain microtome sections. The wood was identifiable only as coniferous (unpublished GSC Wood Identification Report No. 76-61 by L.D. Farley-Gill).

McNeil River Series (Part A)

Fossil plant material and marine shells from a section on McNeil River 1 km north of the confluence of McNeil and Skeena rivers and 25 km southeast of Prince Rupert, British Columbia (54°12.4'N, 129°59.0'W). The following units are exposed in this section, from top to bottom: (1) Woody fibrous peat (ca. 1 m thick). This unit underlies the land surface throughout the McNeil River area and is transitional to the underlying unit. The transitional zone consists of 0.4 m of interlensing organic sediments and pebbly sand. (2) Pebbly sandy silt and silty sand with weak horizontal stratification (1.7 m thick). The contact with the underlying unit is sharp and horizontal. (3) Pebble-cobble gravel with parallel inclined stratification (up to about 2 m thick). (4) Massive silty sand containing scattered granules and pebbles and abundant plant material. The sand grades downward into sandy silt containing marine mollusc shells and rare wood and bark fragments. Concentrations of plant detritus occur at the contact between this unit (maximum exposed thickness 5.5 m) and the overlying gravel. This contact is sharp, unconformable, and inclined about 5°. All samples collected 1975 by J.J. Clague.

GSC-2222. McNeil River (I) 4400 ± 70
δ^{13} = -24.0 ‰

Wood (sample CIA-526-4; 11.2 g, **Abies** sp. cf. **A. amabilis**; identified by R.J. Mott) from pebbly sandy silt transitional from unit 2 to unit 1, at an elevation of 3 m (reference datum for this and other dates of this series is high sea level).

GSC-2471. McNeil River (II) 7710 ± 150
δ^{13} = -25.9 ‰

Wood (sample CIA-526-3B; 2.0 g, **Abies** sp. cf. **A. amabilis**; identified by R.J. Mott) from pebbly sandy silt of unit 2, at an elevation of 2 m.

GSC-2248. McNeil River (III) 8460 ± 90
δ^{13} = -25.0 ‰

Wood (sample CIA-256-2; 11.3 g; **Picea** sp.; identified by R.J. Mott) from a pocket of plant detritus at the contact between units 3 and 4, at an elevation of 1 m.

GSC-2307. McNeil River (IV) 8580 ± 100

A single piece of bark (sample CIA-526-0A; 5.7 g; dimensions, 8x4x1 cm) from sandy silt of unit 4, at an elevation of -3 m.

GSC-2343. McNeil River (V) 9180 ± 150
δ^{13} = -0.9 ‰

A single marine mollusc valve (sample CIA-526-0B; 11.3 g; **Clinocardium nuttalli**; identified by M.F.I. Smith, National Museum of Natural Sciences, Ottawa) from sandy silt of unit 4, at an elevation of -4 m. This intact aragonitic valve was 6.7 cm long and 5.8 cm high.

McNeil River Series (Part B)

A shallow excavation on the east side of Highway 16 (54°12.4'N, 129°58.5'W), ca. 0.5 km east of the above section McNeil River series (Part A) provided two additional dates, McNeil (VI) and McNeil (VII), from peat correlative with unit 1. The peat, 2.5 m thick, overlies pebbly sandy silt of unit 2. The sediments at the excavation occur at a higher elevation than correlative strata in the bank of McNeil River. Collected 1975 by J.J. Clague.

GSC-2235. NcNeil River (VI) 8120 ± 80
$\delta^{13}C$ = -26.8 ‰

Wood (sample CIA-533-1; 11.0 g; **Picea** sp., identified by R.J. Mott) from woody fibrous peat, at an elevation of 11.5 m. Sample collected from the basal 10 cm of peat.

GSC-2457. McNeil River (VII) 2780 ± 80
δ^{13} = -27.1 ‰

Peat (sample CIA-533-4; 15.2 g) from woody fibrous peat, at an elevation of 13 m. Sample collected 1.5 to 1.6 m above the base of the peat.

Comment (J.J. Clague): Radiocarbon dates of the McNeil River series provide information on postglacial sea levels and rates of peat aggradation on the northern, inner British Columbia coast. The McNeil River section is interpreted to be a shoaling marine sedimentary sequence deposited during a marine regression resulting from isostatic rebound. The lowest unit, 4, dated by GSC-2307 and -2343, was deposited in marine waters that became progressively shallower until the site emerged ca. 8460 ± 90 years ago (GSC-2248). At this time unit 4 was eroded by waves or currents, and driftwood mats at the top of the unit were buried by gravel of unit 3. Although this gravel is possibly of beach origin, it more likely was deposited by Skeena River on the emergent marine sediments of unit 4. The inclined stratification in the gravel suggests deposition in standing water. Thus lower McNeil Valley probably was a shallow (intertidal?) estuarine environment during deposition of unit 3, and relative sea level may have been a few metres

higher than at present. When estuarine sediments of unit 2 were deposited ca. 7710 ± 150 years ago, sea level was probably about the same elevation as at present. At an elevation of 3 m, peat did not begin to form until after 4400 ± 70 years B.P. (GSC-2222). However, at an altitude of 11 m peat commenced accumulation ca. 8120 ± 80 years B.P. (GSC-2235); at about the same time lower elevation sites became emergent. The fact that estuarine conditions persisted at low elevations (<3 m) until after 4400 years B.P. suggests that sea levels were not much lower than at present during much of middle Holocene time. Peat covers much of the low- to moderate-sloping land surfaces in the Prince Rupert area. Dates GSC-2235 and -2457 provide information on the rate of peat aggradation in this area. The average rate between ca. 8120 years B.P. and the present is 0.3 mm/a. Only the outer 10 per cent of GSC-2343 was removed by HCl leach. Samples GSC-2307, -2343, and -2471 mixed with dead gas for counting. Determinations for GSC-2222 and -2248 each based on two 1-day counts in the 5 L counter; GSC-2307, -2343, -2457, and -2471 each based on two 1-day counts in the 2 L counter; GSC-2235 based on one 3-day count in the 5 L counter.

Prince Rupert Series

GSC-2231. Prince Rupert (I) 5930 ± 80
δ^{13} = -25.7 ‰

Wood (sample CIA-520-2; 11.0 g; probably **Abies** sp. cf. **Abies amabilis**; identified by R.J. Mott) from a roadcut in Prince Rupert, British Columbia (54°18.0'N, 130°20.2'W), at an elevation of 45 m. The wood was collected at the base of peat (2.5 m thick) overlying pebbly sandy silt (0.3 m thick on average), which, in turn, overlies bedrock. GSC-2299 (2830 ± 60 years, this series) is a date from the sandy silt. Collected 1975 by J.J. Clague.

GSC-2299. Prince Rupert (II) 2830 ± 60

Sedges (sample CIA-520-1; 18.0 g) from a roadcut in Prince Rupert, British Columbia (54°18.0'N, 130°20.2'W), at an elevation of 44 m. The sedges occur in pebbly sandy silt which overlies bedrock and is overlain by 2.4 m of woody fibrous peat (the same section as Prince Rupert (I)). Collected 1975 by J.J. Clague.

GSC-2290. Prince Rupert (III) 12 700 ± 120
δ^{13} = +1.1 ‰

Shell fragments of marine molluscs (sample CIA-551; 28 g; **Mya truncata**; identified by W. Blake, Jr.) from an excavation at Prince Rupert, British Columbia (54°17.0'N, 130°21.3'W), at an elevation of 11 m. The shells occur in stony silt-sand up to 9 m thick, which overlies a sloping bedrock surface and is overlain by colluvium. Collected 1975 by J.J. Clague.

Comment (J.J. Clague): Date GSC-2290 is a minimum for deglaciation of the northern British Columbia coast in the vicinity of Prince Rupert and is comparable to deglaciation dates for the southern inner coast in the Strait of Georgia-Fraser Lowland area (e.g., see Mathews et al., 1970). Deglaciation probably occurred 1000 to 2000 years earlier at Prince Rupert than in the Terrace-Kitimat area (e.g., see GSC-2408, 10 700 ± 160 years, this list; also Kitimat-Terrace series, GSC VI, 1967, p. 174; Clague, 1975b). GSC-2231 is a basal peat date. The peat occurs as a layer mantling a rock surface sloping 5 to 10° in the vicinity of the dated locality. The origin of the thin pebbly sandy silt underlying the peat is questionable, although it is perhaps colluviated early-postglacial marine mud, similar to that of Prince Rupert (III). Pebbly silt similar to that described here is common in the Prince Rupert-Port Edward area, although nowhere is it thick. GSC-2299 (2830 ± 60 years) was obtained from sedges underlying wood which yielded an older apparent age (GSC-2231, 5930 ± 80 years). The younger date is considered to be invalid as an age indicator of the pebbly sandy silt in which the sedges occur. Either the sedges have been contaminated by "young" carbon transported in groundwater through the silt and along its upper and lower contacts, or modern plant material was collected and submitted with the sedges. The former explanation for the discordant date is considered the more probable. Sample GSC-2299 mixed with dead gas for counting. Determinations for GSC-2290 and -2299 each based on one 3-day count in the 2 L counter; GSC-2231 based on two 1-day counts in the 5 L counter.

Skeena River Series

GSC-2411. Skeena River (I) 450 ± 40
δ^{13} = -22.2 ‰

Wood (sample CIA-3027; 11.9 g; **Picea** sp.; identified by L.D. Farley-Gill) from the bank of Skeena River, 24 km west-southwest of Terrace, British Columbia (54°23.8'N, 128°54.1'W), at an elevation of 35 m. The sample was part of a large log found in fluvial sand at river level, ca. 2 m below the floodplain surface. Collected 1976 by J.J. Clague.

GSC-2455. Skeena River (II) 4640 ± 50
δ^{13} = -24.6 ‰

Charcoal (sample CIA-3028; 11.6 g; **Picea** sp. (in part); identified by R.J. Mott) from a 5 m high bank of Skeena River, 25 km west-southwest of Terrace, British Columbia and 2 km southeast of CN Shames (54°23.6'N, 128°54.9'W), at an elevation of 34 m. The charcoal occurs within sand and silt which grades downward into, and is interbedded with, gravel. These sediments contain lithologies which indicate derivation from the northeast and transport by Skeena River. The sand and silt is overlain across an irregular, and perhaps unconformable, contact by sand and gravel derived from the south and transported by Dasque Creek. A possible paleosol occurs at the contact between the two units. Collected 1976 by J.J. Clague and A. Wallingford, 3 to 4 m below the top of the river bank within the uppermost metre of the lower unit.

Comment (J.J. Clague): There have been marked postglacial sea level changes on the British Columbia coast due to the combined effects of diastrophism, isostasy, and eustacy (Mathews et al., 1970; Clague, 1975b). Lower Skeena River, graded to present sea level, undoubtedly responded to changes in sea level by aggrading (sea level rise) and degrading (sea level fall). The sediments at Skeena River (I) and the lower unit at Skeena River (II) are channel and overbank materials deposited when Skeena River was flowing within a metre or two of its present level. Thus, it is probable that sea level ca. 450 and 4640 years ago was not markedly different from the present on the British Columbia inner north coast. The upper unit at Skeena River (II) is part of a large alluvial fan derived from Dasque Creek, a tributary of Skeena River. GSC-2455 thus is a maximum limiting date for the building of the distal part of this fan. Other dates on alluvial fans in the Skeena River basin include GSC-2392 (7900 ± 90 years, this list) and GSC-2535 and -2552 (GSC XVIII, 1978, p. 11). It is probable that, during and subsequent to the building of the Dasque Creek fan, Skeena River was not flowing at a higher level than at present, because no Skeena River overbank deposits are interstratified with or overlie the Dasque Creek fan sediments at Skeena River (II). Each date based on one 3-day count in the 5 L counter.

GSC-2306. Amsbury Creek 10 200 ± 100

Shell fragments of marine cirripeds (sample CIA-474; 35.0 g; **Balanus** sp., identified by W. Blake, Jr.) from a fresh roadcut bordering Highway 16, 1.5 km east-northeast of Amsbury Creek and 12 km west-southwest of Terrace, British

Columbia (54°28.5'N, 128°45.6'W), at an elevation of ca. 141 m. The shells occur in massive to weakly stratified, stony silty clay containing sandy lenses. The stony clay is the surface unit in the vicinity of the collection site. Collected 1975 by J.J. Clague, S. Marshall, and S. Hicock.

Comment (J.J. Clague): Lower Skeena Valley was a fiord at the close of the Pleistocene, and fine grained marine and glaciomarine sediments were deposited on the lower walls and floor of this valley. GSC-2306 dates a sea level stand of >150 m (approximate elevation of highest marine sediments in the vicinity of Amsbury Creek). Other marine and glaciomarine shell dates from the Terrace-Kitimat area are GSC-522, -523, -535; Armstrong, 1966; GSC VI, 1967, p. 174; GSC-2276, -2408, and -2492; Clague 1975b; this date list). Only the outer 10 per cent of these aragonitic shells was removed by HCl leach. Date based on two 1-day counts in the 5 L counter.

Zymagotitz River Series

GSC-2276. Zymagotitz River (I) 10 600 ± 110

Shell fragments of marine molluscs (sample CIA-507; 27.35 g; **Mytilus** sp., identified by W. Blake, Jr.) from a 4 m high bluff of Zymagotitz River, 12 km west-northwest of Terrace, British Columbia (54°32.7'N, 128°45.8'W), at an elevation of ca. 81 to 83 m. The shells occur in a massive to weakly stratified, stony silty clay containing sandy lenses. The stony clay is the only unit exposed in the bluff and directly underlies the land surface in this portion of Zymagotitz Valley. Collected 1975 by J.J. Clague, S. Marshall, and S. Hicock.

GSC-2408. Zymagotitz River (II) 10 700 ± 160
δ^{13} = -1.2 ‰

Shell fragments of marine molluscs (sample CIA-1558-1; 27.7 g; probably **Mytilus** sp., identified by W. Blake, Jr.) from a 3 m high bluff of Zymagotitz River, 9 km west of Terrace, British Columbia (54°32.2'N, 127°43.8'W), at an elevation of ca. 62 m. The shells occur in a silty clay containing sandy lenses. The clay directly underlies the land surface in this portion of Zymagotitz Valley. Collected 1976 by J.J. Clague and A. Wallingford

Comment (J.J. Clague): At the close of the late Wisconsin glaciation, lower Zymagotitz Valley was occupied by an arm of the sea extending east from Prince Rupert and north from Kitimat. Fine grained marine and glaciomarine sediments were deposited on isostatically depressed terrain below about 200 m elevation. Because glaciomarine clays extend upvalley from Zymagotitz (I) less than 1 km and there terminate abruptly in a depositional escarpment, it is thought that these sediments were deposited proximal to the calving terminus of a late Wisconsin remnant valley glacier. Thus, GSC-2408 probably dates a recessional position of the Zymagotitz valley glacier and further dates a sea level stand of >113 m (highest preserved marine sediments in Zymagotitz Valley). Other marine and glaciomarine shell dates from the Terrace-Kitimat area are GSC-522, -523, -535, -2306, and -2492 (Armstrong, 1966; GSC VI, 1967, p. 174; Clague, 1975b; and this date list). The range of these shell dates is 9880 ± 160 years to 10 790 ± 180 years. GSC-2276 and -2408 based on one 2-day count and one 3-day count, respectively, in the 2 L counter.

Comment (W. Blake, Jr.): Both samples contained barnacles also, but only the blue-violet shell fragments typical of **Mytilus** were used for dating.

GSC-2546. Deep Creek 3280 ± 50
δ^{13} = -24.0 ‰

Wood (sample CIA-1908; 11.3 g; **Picea** sp.; identified by L.D. Farley-Gill) from a new roadcut, 2.7 m high, near the north valley wall of Deep Creek, 7 km north-northwest of Terrace, British Columbia (54°34.5'N, 128°38.6'W), at an elevation of 107 m. The wood is from the base of a peat unit (maximum thickness 1.0 m) which underlies the land surface in the vicinity of this station. The peat overlies sand and gravel which, in turn, overlies marine silty clay. Collected 1977 by J.J. Clague.

Comment (J.J. Clague): The detrital sediments beneath the peat were deposited during and after deglaciation of the area, but prior to postglacial downcutting by the major streams. It was hoped that the age of the base of the peat would provide a close limiting date as to the time of incision of the detrital sediments by Deep Creek; this is assumed on other evidence to have occurred during early postglacial time. However, GSC-2546 suggests that the peat did not begin to accumulate until long after sand and gravel deposition ceased, and probably after the detrital sediments had been incised by Deep Creek. Determination based on one 3-day count in the 5 L counter.

GSC-2528. Erlandsen Creek 37 200 ± 1060

Wood (sample CIA-3511-1; 11.7 g, **Picea** sp. or **Larix** sp.; identified by L.D. Farley-Gill) from a 9 m deep gully, tributary to, and ca. 0.2 km west of Erlandsen Creek, and 11 km northwest of Terrace, British Columbia (54°35.5'N, 128°42.7'W), at an elevation of ca. 217 m. The wood occurs in a thin (ca. 15 cm) bed of clay containing sand laminae and scattered stones. This unit is underlain by weakly stratified cobble-boulder fluvial gravel, talus, and bedrock, and is overlain by interlensing gravelly sand, poorly sorted gravel, and diamicton. The upper surface of the wood-bearing clay is disrupted, and clay locally intrudes the overlying sand and gravel. Collected 1977 by J.J. Clague and A.C. Clague.

Comment (J.J. Clague): The uppermost unit at this site is thought to be subglacial or proglacial outwash and flowtill deposited during final deglaciation of the Erlandsen Creek area. A genetic interpretation for the underlying wood-bearing clay, however, is less certain. It was originally thought that the clay accumulated in a local proglacial or subglacial pond during the same deglacial episode that produced the overlying unit. The date, however, indicates that either the clay is significantly older than the overlying outwash-flowtill complex and is separated from it by a disconformity, or the wood is derived from an older unit not present at this site and has been redeposited in the clay. Whichever explanation is correct, the date indicates the existence of a forest cover in this mountainous area ca. 37 000 years ago during what has been termed the Olympia Interglaciation (or nonglacial interval) in southern British Columbia. GSC-2528 is the first middle Wisconsin date from the Coast Mountains of northwestern British Columbia. No other sediments which predate the last (late Wisconsin) glaciation have been recognized in exposures in the Terrace-Kitimat-Prince Rupert area. The nearest comparable dates are from Babine Lake, 170 km to the east, in central British Columbia (Harington et al., 1974). Determination based on one 3-day count in the 5 L counter.

Comment (W. Blake, Jr.): The wood fragments comprising this sample, all derived from a single piece, were highly lignified, compressed, distorted, and brittle; the material appeared "old". Adhering silt and clay were removed.

GSC-2392. Doughty 7900 ± 90
δ^{13} = -25.4 ‰

Wood (sample CIA-884-1; 10.0 g; **Picea** sp.; identified by L.D. Farley-Gill) from a drainage ditch near the railway at CN Doughty, 23 km north-northwest of Smithers, British Columbia (54°57.8'N, 127°20.8'W), at an elevation of ca. 440 m. The wood is from pebbly silty sand at the base of 1.7 m of alluvial fan sediments (mainly pebble-cobble gravel) which overlie till. Collected 1976 by J.J. Clague.

Comment (J.J. Clague): The date provides some chronologic control on alluvial fan deposition in Bulkley Valley. Thus, the oldest fan sediments at this section are 7900 ± 90 years old. Because the section is midway between the fan apex and the fan distal margin, the inception of alluviation may have occurred somewhat earlier, although probably not much; see also GSC-2455, -2535, and -2552 (this date list). Date based on two 1-day counts in the 5 L counter.

GSC-2463. Bulkley River 9360 ± 180

Wood (sample CIA-978; 1.9 g) from Bulkley River bluff, 12 km east-southeast of New Hazelton, British Columbia and 3 km southeast of confluence of Bulkley and Suskwa rivers (55°12.8'N, 127°24.4'W), at an elevation of ca. 318 m. The wood was collected 7 m below the top of the 28 m high river bluff from a sand lens within lacustrine or glaciolacustrine clayey silt. The silt is unconformably overlain by fluvial gravel deposited by the early postglacial Bulkley River. A flight of terraces forms the land surface in the vicinity of this site. Collected 1976 by J.J. Clague and A. Wallingford.

Comment (J.J. Clague): Layering in the silt is locally inclined and offset by high-angle faults. The deformation does not affect the overlying terrace gravel, thus is thought to have developed at the same time that the silt was deposited. The silt accumulated in a lake dammed either by residual decaying ice masses in lower Bulkley Valley northwest of the date site, or behind alluvial fan deposits of Suskwa River. Incision of the drift fill in Bulkley Valley and, probably, cutting of Bulkley Canyon postdate GSC-2463. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Comment (W. Blake, Jr.): The single largest piece of wood, 15 cm long and 0.5 cm in diameter, was used for dating. The surface of the wood was characterized by imbedded sand grains.

Babine Lake Series

Wood samples and bone in silt from the Noranda open pit mine on Newman Peninsula, Babine Lake, British Columbia (55°00'00"N, 126°14'00"W), at an elevation of ca. 703 m. The silt unit is up to 6 m in thickness. It is underlain by 6 m of clay and overlain by 0.3 to 1.5 m of gravel and a buff to light grey till up to 24 m in thickness. Collected 1971 by H.W. Tipper.

GSC-1657. Babine Lake (I) 42 900 ± 1860
δ^{13} = -20.7 ‰

Wood (sample TD-Nor-2-71; 10.6 g; **Picea** sp.; identified by L.D. Farley-Gill) from organic silt. The sample was a single piece of wood, wet (25.5 g on receipt) and with a right angle bend; total length 16 cm, maximum diameter 2 cm. Date based on one 3-day count in the 5 L counter.

GSC-1687. Babine Lake (II) 43 800 ± 1830
$\delta^{13}C$ = -20.3 ‰

Wood (sample TD-Nor-2(A)-71; 10.7 g; **Abies** sp.; identified by R.J. Mott) from organic silt. This single piece of damp wood (21.1 g on receipt) was 23 cm long with 2 cm maximum diameter. Date based on one 4 day count in the 5 L counter.

GSC-1754. Babine Lake (III) 34 000 ± 690
$\delta^{13}C$ = -19.4 ‰

Anterior rib fragment of an elephant (sample NMC-17915; 496 g; **Mammuthus** cf. **M. columbi**; identified by C.R. Harington, National Museum of Natural Sciences, Ottawa) from organic silt. Collagen fraction utilized after pretreatment with 3N HCl and 0.1N NaOH. Date based on one 4-day count in the 5 L counter.

Comment (C.R. Harington): This date on bone from the rib of a partial skeleton of a large mammoth (cf. **M. columbi**) indicates that these mammals occupied central British Columbia during the Olympia nonglacial interval (Clague, 1977). Presuming that the thick till overlying the organic silts that enclosed the mammoth remains was laid down during the last (Fraser) glaciation, an age of more than 20 000 years for the bones would seem reasonable. Because the pieces of wood (**Picea** sp. and **Abies** sp.) associated with the skeletal remains yielded dates of 42 900 ± 1860 years (GSC-1657) and 43 800 ± 1830 years (GSC-1687), it would appear that the bones intruded from above. Perhaps the mammoth sank into sticky pond deposits and died there. Paleobotanical data indicate that a type of shrub tundra covered the region during part of the Olympia nonglacial interval (Harington et al., 1974; Harington 1974, 1977b).

Comment (W. Blake, Jr.): It is worth noting that the two age determinations on wood are among the oldest obtained in the Geological Survey of Canada laboratory using the 5 L counter at normal pressure (1 atm). Another piece of wood, from the peat utilized for palynological study, was identified as **Salix** sp. (unpublished GSC Palynological Report No. 72-22 by R.J. Mott). That the site was wet is indicated by the presence in the silt of the aquatic moss **Drepanocladus exannulatus** (unpublished GSC Bryological Report No. 177 by M. Kuc).

GSC-1497. Finlay-Parsnip Access Road 9280 ± 200
$\delta^{13}C$ = -20.0 ‰

Horn (sample RR-70-1X; 550 g; **Ovis canadensis**; identified by D.M. Shackleton, then University of Calgary, Calgary, now University of British Columbia, Vancouver) from a skull unearthed during the operation of a gravel pit on the west side of the Finlay-Parsnip Access Road, British Columbia (55°48'00"N, 123°38'30"W), at an elevation of ca. 730 m. The skull was found ca. 3 m below the normal ground surface in dry ice-contact fluvial gravels. Collected 1969 by K. Sumanik, British Columbia Department of Recreation and Conservation; submitted by N.W. Rutter, then Geological Survey of Canada, now University of Alberta, Edmonton.

Comment (W. Blake, Jr.): This date on a Bighorn sheep skull provides a minimum age for deglaciation in Parsnip Valley (Rutter et al., 1972; Rutter, 1977). The horn was well preserved with large interstices (1 to 2 cm in diameter). The horn was stained brownish, but no rootlets were present. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 5 L counter.

GSC-2859. Portage Mountain moraine 25 800 ± 320
$\delta^{13}C = -24.1$ ‰

Ivory from an elephant tusk (sample "I-2244"; 668 g; Proboscidea cf. **Mammuthus** sp.; identified by C.R. Harington, National Museum of Natural Sciences, Ottawa), recovered by a bulldozer operator from a large gravel pit used for raw material for the W.A.C. Bennett Dam, ca. 12.5 km S80°W of Hudson Hope, British Columbia (approximate coordinates, as the specific collection site was not documented: 56°0.6' ± 0.3'N, 122°06.7' ± 0.3'W), at an elevation of ca. 760 m. Collected 1966 by L.T. Jory, British Columbia Hydro and Power Authority; submitted by J.F. O'Kelly of the same organization, Hudson Hope, and W.H. Mathews, University of British Columbia, Vancouver.

Comment (W.H. Mathews): "A special problem is presented by the two dates GSC-2859 and I-2244A from bone collagen of a tusk from the Portage Mountain kame-moraine found in 1966 during the construction of the W.A.C. Bennett dam. When the tusk was first discovered a sample was submitted to Isotopes, Inc. and a date of 7670 ± 170 years (I-2244) was obtained from the carbonate fraction. Suspicion was then raised that carbonate-bearing ground waters had contaminated the tusk, and the organic (collagen) fraction remaining from the first determination was dated. This yielded a date of 11 600 ± 1000 years (I-2244A). The weight of collagen utilized, however, was so small that no estimate of counting precision could be made and the quoted age "represents a minimum value" (J. Buckley, Teledyne-Isotopes, personal communiction 1972 to W. Blake, Jr.). The remainder of the tusk was coated with a preservative (Krylon?) and placed on display at the dam. In 1978 still another sample was obtained from the same tusk, by carefully selecting core material which, although partially imbedded in plaster used to fill the hollow interior, had escaped impregnation by the preservative. The collagen obtained in this way yielded the 25 800 ± 320 year age (GSC-2859). This date, from a proglacial deposit near the Cordilleran ice limit, is difficult to reconcile with the nearly contemporaneous date (GSC-573) from nonglacial sand (Rutter, 1977, p. 19, 20) 135 km to the west and much closer to the source of Cordilleran ice. This discrepancy raised the question of some contamination, notwithstanding the care taken in the latest sampling of the tusk, or even of the remote chance of redeposition of the tusk. Alternatively, however, it raises the possibility that the Cordilleran climax at Portage Mountain was early in Classical Wisconsinan time and that Cordilleran glacial deposits still farther to the east are significantly older. The date, moreover, throws in doubt the previous interpretation that the tusk, the kame-moraine, and the apparently contemporaneous Bessborough stage of Lake Peace were of late Classical Wisconsinan age (Mathews, 1978, p. 17 and Fig. 7, p. 14)" (Mathews, in press).

Comment (W. Blake, Jr.): The greatest care was taken at the National Museum of Natural Sciences (G. Fitzgerald and C.R. Harington) and at the Geological Survey of Canada (R.J. Richardson and W. Blake, Jr.) to ensure that the sample was clean ivory. No gloss or surface film such as characterizes items sprayed with Krylon was present on the clean ivory sent to the laboratory. After pretreatment with 3N HCl and distilled water rinses, 30.7 g were burned, yielding ca. 70 cm of CO_2. Date based on one 3-day count in the 5 L counter.

Date GSC-573 (25 940 ± 380 years; GSC XI, 1971, p. 298-299), referred to in Mathew's comment above and first published by Rutter (1967), was obtained on plant material in sand along Ospika River; the sand was overlain by gravel and till-like material inferred to represent a glaciation.

An earlier attempt to date ivory from a mammoth tusk recovered from an active gravel pit 4.3 km S35°W of Hudson Hope was unsuccessful. For GSC-2608, 318 g of clean ivory was treated with 6N HCl; 18.6 g of what was thought to be collagen was burned, but no CO_2 was produced.

GSC-2034. Ostero Pit, Taylor 27 400 ± 580
$\delta^{13}C = -21.1$ ‰

Part of a woolly mammoth's upper molar (sample NMC-17679; 700 g; **Mammuthus primigenius;** identified by C.R. Harington, National Museum of Natural Sciences, Ottawa) from gravel in the Ostero pit, on the northwest side of Peace River at Taylor, British Columbia (56°08.5'N, 120°40.5'W), at an elevation of ca. 455 m. The slightly iron-stained specimen was found about 15 to 18 m below the surface in an actively worked gravel pit. Collected 1970 by Mrs. N. Ostero, Taylor, B.C.

Comment (W.H. Mathews): The deeper parts of the gravel deposit, from which the mammoth tooth was obtained, are now interpreted as the lower portion of an interglacial succession. Correlative gravels are exposed in cutbanks of Peace River at a similar elevation (ca. 475 m) 0.8 km upstream (west) where they are overlain, in turn, by a thick succession of silts and clays, by till, and by later glaciolacustrine beds. At the site of the Ostero pit, however, the silts, clays, and younger beds have been eroded away in early postglacial time by Peace River which left a broad terrace here in their place (Mathews, 1978).

Comment (W. Blake, Jr.): The molar was part of the same tooth (apatite) which had been processed earlier as GSC-1901 (561 g). Unfortunately, that sample, the middle four plates of the upper molar, was lost when the CO_2 prepared leaked out of the metal cylinder in which it was stored. Another sample (NMC-17681 = GSC-2247) from the Ostero pit, a right metatarsal of a moose **(Alces alces;** identified by C.R. Harington) weighed only 205 g, and insufficient material (0.4 g) remained to burn after the treatment in 3N HCl. For GSC-2034 the crushed sample did not react with HCl, hence it was treated with acetic acid to recover the collagen fraction; 115.3 g was burned, resulting in a yield of 24.8 cm of CO_2. Date based on two 1-day counts in the 2 L counter.

Northern Canada, Mainland and Offshore Islands

Yukon Territory

GSC-2848. Dezadeash Lake 90 ± 60

Wood (sample DEZ; 8.0 g; **Picea** sp.; identified by R.J. Mott) from the outer 0.5 cm of a dead tree on the surface of a rock glacier 45 km south of Haines Junction, Yukon Territory, and about 300 m west of Haines Highway (60°25'N, 137°05'W). The tree grew in a small topographic break in the lower portion of the rock glacier at an elevation of approximately 1000 m. Collected 1978 by R.W. May, University of Alberta, Edmonton; submitted by J.J. Clague.

Comment (R.W. May): The age of this wood, most likely **Picea glauca,** suggests that it may have died sometime in the middle to late 1800s. Comparison of the diameter of this tree with that of others in the area indicates that it may have been about 100 years old when it died. Denton (1965) estimated that **Picea glauca** takes at least 53 years to become established on glacial drift following retreat of the ice. If this is the case, then it would imply that the lower portion of the rock glacier has been inactive since about the early 1700s. It can be suggested, at least initially, that the rock glacier formed and was active during the Neoglacial (Denton and Stuiver, 1966). As the Neoglacial came to an end, the activity of the rock glacier ceased.

Comment (W. Blake Jr.): This wood sample, part of a larger piece, measured 22.4 cm in length by 2.2 x 0.5 cm in cross-section. The weathered surface was scraped clean. Date based on one 1-day count in the 5 L counter.

GSC-1301. Kirkland Creek 4710 ± 180
$\delta^{13}C$ = -26.0‰

Organic detritus (sample HH68-1D; 9.5 g) in silt from a depth of 4.57 to 4.79 m in a boring on the north side of a thermokarst pond; the pond is on the north side of an unnamed tributary of Kirkland Creek, Aishihik map area (National Topographic System map 115 H), Yukon Territory (61°29.5'N, 136°44'W), at an elevation of ca. 1180 m. Collected 1968 by O.L. Hughes.

Comment (O.L. Hughes): The enclosing silt was originally thought to be glaciolacustrine sediment deposited when the locality was submerged beneath a glacial lake dammed by ice of the Cordilleran Ice Sheet during the Classical Wisconsinan McConnell advance. However, the Cordilleran ice sheet had withdrawn from the region by 9660 ± 150 years ago (GSC-749; GSC IX, 1970, p. 74); the dated sediments are therefore either pond or alluvial deposits that postdate the glaciolacustrine event. Because of the fine nature of this small sample, the NaOH leach was omitted. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2817. Nisling River >39 000

Twigs (sample HH78-17(4.72 m); 2.80 g) from peat in a natural exposure on the right (north) bank of Nisling River, Yukon Territory (62°00.5'N, 136°59.5'W), at an elevation of ca. 960 m. Collected from 4.7 m above low water level (5.3 m below the ground surface). At the site, Nisling River is eroding a fan apron that lies between the river and an upland surface developed on quartz monzonite that lies to the northeast (Tempelman-Kluit, 1974, Map 17-73). Except for rare clasts of greenstone, the fan sediments consist entirely of coarse feldspathic sand derived from the upland to the northeast. The peat forms part of the infilling of a fossil ice wedge cast. Collected 1978 by O.L. Hughes.

Comment (O.L. Hughes): The locality is beyond the limit of advance of the Cordilleran ice during the Classical Wisconsin McConnell advance, and probably also beyond the limit of the earlier Reid advance (Hughes et al., 1969, Map 6-1968). The date is a minimum for initiation of accumulation of the fan deposits.

Comment (W. Blake, Jr.): The twigs in the coarse size fractions (+30 mesh and +100 mesh) were used for dating. They were fine and fragile and did not appear worn or to have undergone much transport, although no bark remained on the twigs. Fine rootlets were removed and no contaminants such as coal or amber were noted in these size fractions. Date based on two 1-day counts in the 5 L counter.

GSC-2781. Dawson 1740 ± 50

Wood (sample HH78-46, 11.0 g **Picea** sp., identified by R.J. Mott) from a borrow pit in the lower part of Dawson slide, at the northern edge of the city of Dawson, Yukon Territory (64°04.2'N, 139°25.2'W) at an elevation of ca. 335 m. The wood was collected from a 25 cm thick layer of forest peat. The peat layer occurs about 1 m above the pit floor, is underlain by a yellowish grey brown soil developed in rock detritus consisting mainly of serpentinized ultrabasic rock, and is overlain by 6.5 m of unweathered rock detritus similar to that underlying the peat. Collected 1978 by J.G. Fyles, O.L. Hughes, R.O. van Everdingen, Inland Waters Directorate, Department of the Environment, Calgary, and P.J. Williams, Carleton University, Ottawa.

Comment (O.L. Hughes, R.O. van Everdingen): The peat contained plant remains and beetles indicating deposition on quite a dry site (identification and interpretation by J.V. Matthews, Jr.; unpublished GSC Plant Macrofossil Report No. 78-11, unpublished GSC Fossil Arthropod Report No. 78-13).

Although numerous slides developed on serpentinized ultrabasic rocks occur along Klondike and Yukon rivers, the Dawson slide is unique among them in exhibiting several features characteristic of rock glaciers, as noted by Tyrrell (1910) who described the feature as a "rock glacier" or chrystocrene. Whether the feature is a rock glacier or some type of slide or earth flow, the forest peat and subjacent soil development indicate a period of stability followed by reactivation resulting in burial of the collecting site sometime after 1740 radiocarbon years B.P. Morphology of the feature (see Airphoto A22199-99 to 101) suggests two possible subsequent stages of rock glacier activity. Despite the morphology of the feature, caution is warranted in interpreting it as a rock glacier in view of the fact that the numerous rock glaciers in the nearby Ogilvie Mountains occur, with few exception, at elevations of 1500 m or more (Vernon and Hughes, 1966). Date based on two 1-day counts in the 5 L counter.

GSC-2438. Ogilvie River 6240 ± 70

Wood (sample HH62-35(1976) 16.7 m; 11.4 g; **Populus** sp., identified by L.D. Farley-Gill) collected from gravel on a low bedrock terrace on the right (south) bank of Ogilvie River 13 km direct distance above the mouth of Hart River, Yukon Territory (65°49'N, 136°40'W), at an elevation of ca. 365 m. At the locality, a bedrock bench 3 m above low water level is overlain by 5 m of gravel and 5 m of organic silt. The dated wood was collected from the gravel 3.5 m above the bedrock terrace and 6.5 m below the ground surface. Collected 1976 by O.L. Hughes.

Comment (O.L. Hughes): The gravel is a point bar deposit and the overlying organic silt is floodplain alluvium. The surface is 8 to 10 m above the modern floodplain, indicating that amount of downcutting in the last 6170 to 6310 years.

Comment (W. Blake, Jr.): This damp soft wood, 50 cm long and 5.3 cm in diameter, was part of a much larger piece. On drying, 42.3 g of wood decreased in weight to 13.4 g. Date based on two 1-day counts in the 5 L counter.

GSC-2393. Peel River 10 600 ± 180

Wood (sample HH76-4(10.9 m); 3.0 g) together with moss and other organic material in a silt lens 10.9 m below the surface in a 20 m thick gravel unit overlying siltstone and sandstone of Tertiary(?) age. The collection site is in a steep gully 1.6 km north of Peel River on the east side of a stream that enters Peel River opposite the mouth of Bonnet Plume River, Yukon Territory (65°57'N, 134°59'W), at an elevation of ca. 275 m. Collected 1976 by O.L. Hughes.

Comment (O.L. Hughes): The gravel deposit lies on a high terrace about 70 m above Peel River but is inset about 80 m below an extensive glacial lake plain that occupies the area between Wind and Bonnet Plume rivers south of Peel River. The date therefore relates to a stage when the glacial lake had drained and Peel River was established along its present course (see also GSC-2484, 7490 ± 120 years, this list).

Comment (W. Blake, Jr.): Only twigs were utilized for dating; both those with bark and those without bark appeared compressed. They were too small for identification. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2484. Eagle River 7490 ± 120

Bark and twigs (sample HH72-92-1; 6.2 g) from a silt lens 10 m below the surface in a natural exposure on the right bank of Eagle River, 14.5 km north of Moose Lake, Yukon Territory (66°20'N, 136°29.5'W), at an elevation of ca. 350 m.

The exposed deposits consist of alluvial fan gravel and sand with several lenses of organic silt, of which the lowermost was sampled for dating. Collected 1972 by O.L. Hughes.

Comment (O.L. Hughes): The collection site is at the north end of a major channel by which Peel River plus meltwater was diverted by glacial damming into the Porcupine River system. The alluvial fan deposits postdate the last stage of diversion, and the date is a minimum for the re-establishment of Peel River to flow east and north to the Mackenzie Delta (see also GSC-2393, 10 600 ± 180 years, this list).

Comment (W. Blake, Jr.): The dated material was 6.2 g of bark with attached wood, unidentified. Some adhering silt remained. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Bluefish River Tributary Series

Wood samples from a natural exposure on the left (west) bank of an unnamed tributary of Bluefish River, Yukon Territory (67°22.5'N, 140°12'W), at an elevation of ca. 275 m. From stream level, 9.3 m of fine gravel and sand with several layers containing abundant wood, spruce cones, and organic detritus are overlain by 3.7 m of coarse gravel and 1 m of silt. The contact between fine gravel and sand below and the coarse gravel above is marked by a prominent layer of cobbles and boulders. The upper surface is a terrace inset about 25 m below the surface of Bluefish Basin. Collected 1973 by O.L. Hughes.

GSC-2155. Bluefish River tributary (I) 8870 ± 90

Wood (sample HH73-30-2; 11.0 g; **Populus** sp.; identified by L.D. Farley-Gill) from 1.8 m above the prominent layer of boulders and cobbles.

GSC-2158. Bluefish River tributary (II) >42 000

Wood (sample HH73-30-1; 11.3 g; **Larix** sp.; identified by L.D. Farley-Gill) from 0.6 m below the prominent layer of cobbles and boulders.

Comment (O.L. Hughes): The dates support an initial interpretation that the cobble and boulder layer marks a disconformity, with "old" sediments below that are comparable in age to those exposed on Bluefish River that yielded dates of 51 900 ± 1350 years (GSC-2372-2) and >53 000 years (GSC-2372-3). Sediments above the disconformity are terrace deposits that formed during regional downcutting of drainage that probably began some time after 12 460 ± 220 years ago (I-3574; cf. Harington, 1977c).

Comment (W. Blake, Jr.): Both samples were single pieces of wood. GSC-2155 was 70 cm long, maximum diameter of 4.5 cm. The outside wood was cracked, but this was cut away. An estimated 28 annual rings comprised the dated sample. GSC-2158 was 31 cm long, 7.5 cm in diameter; the whole radius represents ca. 150 annual rings. Outside wood cut away to expose solid wood inside. GSC-2155 and -2158 based on two 1-day counts and one 3-day counts, respectively, in the 5 L counter.

Twelvemile Bluff Series

Shells and organic detritus from silt beneath an upper glaciolacustrine unit (Unit 6 of Hughes, 1969, Table 1) that occurs widely in the Old Crow and Bluefish basins. Collected from 1.5 to 2.4 m beneath the base of the upper glaciolacustrine unit at the Twelvemile Bluff exposure, left (south) bank of Porcupine River, 9.7 km (direct distance) southwest of Old Crow, Yukon Territory (67°28'N, 139°54'W). The sample interval brackets the **"Cytherissa lacustris"** zone of Delorme (1968). Collected 1967 by C.R. Harington for O.L. Hughes.

GSC-952. Twelvemile Bluff, shells 32 400 ± 770

Shells (sample HHCR67-18A(shells); 46.2 g; **Pisidium idahoense**; identified by A.H. Clarke, Jr., then National Museum of Natural Sciences, Ottawa; now Smithsonian Institution, Washington, D.C.). Separated from bulk sample of silt.

GSC-958. Twelvemile Bluff, wood >37 000

Wood (sample HHCR67-18A(wood); 7.9 g) from the same bulk sample as GSC-952.

Comment (O.L. Hughes): Prior to separation from the bulk sample, some of the shells occurred as paired valves, and the periostracum remained on most of the separated shells, suggesting that the pelecypods were in situ. The wood fragments, on the other hand, were rounded to varying degrees, indicating possible transport and redeposition from older deposits.

Comment (J.V. Matthews, Jr.): Macrofossils recovered from the bulk sample indicate a tundra environment (Matthews, 1975); however, they include a few spruce needles, which may have been redeposited from older deposits. The sampled interval also contained fossils of fish and mammals (McAllister and Harington, 1969; Harington, 1977c).

Comment (O.L. Hughes and J.V. Matthews, Jr.): The date on the shells comprising GSC-952 is comparable to GSC-1191 and GSC-2739 (31 300 ± 640 and 31 400 ± 660, respectively, this list) from comparable stratigraphic positions in the Old Crow Basin. If the shell date is accepted as reliable, then the wood must be interpreted as being redeposited from older sediments. Note that redeposition of wood best explains inconsistencies between dates of the Old Crow Basin, Locality 12 series (this list). GSC-952 is a maximum for the beginning of the last glacial lake stage in the Bluefish and Old Crow basins. Other dates from the same section are GSC-199, wood 7.6 m below the base of the glaciolacustrine unit, >41 300 years (GSC IV, 1965, p. 38) and GSC-121, peat from above the upper glaciolacustrine unit, 10 740 ± 180 years (GSC III, 1964, p. 172). GSC-952 based on one 3-day count in the 5 L counter. GSC-958 mixed with dead gas for counting; date based on two 1-day counts in the 2 L counter.

GSC-2389. Old Crow Basin 170 ± 50

Wood fragments (sample CR 67-38; 6.2 g) from autochthonous peat near the top of Locality 11-1 section on Old Crow River, Yukon Territory (67°49.5'N, 139°50'W) at an elevation of ca. 265 m. Collected 1967 by C.R. Harington, National Museum of Natural Sciences, Ottawa; submitted by J.V. Matthews, Jr.

Comment (J.V. Matthews, Jr.): The peat was collected from below a unit of alluvial gravel and coarse sand containing **Bison crassicornis** bones (identified by C.R. Harington) dated at 11 910 ± 180 years (I-7765) and 12 460 ± 220 years (I-3574) (Harington, 1977c); but in view of date GSC-2389, the peat is interpreted as probably being a fragment of surface turf buried by slumping. Macrofossils from the peat have been examined (unpublished GSC Plant Macrofossil Report No. 76-10 by J.V. Matthews, Jr.; cf. also compilation in Matthews, 1979).

Comment (W. Blake, Jr.): The sample utilized for dating comprised 6.2 g of twigs with bark; none of this well preserved wood was compressed. Date based on one 3-day count in the 2 L counter.

Old Crow Basin, Locality 12 Series

The samples in this series derive from sediments beneath the base of an upper glaciolacustrine unit (Unit 6 of Hughes, 1969, Table 1) that occurs widely in the Old Crow and Bluefish basins. The sampled locality is on the right bank of Old Crow River 2.1 km (direct distance) southwest of the mouth of Johnston Creek, Yukon Territory (67°50'00"N, 139°51'45"W), at an elevation of ca. 260 m.

GSC-2507. Locality 12, Old Crow (I) — 35 500 ± 1050

Allochthonous peat (sample 3176(a); 40.0 g (dry); peaty detritus) located approximately 2.3 m below the base of the upper glaciolacustrine unit. Collected 1976 by J.A. Westgate, University of Toronto, Toronto; submitted by J.V. Matthews, Jr.

GSC-2775. Locality 12, Old Crow (II) — >36 000

Single piece of wood (sample 3176(a); 7.5 g; **Betula** sp.; identified by R.J. Mott) from the same sample as GSC-2507.

GSC-2739. Locality 12, Old Crow (III) — 31 400 ± 660

Autochthonous peat lens (sample MRA 7-23-78-6(a); 33.3 g (dry)) from a cryoturbated horizon 2.6 m beneath the base of the upper glaciolacustrine unit. Collected 1978 by J.V. Matthews, Jr.

Comment (J.V. Matthews, Jr.): Although the peat sample dated as GSC-2739 is stratigraphically lower than GSC-2507 and GSC-2775, both of which are older, the date is considered reliable because it is based on autochthonous peat. The sample that yielded dates GSC-2507 and GSC-2775, on the other hand, comprises detrital organic material, some of which may be reworked and hence older than the allochthonous peat from which it was derived. Macrofossils of insects and plants from the peat lens dated by GSC-2739 suggest that it was once a continuous horizon which formed the margin of a small tundra pond. The date is a maximum for the beginning of the last glacial lake stage in Old Crow and Bluefish basins. See also discussion of GSC-952 and -958 (this list). GSC-2775 based on one 3-day count in the 2 L counter. GSC-2739 and -2507 based on one 3-day count and one 4-day count, respectively, in the 5 L counter.

Old Crow Basin, Locality 32 Series

An upper glaciolacustrine unit (Unit 6 of Hughes, 1969, Table 1) occurs widely in Old Crow Basin and in Bluefish Basin to the south. This series from Locality 32, left bank of Old Crow River, Yukon Territory (68°03'N, 139°49'W) includes a limiting date for initiation of the glacial lake stage and dates for postlacustrine sediments and peat. Samples collected 1968 by O.L. Hughes.

GSC-1175. Locality 32, Old Crow (I) — 7690 ± 150, $\delta^{13}C = -22.3‰$

Wood (sample HH68-13-8b; 40 g) from 2.4 m below the surface and 0.9 m from the top of alluvial sand that overlies the upper glaciolacustrine unit and is in turn overlain by peat.

GSC-1243. Locality 32, Old Crow (II) — 8100 ± 160, $\delta^{13}C = -24.6‰$

Organic detritus (sample HH68-13-8c; 32 g) from 4.6 m below the surface at the base of alluvial sand that overlies the upper glaciolacustrine unit and is in turn overlain by peat.

GSC-1191. Locality 32, Old Crow (III) — 31 300 ± 640

Organic detritus (sample HH68-13-6a; 175 g) from an organic-rich zone in silt 1.3 m beneath the base of the upper glaciolacustrine unit.

Comment (O.L. Hughes): GSC-1191 is a maximum for initiation of the last glacial lake stage in Old Crow and Bluefish basins. Other maximum dates for the same event are comparable: 32 400 ± 700 years (GSC-952; Twelvemile Bluff series, this list) and 31 400 ± 660 years (GSC-2739; Old Crow Basin, Locality 12 series, this list). GSC-1243 is a minimum for drainage of the glacial lake, but other dates suggest that the glacial lake drained considerably earlier (see discussion of Old Crow River series, this list).

Comment (J.V. Matthews, Jr.): The pollen spectrum from the level of GSC-372 (6430 ± 140 years; GSC V, 1966, p. 116; Lichti-Federovich, 1973, Old Crow 4, 98 ft) shows a high percentage of **Alnus**, indicating that alders were growing near the site by 6400 years B.P.

Comment (W. Blake, Jr.): NaOH leach omitted from the pretreatment of GSC-1243. GSC-1175 based on two 1-day counts in the 5 L counter; GSC-1191 based on one 3-day count in the 5 L counter; GSC-1243 based on one 3-day count in the 2 L counter.

Old Crow River Terrace Series

Shells (sample HH-68-15-3) collected from near the base of a low terrace bordering the left bank of Old Crow River, Yukon Territory (68°04'N, 139°41'W), at an elevation of ca. 285 m. Similar shells, collected by C.R. Harington (National Museum of Natural Sciences, Ottawa) have been identified by A.H. Clarke, Jr. (then of National Museum of Natural Sciences, Ottawa; now of the Smithsonian Institution, Washington, D.C.) as **Anodonta beringiana**. The shells, many of them paired with periostracum intact and in living position, occurred in yellowish brown sand about 1 m above low water level of Old Crow River but several metres below high water level. The sand is underlain by compact dark grey silty clay with brown mottling and is overlain by 7 m of yellowish grey sand, organic silt and peat. Collected 1968 by O.L. Hughes and C.R. Harington.

A 1340 g portion of the sample was dissolved (in batches of ca. 686 g and 654 g) in phosphoric acid to recover the periostracum. A separate 125 g sample was utilized for the age determinations on shell carbonate.

GSC-1166. Periostracum (11.6 g burned) — 10 700 ± 150

No further treatment given to this portion of the sample. Date based on one 3-day count in the 5 L counter.

GSC-1167. Carbonate fraction (outer) — 10 600 ± 150

The outermost 20 per cent was removed by HCl leach; this fraction represents 21 to 60 per cent of shell material. Date based on one 3-day count in the 5 L counter.

GSC-1167. Carbonate fraction (inner) — 10 700 ± 160

This sample represents 61 to 100 per cent of shell material. Date based on two 1-day counts in the 5 L counter.

Comment (O.L. Hughes): The dates indicate that Old Crow River had cut down through glacial lake deposits of glacial Lake Old Crow and the underlying basin-fill sediments to near its present level by 10 700 years ago and are

compatible with date I-3574 (12 460 ± 220 years; Harington, 1977c) on a **Bison crassicornis** vertebra, derived from sand overlying the glacial lake deposits, that indicates that the glacial lake drained prior to ca. 12 460 years B.P.

Comment (W. Blake, Jr.): This sample is one of the first for which we were able to date both the organic and inorganic fractions. The correspondence in ages is reassuring. Another date on **Anodonta beringiana**, from Locality 69 in the central part of the Old Crow Basin, is 10 850 ± 160 years (I-4224; Harington, 1977c).

Old Crow Basin, Locality 44 Series

The typical sedimentary sequence in Old Crow Basin consists of (from river level up): 1 to 2 m (exposed above low water level) of dark grey silty clay devoid of megascopic plant remains, considered to be of glaciolacustrine origin and correlated with Unit 3 of Bluefish Basin (Hughes, 1969, Table 1); 1 to 2 m of dark grey silty clay with wood and plant macrofossils, thought to be the product of reworking of the silty clay below; 14 to 20 m of silt, sand, and minor gravel, containing lenses of wood, organic detritus, and peat, correlated with Units 4 and 5 of Bluefish Basin; 1 to 4.7 m of glaciolacustrine silt and clay, ice-rich and subject to retrogressive thaw flow slides, correlated with the upper glaciolacustrine unit (Unit 6) of Bluefish Basin; and 1 to 3 m of silt and sand with organic layers and 1 to 2 m of peat, correlated with Units 7 and 8 of Bluefish Basin. The sequence at Locality 44, on the left bank of Old Crow River, Yukon Territory (68°13'N, 140°00'W), is typical for the basin.

GSC-1329. Locality 44, Old Crow (I) 8270 ± 140

Wood (sample HH69-30-6; 11.0 g; **Populus** sp.; identified by R.J. Mott) from silt overlying the upper glaciolacustrine unit. Collected 1969 by O.L. Hughes.

GSC-2605. Locality 44, Old Crow (II) 8460 ± 120

Wood (sample MRA-6-21-75-6; 4.6 g) from autochthonous peat 1 m above the upper contact of the upper glaciolacustrine unit. Collected 1975 by J.V. Matthews, Jr.

GSC-1593. Locality 44, Old Crow (III) >44 000

Wood (sample HH69-30-3b; 11.9 g; **Picea** sp.; identified by R.J. Mott) from the same grey sand with wood as GSC-2066 (>54 000 years; GSC XVII, 1977, p. 17) and 17.7 m below the base of the upper glaciolacustrine unit. Collected 1969 by O.L. Hughes.

Comment (O.L. Hughes and J.V. Matthews, Jr.): GSC-2066 (>54 000 years; GSC XVII, 1977, p. 17) indicates that the age of the lower part of the section is beyond the range of radiocarbon dating. Macrofossils associated with this wood (Matthews, 1975) and vertebrates (Harington, 1977a, 1978) indicate a climate warmer than at present. GSC-2605 is a minimum for the end of the last glacial lake stage in Old Crow Basin, but other dates suggest that the glacial lake drained considerably earlier (see discussion of Old Crow River terrace series, this list). GSC-1329 is a minimum for the reintroduction of **Populus** sp. (aspen) into the basin following drainage of the glacial lake.

Comment (W. Blake, Jr.): GSC-1329 was based on a single branch (ca. 2.5 cm in diameter) of slightly mouldy, lightweight wood, whereas GSC-2605 is composed of twigs and wood fragments, some with bark still attached. Only tiny twigs with bark were utilized, but no identification was attempted because of the small size of individual fragments. No record was made of how many pieces were used for GSC-1593. GSC-2605 mixed with dead gas for counting; date based on two 1-day counts in the 2 L counter. GSC-1593 and -1329 based on two 1-day counts and one 3-day count, respectively, in the 5 L counter.

Northwest Territories

Pelly Island Series

Wood and peat from two localities on Pelly Island, Northwest Territories. Collected 1974 by J.R. Mackay, University of British Columbia, Vancouver.

GSC-2291. Pelly Island (I) 2570 ± 90

Peat (sample MX 3/7/74B; 48.5 g) from an organic layer at 60 cm depth below the top of an earth hummock and slightly below the base of the active layer, at a site on the northwest side of Pelly Island (69°37'30"N, 135°30'30"W), at an elevation of 10 m.

Comment (J.R. Mackay): The age of GSC-2291 gives an indication of the rate of downslope movement and burial of interhummock organic material. A sample of peat 15 cm below GSC-2291, within stony frozen clay, has been dated at 4530 ± 145 years (GX-4354), and another sample 25 cm above GSC-2291 and within the active layer is 345 ± 125 years old (GX-4353). The three dates, when combined, give a measure of the rate of downslope movement of the active layer.

Comment (W. Blake, Jr.): The sample was dried in an electric oven, and the weight decreased from 110 g to 48.5 g. A few tiny rootlets were noticed but they did not represent any significant per cent of the sample in terms of possible contamination. Date based on two 1-day counts in the 5 L counter.

GSC-2197. Pelly Island (II) 9180 ± 110

Wood (sample MX 1/7/74; 5.5 g; **Salix** sp., identified by L.D. Farley-Gill) from a 10 m high coastal exposure on the northwest side of Pelly Island (69°37'30"N, 135°30'30"W). The wood is from an elevation of 6.5 m, just above a thaw unconformity. From 6.5 to 7.5 m a.s.l. lake silts are present; from 7.5 m to the ground surface at 10 m there is peat intermixed with clay and gelifluction material; cf. GSC-2291, 2570 ± 90 years, this series.

Comment (J.R. Mackay): The sample helps to date a widespread thaw unconformity seen at Pelly Island, Hooper Island, Garry Island, near Tuktoyaktuk, Northwest Territories, and elsewhere along the western Arctic coast (Mackay, 1978). The date is for organic material above the same thaw unconformity reported for GSC-2305 (this series; cf. further comments there).

Comment (W. Blake, Jr.): The dated sample was a single piece of wood, 7.1 cm long and with a maximum diameter of 1.9 cm. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-2305. Pelly Island (III) 7950 ± 280

Roots (sample MX 2/7/24/1 and 2; 6.4 g) from a coastal bluff at the northwest side of Pelly Island (69°38'N, 135°30'W), at an elevation of 15 m. The sample is from a stony clay unit beneath peat and soil and 3 m below the ground surface.

Comment (J.R. Mackay): The sample came from just above a thaw unconformity which truncates relict ice wedges and high ice content glacially deformed sediments (Mackay, 1975). The thaw unconformity lies about 2 to 4 m below the general level of the ground surface. When roots of the sample were growing, the unconformity marked the bottom of the active layer. When allowances are made for thickening of the material above the thaw unconformity by downslope movement and ice lens growth as the active layer

thinned, the former active layer was still very much thicker than at present, the difference being a measure of much warmer conditions than at present.

Comment (W. Blake, Jr.): The sample was concentrated by wet-sieving, and only the coarse material retained on the 0.5 mm mesh screen was utilized for dating. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-1814. West of Frog Creek 9490 ± 90
$\delta^{13}C$ = -25.6‰

Beaver-gnawed sticks (CR-72-42; 12.85 g; piece A, utilized for dating, is **Populus** sp.; identified by L.D. Farley-Gill) from a roadcut along a newly constructed section of the Dempster Highway to Fort McPherson, ca. 32 km west of Arctic Red River and west of Frog Creek, Northwest Territories (67°25'N, 134°28'W). Collected 1972 by J.F.V. Millar, University of Saskatchewan, Saskatoon; submitted by C.R. Harington, National Museum of Natural Sciences, Ottawa. According to Millar (personal communication to W. Blake, Jr., 1972) a large quantity of buried wood encountered during highway construction was bulldozed onto the slope of the highway cut, presumably because it was recognized as unusual (information supplied by D. Aspden, Project Engineer, Dept. of Public Works). No stratigraphy was exposed at the time Millar collected the sample, but the setting suggested that the wood originally had been intercalated within till.

Comment (C.R. Harington): The age of these beaver-cut sticks (of eight examined by L.D. Farley-Gill, four are **Populus** sp. and four are **Salix** sp.), considered to be part of an ancient beaver dam, is of interest because it suggests that beavers (probably **Castor canadensis**) had occupied a habitat only 2° south of their present interglacial limit of 69°N in this region by the close of the Wisconsin glaciation (Harington, 1978). Presumably the sticks were derived from organic material overlying till in the roadcut, rather than coming from below a till as originally thought by the collector. The fact that the wood sampled had been lifted by a bulldozer blade probably accounts for the discrepancy.

Comment (O.L. Hughes): The roadcut is through a broad ridge within an area of hummocky moraine. Caution is needed in interpreting the apparent intertill provenance of the sample. Till of hummocky moraine in the region is locally ice rich and subject to thermokarst subsidence and retrogressive thaw flow slides (Hughes et al., 1973). The wood could have been buried beneath slumping or flowing till considerably after original deposition of the till. (See also comment on GSC-2298, this list).

Comment (W. Blake, Jr.): The single (largest) piece of wood utilized for dating was 50 cm long and 7 cm in diameter. Date based on one 2-day count in the 5 L counter.

GSC-1797. Pingo, Tuktoyaktuk Peninsula 6730 ± 80

Peat (sample MX 26/6/72-1; 41.0 g) from 80 cm below ground surface at the top of a 30 m high pingo at 69°04'N, 134°19'W, elevation ca. 60 m. The pingo is about 4 km southeast of Swimming Point, Richards Island, Northwest Territories. The pingo has been drilled (Pihlainen et al., 1956), and a partial stratigraphy with comments on shells and plant remains has been given by Porsild (1938). According to M. Kuc (unpublished GSC Bryological Report No. 209, 1972) the material is a typical eutrophic lake sediment, in particular a moss and detrital sapropel. This is the northernmost postglacial locality of **Nuphar polysepalum** in Canada. Other vascular plant species present include **Potamogeton** sp., **Carex** sp., **Menyanthes trifoliata**, and the mosses **Drepanocladus exannulatus, Scorpidium scorpioides**, and **Sphagnum** sp. Collected 1972 by J.R. Mackay, University of British Columbia, Vancouver.

Comment (J.R. Mackay): The pingo is only a few hundred years old, and the lake was in existence long before 6730 years ago; because the sample is from the upper third of a peat section, a deep talik would have formed beneath the lake in an area where permafrost is now about 400 m deep. There is field evidence to show that the former lake, which was 1 km in diameter, was old enough to have had a through-going talik. Accurate levelling of bench marks installed in permafrost on the pingo and lake flat suggest subsidence from consolidation by water loss through the talik (Mackay, 1979). Date based on two 1-day counts in the 5 L counter.

GSC-1860. Tuktoyaktuk Peninsula 2280 ± 50

Peat (sample MX 30/7/72-1; 85.0 g damp) from a peaty layer frost-heaved to the surface from a depth greater than 1 m and exposed on the bottom of a lake which drained between 1950 and 1958. The sample is from 70 cm below ground level, at a site about 31.5 km south-southwest of Atkinson Point on Tuktoyaktuk Peninsula, Northwest Territories (69°40'N, 131°26'W), at an estimated elevation of 12 m. According to M. Kuc (unpublished GSC Bryological Report No. 246, 1973) the peat is a detrital sapropel. Ostracoda, plankton, **Potamogeton** sp., and rounded parts of detritus indicate deposition of material on the bottom of a water body. **Carex** sp. rhizomes and branches of **Salix** sp. are also present.

Comment (J.R. Mackay): Since the lake bottom was exposed by drainage between 1950 and 1958, a polygon system, similar to an ice-wedge polygon system, has developed in several areas where there are signs of lake enlargement prior to drainage. The newly formed polygons are unique in having the outlines marked by upturned beds of peat, from one of which the dated sample came. The field evidence suggests that the polygon system, now developing, is re-activating an older ice-wedge system partially buried by lake enlargement several thousand years ago. Another site has been found where a lake which drained in 1972 now has re-activated polygons forming on the exposed lake bottom. Date based on one 3-day count in the 5 L counter.

GSC-1694. Tree River >32 000

Wood (sample HHP-71-13-3-2 wood; 2.6 g; **Picea** sp.; identified by R.J. Mott) from a natural exposure on the right (east) bank of Tree River, a north-flowing tributary of Mackenzie River, Northwest Territories (67°15'N, 132°25'W), at an elevation of ca. 46 m. The sample was collected from near the top of a unit composed of gravel and minor sand resting on shale bedrock and overlain by glacial till, which in turn was overlain by silt, diamicton, and sand. Sample from 10 m above stream level; the total section is 26.8 m high. Collected 1971 by J.A. Pilon for O.L. Hughes.

Comment (O.L. Hughes): The date is one of several "greater than" dates on wood from within or beneath till in the Mackenzie Valley region; cf. GSC-1190 (>52 000 years; GSC XIII, 1973, p. 35) and GSC-2319 (>36 000 years; this list). No finite dates have been obtained from within or beneath till of the region.

Comment (W. Blake, Jr.): Only one small dry piece of wood was submitted to the laboratory. Rounded ends suggested transport. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-1785. Many Beaver Lake 2060 ± 130

Wood (sample HHP-72-34-2; 11.8 g; identified by L.D. Farley-Gill) from the base of a 2 m thick gravel layer resting on till, on the north side of an unnamed creek 36 km south-southwest of Many Beaver Lake, Northwest Territories

(65°42'N, 132°24'W), at an estimated elevation of 425 to 430 m. The gravel is overlain by sand and peat with a total thickness of 1 m. Collected 1972 by J.A. Pilon for O.L. Hughes.

Comment (O.L. Hughes): The gravel initially was interpreted to be glacial outwash; the young date indicates that it is recent alluvium.

Comment (W. Blake, Jr.): The single dry piece of wood was tough and stained brownish yellow on the outside (grey on the inside). It was 25 cm long and had a maximum diameter of 5 cm. All outside wood was cut off. Date based on one 3-day count in the 5 L counter.

GSC-2298. Grandview Hills 9560 ± 120

Beaver-chewed wood (sample HH71-21-3; 11.7 g; **Populus** sp., identified by L.D. Farley-Gill) from an organic silt lens at the top of the headwall of a retrogressive thaw flow slide, west side of an unnamed lake in Grandview Hills, Northwest Territories (67°06'N, 131°13'W), at an elevation of ca. 275 m. The sample is from the base of a silt lens about 2.4 m thick, disconformably overlying glaciolacustrine clay with reticulate ground ice and thick tabular bodies of segregated ice. Collected 1971 by O.L. Hughes.

Comment (O.L. Hughes): The organic silt is interpreted to be filling in a thermokarst pond developed by thawing of subjacent ice-rich clay. The date is a minimum for initiation of the thermokarst pond. According to Rampton (1973a, b), thermokarst development reached a maximum in the Mackenzie Delta to the north between 10 000 and 9000 years ago. The date is also a minimum for the postglacial occurrence of **Populus** in the region.

Comment (W. Blake, Jr.): The single soft piece of wood used for dating was badly splintered; dimensions were estimated at 22 cm long and 9 cm in diameter. On drying its weight decreased from 171 g to 81 g. Date based on two 1-day counts in the 5 L counter.

GSC-1573. Sans Sault Rapids 11 200 ± 220

Wood (sample HHH-71-8-B; 8.0 g; **Salix** sp.; identified by R.J. Mott) from stratified sand 13.25 m below the surface and ca. 50 m above river level, in an exposure on the west bank of Mackenzie River about 19 km north of Sans Sault Rapids, Northwest Territories (65°49'N, 129°00'W). Collected 1971 by O.L. Hughes.

Comment (O.L. Hughes): The date is minimal for withdrawal of the Laurentide Ice Sheet from the region, and drainage, or at least shallowing, of a glacial lake that subsequently covered the site. The date is compatible with others: I-3913 (11 140 ± 160 years) and I-3734 (11 530 ± 170 years) on wood from similar context reported by Mackay and Mathews (1973, Table 1) and with GSC-2328 (10 600 ± 260 years, this list) which is a minimum for withdrawal of the Laurentide Ice Sheet from Great Bear River.

Comment (W. Blake, Jr.): The single largest piece of wood was used for dating. Its weight decreased from 27.7 to 13.7 g during drying; dimensions were 17 cm long by 1 to 2 cm in diameter. The wood was not worn and the ends had rough features. All outside wood, with whitish spots, was cut away. Date based on two 1-day counts in the 2 L counter.

GSC-2504. Mountain River 940 ± 50

Wood (sample HH-69-78d; 11.6 g; **Picea** sp.; identified by L.D. Farley-Gill) from a stump in growth position; collected from 1.7 m above the base of 19 m of eolian sand overlying about 80 m of coarse gravel that rests on a bedrock bench on the right (east) bank of Mountain River, Northwest Territories (65°15'N, 128°34'W). Two organic layers plus scattered terrestrial snails occur in the base of the sand below the level of the dated stump; deflation has exposed several horizons with remains of trees in growth position above the sample level. Collected 1971 by O.L. Hughes.

Comment (O.L. Hughes): The eolian sand is a cliff-top dune. Such dunes are formed of sand carried by up-draughts from bare eroding cliffs or cutbanks. The presence of several horizons with trees in growth position suggests an alternation between periods when the adjacent cutbank was stabilized by vegetation and periods when the cutbank was bare and eroding and supplying sand to the cliff-top dune, with resultant burial of vegetation.

Comment (W. Blake, Jr.): The wood used, apparently three pieces from a single root, was 20 cm long and 2.5 cm in diameter. Date based on two 1-day counts in the 5 L counter.

Norman Wells Series

Wood and organic debris from a 4.5 inch (11.4 cm) diameter borehole advanced to 12 m below the surface ca. 1.6 km northeast of Norman Wells, Northwest Territories (65°18'N, 126°52'W); the ground surface elevation is 69 m (by surveying). The borehole was drilled at the ice variability study site (Mackenzie Valley Pipeline Research, Ltd. test site). The core was frozen, and both samples were from below the active layer. Collected 1974 by W.D. Roggensack, then at University of Alberta, Edmonton; now EBA Engineering Consultants, Ltd., Edmonton.

GSC-2204. Norman Wells (I) 3290 ± 100

Wood fragments with intact bark (sample NW2-4; 3.7 g; **Picea** sp.; identified by R.J. Mott), from beach wash horizon at 2.0 m depth. The sample horizon is at the top of a bedded silty lake clay and is overlain by beach deposits and reworked clayey silt that constitutes the permafrost active layer. The sediments appear to be the same unit from which GSC-2206 was collected.

GSC-2206. Norman Wells (II) 9320 ± 100

Twigs (sample NW2-14; 31 g; one twig is **Betula** sp. and other fragments are probably **Salix** sp.; identified by R.J. Mott) in peaty material at 7.5 m depth. The sample horizon is the lowest of several peaty layers within the bedded silty clay. Gastropod shells are present at this level.

Comment (W.D. Roggensack): The twigs and organic debris comprising GSC-2206 are interpreted as having accumulated in glaciolacustrine clay, possibly in a lake impounded behind Fossil Lake Spillway (Mackay and Mathews, 1973); (cf. also GSC-2328; 10 600 ± 260 years, this list). GSC-2204 provides a limiting age for the existence of a lake at the site.

Comment (W. Blake, Jr.): Charcoal in GSC-2204, not used for dating, was identified as probably **Salix** sp. or **Populus** sp. (unpublished GSC Wood Identification Report No. 75-66 by R.J. Mott). GSC-2204 mixed with dead gas for counting. Both dates based on two 1-day counts in the 2 L counter.

GSC-2328. Great Bear River 10 600 ± 260

Organic detritus (sample HH-WS-7527-1; 2.0 g) from a lens within a 20 m thick sand layer that overlies (in downward succession) glaciolacustrine silt and clay, till, and Tertiary sandstone. The sample was collected 5 m below ground surface and about 95 m a.s.l., in a natural exposure on the left (south) bank of Great Bear River, 6.5 km from its confluence with Mackenzie River, Northwest Territories (64°56'30"N, 125°29'45"W). Collected 1975 by K.W. Savigny for O.L. Hughes.

Comment (O.L. Hughes): The date is minimal for withdrawal of the Laurentide Ice Sheet and drainage or shallowing of a glacial lake that subsequently covered the site (see also discussion of GSC-1573, 11 200 ± 220 years, this list).

Comment (W. Blake, Jr.): Every effort was made to avoid lignitized wood in selecting material out of a 50 g sample. Some bark fragments (up to 1 cm thick) were used, plus pieces of wood and twigs with bark still attached; no material was used that appeared worn or rounded at the ends. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-1471. Mackenzie Valley terrace 8510 ± 280

Wood (sample 22-6-70-1; 2.0 g; **Populus** sp., identified by R.J. Mott) from the base of a 2 m thick peat unit and overlying lacustrine silts at Mile 456 on Mackenzie River, opposite the mouth of Keele River, Northwest Territories (64°20'N, 124°45'W), at an elevation of ca. 107 m. The surface of the lake silts, above slumped sands, is 35 m above river level. Collected 1970 by J.R. Mackay, University of British Columbia, Vancouver.

Comment (J.R. Mackay): The date indicates that the lake was drained prior to 8500 years ago, and that since then there has been a long period of peat accumulation.

Comment (W. Blake, Jr.): Several small pieces of wood were extracted from the blackish peat and dried in an electric oven. These pieces, all <4 cm long and <1 cm in diameter, showed no sign of wear or transport. The wood was soft and light in weight. Date based on two 1-day counts in the 1 L counter.

GSC-2319. Whitefish River >36 000

Wood (sample HHS-75-50-5C; 3.5 g; **Picea** sp., identified by L.D. Farley-Gill) from a natural exposure on the left bank of an unnamed tributary to Whitefish River, 3 km from its confluence with Whitefish River and 41 km south-southeast of Bydand Bay, Great Bear Lake, Northwest Territories (65°33'N, 124°29'W), at an elevation of ca. 183 m. The sample is from the base of a 135 cm thick bed containing sand, diamicton, and gravel, underlain by 3 m of till to stream level and overlain by 3 m of till and 4.8 m of silty clay with sparse pebbles. Collected 1975 by S.C. Chatwin; submitted by O.L. Hughes.

Comment (O.L. Hughes): The date presumably relates to a nonglacial interval preceding the last advance of the Laurentide Ice Sheet over the region.

Comment (W. Blake, Jr.): The dated sample is the single largest piece of wood in the collection, measuring 12 x 1.2 x 0.7 cm. Adhering silt and sand was scraped off. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Nahanni National Park Cave Series

Hair, horn, and cartillage from the skull of a Dall's sheep (**Ovis dalli**; identified by G.W. Scotter, Canadian Wildlife Service, Edmonton) in a cave at the mouth of First Canyon, South Nahanni River, in Nahanni National Park, Northwest Territories (61°17'N, 124°06'W), at an elevation of ca. 700 m. The skull was taken from an animal found on the floor of the cave, 305 m from the entrance; it was one of 93 remains of Dall's sheep found in 12 locations in this cave, beyond daylight. Collected 1971 by G.W. Scotter. Three determinations were made:

GSC-1649. Dall's sheep (I) 2400 ± 160
$\delta^{13}C = -20.9‰$

Hair (sample 1-1971-GWS; 9.0 g) from the skull. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-1774. Dall's sheep (II) 2370 ± 150
$\delta^{13}C = -22.4‰$

Cartillage (sample 3(a)-1971-GWS; 6.5 g) from the same skull. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-1757. Dall's sheep (III) 2440 ± 80
$\delta^{13}C = -22.1‰$

Horn (sample 2-1971-GWS; 266 g) from the same skull. Acetic acid treatment to obtain the apatite fraction. Date based on two 1-day counts in the 5 L counter.

Comment (W. Blake, Jr.): The age determinations show excellent internal agreement. Unfortunately the fourth sample in the series, the bone of the skull itself (GSC-1751) was lost in the laboratory as a result of explosions while burning. Details of the sheep remains in the South Nahanni caves are presented by Scotter and Simmons (1976); previous ^{14}C dates on wood from the floor of the cave, GSC-1634 (7920 ± 140 years) and GSC-1727 (880 ± 130 years), are reported by Lowdon and Blake (1973).

GSC-1460. Mackenzie Valley slump 1280 ± 130

Wood (sample 18-6-70 no. 1; 6.8 g; **Salix** sp., identified by R.J. Mott) from a riverbank exposure (left bank) at Mile 227 on Mackenzie River (62°00'N, 122°51'W), at an elevation of ca. 137 m. The wood is from 4 m below ground surface at the base of a unit comprising silt, peat, and wood fragments; this unit is overlain, in turn, by a layer of in situ buried stumps, and more than 1 m of stratified, grey, lacustrine silt. Collected 1970 by J.R. Mackay, University of British Columbia, Vancouver.

Comment (J.R. Mackay): The massive ground ice which underlies the organic deposits is more than 6 m thick and is exposed for over 60 m along the river; this ice is probably younger than the peat.

Comment (W. Blake, Jr.): This well preserved wood was frozen when collected and was received wet by the laboratory. After drying in an electric oven, a single piece, 6 to 8 cm long and 2 to 3 cm in diameter, was used for the age determination. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 5 L counter.

'Eildun Lake' Series

'Eildun Lake' (unofficial name) has an area of about 50 hectares and is close to Fish Lake in the District of Mackenzie, Northwest Territories. The co-ordinates of the coring location are approximately 63°08.6'N, 122°46.5'W; lake elevation, ca. 302 m. The core consists of 268 cm of sediment. The upper 75 cm consists of brown algal gyttja. At approximately 75 cm is a 0.5 to 1 cm thick lens of volcanic ash, tentatively identified as White River ash. Below this ash, brown algal gyttja extends for another 80 cm. The next lower 46 cm consists of faintly banded marl. The 67 cm below the marl consists of silty, sandy clay. The core was retrieved from a depth of 2.3 m of water with a Livingstone-type piston sampler. Collected 1977 by D.S. Slater, then Royal Ontario Museum, Toronto; now University of Calgary, Calgary.

GSC-2749. 'Eildun Lake', 80-85 cm — 2380 ± 100; $\delta^{13}C$ = -24.5‰

Brown algal gyttja (sample EL-10; 4.4 g dry) from 80 to 85 cm depth below the top of the sediment core and 5 to 10 cm below a lens of volcanic ash. This date marks approximately the initiation of zone IIIb dominated by a **Picea, Pinus, Betula,** and **Alnus** pollen assemblage.

GSC-2753. 'Eildun Lake', 115-120 cm — 4510 ± 110; $\delta^{13}C$ = -26.7‰

Brown algal gyttja (sample EL-9; 3.9 g dry) from 115 to 120 cm depth below the top of the sediment core and 40 to 45 cm below a lens of volcanic ash. This date marks, both temporally and stratigraphically, approximately the middle of zone IIIa dominated by a **Picea, Betula,** and **Alnus** pollen assemblage

GSC-2743. 'Eildun Lake', 167-172 cm — 10 300 ± 290; $\delta^{13}C$ = -20.5‰

Organic material in marl (sample EL-7; 18.6 g dry) from 167 to 172 cm below the top of the sediment core and 12 to 17 cm below the marl-gyttja contact. This date marks approximately the initiation of zone IIb dominated by a **Picea** and **Betula** pollen assemblage.

GSC-2737. 'Eildun Lake', 199-204 cm — 10 700 ± 230; $\delta^{13}C$ = -23.0‰

Organic material in marl and silty clay (sample EL-5; 17.1 g dry) from 199 to 204 cm depth below the top of the sediment core. This date marks the initiation of marl deposition in 'Eildun Lake' as well as the initiation of zone IIa dominated by a **Populus** and **Betula** pollen assemblage.

GSC-2695. 'Eildun Lake', 240-245 cm — >29 000; $\delta^{13}C$ = -21.1‰

Organic material in silty, sandy clay (sample EL-2; 90.8 g dry) from 240 to 245 cm depth below the top of the sediment core and 39 cm below the marl-clay contact. The section dated is at the base of sediments containing modern (Quaternary) pollen and marks the initiation of zone I dominated by an **Artemisia,** Gramineae, and **Betula** pollen assemblage (Slater, 1978). Further relevance of this radiocarbon date is to the possibility of ice-free conditions having existed in the 'Eildun Lake' area for more than 29 000 years.

Comment (D.S. Slater): In general, the dates are stratigraphically consistent although two possible anomalies occur. The date of 2380 ± 100 years (GSC-2749) at 80 to 85 cm depth below the top of the sediment core marks a section lying only 5 to 10 cm below a volcanic ash lens tentatively identified as White River ash. If this lens is White River ash, approximately 1500 years in age, then a drop, of seemingly unlikely magnitude, of both pollen influx and sedimentation rate is suggested for the section of the core between the ash lens and the stratigraphically lower radiocarbon date. The second anomaly occurs with the date of 10 300 ± 290 years (GSC-2743) at 167 to 172 cm below the top of the sediment core. This section lies only 7 to 17 cm below a section previously dated at 7510 ± 120 years (TX-2919; Texas XIII, 1979, p. 262). If both dates are approximately correct then once again a drop, of seemingly unlikely magnitude, of both pollen influx and sedimentation rate is suggested for the period between these dates. Comparison of the 'Eildun Lake' pollen data with data from M Lake in the Campbell Dolomite Upland, Mackenzie River Delta (Ritchie, 1977), and data from Lofty Lake, Alberta (Lichti-Federovich, 1970) indicates that the date of 10 300 ± 290 years may be too early by 1000 to 1500 years to correlate well. Future work should include comparison of these dates with others marking the same pollen assemblage changes in another core from the region of 'Eildun Lake'.

Comment (W. Blake, Jr.): The large sample used for GSC-2695, at the base of the core (73.4 g burned) contained a particularly high percentage of inorganic material. NaOH leach was omitted from the pretreatment of all samples. Each sample was mixed with dead gas for counting, and each date is based on two 1-day counts in the 2 L counter.

GSC-1820. Coppermine — 3700 ± 80

Driftwood (samples Coppermine beach wood; 11.6 g; **Picea** sp.; identified by L.D. Farley-Gill) exposed by bulldozer during construction of a new airstrip at Coppermine, Northwest Territories (67°50'N, 115°19'W), at an elevation of ca. 16 m (derived from Ministry of Transport survey of the airstrip). The wood, frozen when collected, was 1 m below the surface of a sand unit from which the surface (<3 m) had been stripped away by earlier bulldozer activity. Collected 1969 by H. Nichols, University of Colorado, Boulder, Colorado.

Comment (W. Blake, Jr.): The dated log provides an age for the 16 m beach level; pelecypod shells from the gullied surface of marine clay near Rae River, ca. 26 km west of Coppermine and at an elevation of ca. 98 m, are 9440 ± 120 years old (GSC-39; GSC I, 1962, p. 23; Craig, 1960). The wood received, part of a larger piece, was 18 cm long and had a maximum diameter of 5 cm. Date based on two 1-day counts in the 5 L counter.

GSC-1626. Carr Lake esker — 5980 ± 180

A mixture of marine pelecypod shells (sample SCA-CMS-1; 14.9 g) from a section cut into horizontally bedded sand on the flank of Carr Lake esker along the outlet stream from Carr Lake, Northwest Territories (61°48'N, 95°41'W), at an elevation of 61 ± 3 m. The enclosing material is a reddish diamicton lying on about 6 to 7 m of nonfossiliferous sand. Shells dated were **Clinocardium ciliatum** and **Macoma** sp.; they appeared to be partially leached and somewhat disturbed by frost activity, but barnacles were found in growth position on cobbles within the diamicton. Collected 1971 by W.W. Shilts.

Comment (W.W. Shilts): This is apparently the same site from which shells were collected by H.A. Lee for date I(GSC)-8, 6975 ± 250 years (Lee, 1959; Isotopes I, 1961, p. 50-51) because there are no other nearby exposures except for some cut directly into nonfossiliferous gravels of the esker ridge proper. Careful searching failed to turn up any shells within the sorted sediments below the diamicton. At the location cited by Lee, there is no section; therefore, it is assumed that this is his site. The reason for the discrepancy in age is unknown, but in any case it is hard to relate any date from this site to a glacial event or to sea level as the site is at least 100 m below the local marine limit. There are no interpretable stratigraphic breaks as there are in the Kaminak Lake sections (cf. GSC-1434 and -1484, this list). The sorted sediment underlying the diamicton is a marine deposit representing distal sand and silt that emanated from the esker tunnel mouth in more than 100 m of water and that was trapped between the exposed esker ridge and the valleysides. This deposit has been traced continuously northward from this site along the Carr Lake esker ridge; it forms the major part of the sediment fill in the 120 m deep trench in which the esker lies beneath the surface of the west arm of Carr Lake. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Kaminak Lake Series

Marine shells and organic detritus collected from a delta leading to the northwest arm of Kaminak Lake, Northwest Territories (62°16'N, 95°30'W). Samples collected 1971 by W.W. Shilts from a perennially frozen section by trenching and excavating with a high discharge pump.

GSC-1484. Kaminak Lake, wood 4590 ± 220

Well preserved twigs and stems (sample SCA-70P2; 4.75 g) from vegetation mats in silty sand along foreset bedding planes of a delta built into the Tyrrell Sea at an elevation of 62 ± 2 m and 3 m below the ground surface. The foreset beds overlie, in turn, marine clayey silt, red till, and grey till; both tills contain erratics exclusively from the northwest or west.

Comment (W.W. Shilts): These foreset beds are the upper part of a marine sequence from which a date of 6600 ± 230 years (GSC-1434; this series) was obtained at the base. If the dates on twigs and shells in this section are comparable, it can be concluded that approximately 2000 years were required for isostatic-eustatic net adjustment of 108 m (local marine limit ca. 170 ± 1 m). There are almost no sources of carbonate in the local bedrock, and the glacial sediments are noncalcareous. This is a good age and altitude datum on which to base any paleogeographic reconstruction of the Tyrrell Sea shoreline of ca. 4600 years ago. See Ridler and Shilts (1974, p. 13, 18) for further discussion and a diagram of the section. Date based on two 1-day counts in the 1 L counter.

GSC-1434. Kaminak Lake, shells 6600 ± 230

Marine pelecypod shells (sample SCA-70P1; 24.5 g; **Mya truncata**; identified by W.W. Shilts) at the base of marine clayey silt lying on 5 m of till and grading upward into foreset beds of a marine delta. Shells occur throughout the marine section, but those dated were collected from a 2 to 4 cm thick coquina-like zone located 1 to 2 cm above the contact between till and marine sediments, at an elevation of 61 ± 3 m. The shells were in an excellent state of preservation. Collected 1970 by W.W. Shilts.

Comment (W.W. Shilts): The shells concentrated at the base of this section closely approximate the time of deglaciation; the site is about 100 km east of the Keewatin Ice Divide. The date also closely approximates the age of the marine limit which is well marked at 170 ± 1 m on a hill 15 km from the exposure. This date should probably be used to estimate times of deglaciation and maximum marine submergence in this region as it is the only one that can be tied confidently to a stratigraphic break – the till-marine contact. It should be more reliable than dates I(GSC)-8 (6975 ± 250 years; Isotopes I, 1961, p. 50-51) and GSC-1016 (6570 ± 140 years; GSC IX, 1970, p. 81-82) which are usually cited as approximately dating the marine limit or the time of deglaciation in this area (cf. also the discussion of the relationship between I(GSC)-8 and GSC-1626, this list). A diagram of the field situation and further discussion are presented in Ridler and Shilts (1974). Date based on two 1-day counts in the 1 L counter.

GSC-1427. Eskimo Point 3200 ± 220

Marine pelecypod shells (sample SCA-701; 25.6 g; **Mya truncata**; identified by W.W. Shilts) from the 3 m high face of a gully cut through the north flank of the esker on which the hamlet of Eskimo Point, Northwest Territories, is built (61°06'N, 94°05'W), at an elevation of ca. 2 m above high tide level. The gully was cut by the catastrophic draining of the town reservoir about two days before the sample was collected. The shells were in pockets or pods of marine silt sheared into red, till-like sediment which was perennially frozen prior to excavation. Good state of preservation. Collected 1970 by W.W. Shilts.

Comment (W.W. Shilts): The shells were originally thought to have been reworked by glacier ice and emplaced in till during retreat of the Keewatin Ice Sheet, the edge of which was thought to be standing in more than 100 m of marine water at Eskimo Point 7000 to 9000 years ago. The young date suggests that the deposit in which the shells are contained is in reality a combination of till, marine sediment, and reworked esker sediments, mixed together by grounding pack ice during spring breakup some time between 3200 years ago and present.

Comment (W. Blake, Jr.): The well preserved shells were cleaned in both tap water and distilled water. The collection contained several pairs of **Mya truncata**; numerous valves still had parts of the periostracum intact. Date based on one 1-day count in the 1 L counter.

GSC-2309. Diana Island 6410 ± 90
$\delta^{13}C = +2.4‰$

Broken pelecypod valves (sample Diana 1; 18.3 g; **Mya truncata**; identified by C. Hillaire-Marcel) embedded in foreset sands exposed in a river cut, on the northwest side of Diana Island, Northwest Territories (61°00'43"N, 69°58'33"W), at an elevation of 35 m. The shells were from a medium sand, 1 m above the river, 50 cm behind the face of the exposure, just above the level at which the ground was frozen. Collected 1975 by C. Hillaire-Marcel, Université du Québec à Montréal.

Comment (C. Hillaire-Marcel): The fauna also includes **Macoma calcarea, Hiatella arctica, Astarte montagui striata, Serripes groenlandicus, Clinocardium ciliatum, Natica clausa, Lepeta coeca**, and numerous foraminifera. The sample is related to a beach surface at 61 m elevation, and the age of that relative sea level is in good agreement with other dated sites in the Ungava Bay and Hudson Strait area: QC-354 (6630 ± 115 years; Wakeham Bay – relative sea level above 66 m) and QC-356 (6505 ± 95 years; Payne Bay – relative sea level above 65 m (Gray et al., in press)). Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Northern Canada, Arctic Archipelago

Baffin Island

Cumberland Sound Series

The following age determinations from Cumberland Sound, Baffin Island, Northwest Territories were reported previously in radiocarbon date lists compiled by Andrews (1975, 1976) together with other dates from Baffin Island and with determinations from a number of other dating laboratories. They form part of the basis of a dissertation on the Quaternary history of southwestern Cumberland Peninsula by Dyke (1977; cf. also Dyke, 1979a). All elevations were measured from the highest tide line and were determined with a surveying altimeter except where otherwise indicated. Modern tidal range in this area is about 6 m. All but one date relates to Holocene relative sea level positions.

GSC-2001. Pangnirtung Fiord 8690 ± 90

Marine pelecypod shells (sample GRL-108-S(ASD-73-6); 26.1 g; **Mya truncata**; identified by A.S. Dyke) from a freshly gullied bulldozer cut northeast of the hamlet of Pangnirtung, Northwest Territories (66°08'30"N, 65°43'30"W), at an elevation of 39 m, as determined by levelling instrument. Collected 1973 by A.S. Dyke.

Comment (A.S. Dyke): These shells were collected from gently westward-dipping sand and silt beds which were traced to within a few metres of a prominent shoreline at 50 m. The sample, therefore, dates a 50 m relative sea level stand which is the limit of Holocene marine transgression in Pangnirtung Fiord (Dyke, 1977).

Comment (W. Blake, Jr.): The dated sample comprised 11 left valves, 7 right valves, and 9 other fragments; most pieces included the hinge area, some retained periostracum, no shells were intact. Sample mixed with dead gas for counting. Date based on one 3-day count in the 5 L counter.

GSC-2183. North of Kekertelung Island (I) 8660 ± 110
$\delta^{13}C = -0.4$ ‰

Marine pelecypod shells (sample ASD-74-S2; 20.0 g; **Portlandia arctica;** identified by W. Blake, Jr.) from the surface of a stream cut in bottomset silts of an estuarine delta located 20 km inland from the modern coast, north of the eastern end of Kekertelung Island, Northwest Territories (66°32'30"N, 66°16'W), from an elevation range of 55 to 60 m. Collected 1974 by A.S. Dyke.

Comment (A.S. Dyke): The shells were collected in living position in silts which were overlain by well sorted foreset and topset sands forming an extensive terrace marking the Holocene marine limit at 70 m. The deltaic sediments were deposited by meltwaters from three expanded outlet glaciers of the Penny Ice Cap while they occupied the position marked by Inner Usualuk lateral moraines (Dyke, 1977).

Comment (W. Blake, Jr.): This sample of aragonitic shells was wet sieved to remove adhering silt, then oven dried. Most valves retained periostracum and inner lustre. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-2111. North of Kekertelung Island (II) 7770 ± 110

Marine pelecypod shells (sample ASD-74-S4; 20.2 g; **Serripes groenlandicus;** identified by A.S. Dyke) from a fresh face exposed by slumping of horizontally bedded topset sands and silts in an estuarine delta 4 km inland from the modern coast north of Kekertelung Island, Northwest Territories (66°24'30"N, 66°27'30"W), at an elevation of 30 to 31 m, as determined by levelling. Collected 1974 by A.S. Dyke.

Comment (A.S. Dyke): The aragonitic shells came from in situ positions in sediments which form an extensive terrace at 34 m and are considered to date that relative sea level (Dyke, 1979a). Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-2258. Millut Bay, shells 6030 ± 170
$\delta^{13}C = -1.8$ ‰

Marine pelecypod shells (sample ASD-74-S10; 5.25 g; **Portlandia arctica;** identified by W. Blake, Jr.) from a fresh bluff in horizontally bedded bottomset clayey silts on the west side of the mouth of Ranger River, Millut Bay, Clearwater Fiord, Baffin Island, Northwest Territories (66°33'N, 67°30'W), at an elevation of 0 to 3 m above high tide. Collected 1974 by A.S. Dyke.

Comment (A.S. Dyke): The bottomset sediments are overlain by gently dipping foreset sands which terminate upward in a terrace at 15 m elevation. The local marine limit is 58 m at this site which is 3 km up-ice from the Ranger end moraine formed by the Laurentide Ice Sheet. The regional picture (Dyke, 1977, 1979a) suggests that sea level was >15 m at 6030 ± 170 years ago and that the 58 m marine limit dates from 6500 to 7000 years ago.

Comment (W. Blake, Jr.): The sample was composed of nearly all whole aragonitic shells, plus some fragments; most retained the periostracum. Little internal lustre was preserved, and some shells exhibited iron staining. A single fragment of **Mya truncata** in the collection was not utilized for dating. Because of the small sample size, the HCl leach was omitted. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2138. Shilmilik Bay 5800 ± 70
$\delta^{13}C = +2.4$ ‰

Marine pelecypod shells (sample ASD-74-S12 (Bag A); 28 g; **Mya** sp.; identified by W. Blake, Jr.) from a fresh river cut on the west side of the river mouth at the head of Shilmilik Bay, Clearwater Fiord, Baffin Island, Northwest Territories (66°36'36"N, 67°19'W), at an elevation of 0 to 1 m above high tide. Collected 1974 by A.S. Dyke.

Comment (A.S. Dyke): The sample consisted of whole and paired valves with periostracum at the time of collection and came from bottomset silts overlain by foreset sands terminating upward in two terraces at 17.5 and 21.5 m. The date relates to a sea level marked by one or the other of these terraces (Dyke, 1977).

Comment (W. Blake, Jr.): Both bags of shells comprising this sample were water-soaked when received by the laboratory; bag A was air dried and oven dried. The pieces submitted to the laboratory were all of such size and shape that they could only be **Mya**, yet none of the typical truncated posterior ends of **M. truncata** were present. These aragonitic shells were somewhat chalky, yet there was no pitting or evidence of incrustation, and some periostracum remained. Date based on one 3-day count in the 2 L counter.

GSC-2103. Kangilo Fiord 5550 ± 70
$\delta^{13}C = -0.7$ ‰

Marine pelecypod shells (sample ASD-74-S7; 46.0 g; **Mya truncata;** identified by W. Blake, Jr.) from a fresh river cut in bottomset clayey silts in the innermost of two large raised deltas immediately northwest of False Passage Peninsula on the north side of Kangilo Fiord (near its head), Baffin Island, Northwest Territories (66°33'30"N, 67°56'30"W), at an elevation of 27 to 32 m. Collected 1974 by A.S. Dyke.

Comment (A.S. Dyke): The sediments at the sample site terminate upward as bouldery gravel forming an extensive terrace at 35 m. Many of these boulders are striated, suggesting an ice marginal origin. The date relates to a 35 m relative sea level stand shortly following deglaciation (Dyke, 1977, 1979a). The local marine limit is 47 m.

Comment (W. Blake, Jr.): The aragonitic shells comprising this collection were extremely thin and fragile; most had holes or were fragmented, but only those that could be identified with certainty as **Mya truncata** were used. Some fragments retained the periostracum, and iron staining was common. Other species in the collection included **Hiatella arctica, Clinocardium ciliatum, Serripes groenlandicus,** and **Macoma** sp. Date based on two 1-day counts in the 5 L counter.

GSC-2008. Millut Bay, wood 0 ± 140

Wood (sample GRL-13-W(ASD-73-33); 4.15 g; **Salix** sp.; identified by L.D. Farley-Gill) from the ground surface at the head of Millut Bay, Clearwater Fiord, Baffin Island, Northwest Territories (66°38'N, 67°34'30"W), at an elevation of 1.3 m below high tide line. Collected 1973 by A.S. Dyke.

Comment (A.S. Dyke): This arctic willow was still rooted in the underlying soil at the time of collection. Marine silt with numerous shrimp shells surrounded the site and extended to a distinct jetsam line 1.3 m above it. Hence,

the willow occurs in the present intertidal zone. The northwest coast of Cumberland Sound is presently submerging as indicated by wave-eroded peats and the fact that Thule houses, soils, and peats are overlain by prograding beach gravels (see dates and discussion in Dyke, 1977; Andrews, 1976). This date is younger than was expected and is younger than other dates on material 1 m below modern high tide line: e.g., see QU-306 (280 ± 160 years, on soil at -1.0 to 0.5 m in Shark Fiord; Dyke, 1979a).

Comment (W. Blake, Jr.): The sample was a single piece, 20 cm long, with a twisted stem; 1 cm in diameter at the lower end, 0.8 cm at the upper end. Sample mixed with dead gas for counting. Date based on one 1-day count in the 2 L counter.

GSC-2084. Millut Bay, soil 1790 ± 80

Buried soil A-horizon (sample GRL-164-0(ASD-73-38); 109 g)) developed on gravel oxidized to a depth of 50 cm and overlain by 70 cm of sand at the head of Millut Bay, Clearwater Fiord, Baffin Island, Northwest Territories (66°40'N, 67°33'W), at an elevation of 52 m. The sample was split into >125 µm and <125 µm fractions according to the method described by R. Kihl (in Andrews, 1975), and both fractions were submitted to the dating laboratory. Collected 1973 by A.S. Dyke.

Comment (A.S. Dyke): The presence of shell fragments in the overlying sand suggested that the sample might date a marine transgression. This is clearly impossible, however, in light of the age, and the sand is considered to be an eolian accumulation following a period of soil formation. Similar ages have been obtained on several other such samples (Dyke, 1977).

Comment (W. Blake, Jr.): Only the finer fraction was used for the age determination. The coarser fraction was examined by M. Kuc who classified the deposit as heterogeneous material, containing **Carex** rhizomes and fragments of animal origin; he also noted (unpublished GSC Bryological Report No. 273) that the more decomposed organic material was penetrated abundantly by modern roots. Date based on two 1-day counts in the 5 L counter.

Somerset Island

GSC-2563. Stanwell-Fletcher Lake 9060 ± 90
$\delta^{13}C = +2.3$ ‰

Marine pelecypod shells (sample DCA-77-S6; 27.8 g; **Mya truncata**; identified by W. Blake, Jr.) from deltaic sand and silt 2 km from the northeast shore of Stanwell-Fletcher Lake, Somerset Island, Northwest Territories (72°46'15"N, 94°31'W), at an elevation of 71 m. Collected 1977 by A.S. Dyke.

Comment (A.S. Dyke): The sample was composed of mostly whole valves, some paired, and most with periostracum, from a single couplet of horizontally bedded sand and silt in a fresh exposure below a deltaic terrace at 75 m a.s.l. It was hoped that the sample would date the 75 m terrace. However, the regional pattern of emergence indicates that the sea stood higher than 75 m a.s.l. at that time (Dyke, 1979b).

Comment (W. Blake, Jr.): Previous age determinations in the vicinity of Stanwell-Fletcher Lake are GSC-616 (7750 ± 140 years; 46 m) and GSC-617 (7890 ± 140 years; 26 m; both in GSC VI, 1967, p. 187-188; cf. also Coakley and Rust, 1968; Rust and Coakley, 1970; Dyke, 1979b). Nine valves (4 right and 5 left) were used; they ranged in size from 4.5 x 3.2 cm to 2.5 x 1.5 cm. Date based on one 3-day count in the 2 L counter.

GSC-2561. Creswell Bay 9240 ± 90
$\delta^{13}C = +2.0$ ‰

Marine pelecypod shells (sample DCA-77-S8; 27.9 g; **Mya truncata**; identified by W. Blake, Jr.) from clayey silt 2 km west of the northwest corner of Creswell Bay, Somerset Island, Northwest Territories (72°46'30"N, 94°21'W), at an elevation of 107 m. Collected 1977 by A.S. Dyke.

Comment (A.S. Dyke): The submitted sample consisted of fragments and whole valves (including a few paired valves and many with periostracum) from clayey silts, probably deep water deltaic sediments, overlain by gravel scree on a steep slope below a deltaic terrace remnant at 157 m a.s.l., which marks the local marine limit. The date is considered to relate to this feature.

Comment (W. Blake, Jr.): After the aragonitic shells were cleaned in distilled water using a sonic bath, the following material was selected for dating: 15 right valves and 8 left valves (all including the truncated posterior end). The shells ranged in size from 4.6 x 3.4 cm to 3.0 x 1.8 cm. The shells were characterized by some iron staining and flaking; little internal lustre remained. Date based on one 3-day count in the 2 L counter.

Creswell River Series

GSC-2596. Creswell River (I) 9270 ± 90

Marine pelecypod shells (sample DCA-77-S13; 28.6 g; **Hiatella arctica**; identified by W. Blake, Jr.) from sands 7 km northwest of the mouth of Creswell River, Somerset Island, Northwest Territories (72°50'45"N, 93°36'W), at an elevation of 120 m. Collected 1977 by A.S. Dyke.

Comment (A.S. Dyke): The sample consisted of whole valves from fossiliferous upper foreset sands overlain by topset gravels which form a terrace at 125 m a.s.l. The terrace is accordant in elevation with a wave-cut platform in bedrock.

Comment (W. Blake, Jr.): The **Hiatella arctica** valves making up this sample were heavy and thick, with incrustations, staining, pitting, and spots of lichen growth; the sample utilized 14 valves (6 right and 8 left) of the cleanest, least encrusted, and thinnest shells (aragonitic). The largest valve was 4.0 x 2.4 cm in size. The shells also were characterized by chalkiness, but some internal lustre remained. Date based on one 3-day count in the 2 L counter.

GSC-2445. Creswell River (II) 9200 ± 100
$\delta^{13}C = +1.8$ ‰

Marine pelecypod shells (sample NJ-75-74; 20.0 g; **Mya truncata**; identified by W. Blake, Jr.) from silt and sand ca. 18 km east of the mouth of Creswell River, Somerset Island, Northwest Territories (72°48'50"N, 92°56'W), at an elevation of 84 to 88 m. Collected 1975 by A.S. Dyke; submitted by the late J.A. Netterville.

Comment (A.S. Dyke): The sample is from silty sand overlain by beach gravel extending to 90 m a.s.l. Ten whole or partial valves (eight left and two right; aragonitic) with little or no encrusting material but some discoloration and pitting were utilized for dating. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2493. Creswell River (III) 9030 ± 80
$\delta^{13}C = +1.9$ ‰

Marine pelecypod shells (sample NJ-75-76; 25.2 g; **Hiatella arctica**; identified by W. Blake, Jr.) from silt on the north side of Creswell River, 18 km north of Creswell Bay, Somerset Island, Northwest Territories (72°56'N, 93°46'W), at an elevation of 80 to 85 m. Collected 1975 by A.S. Dyke.

Comment (A.S. Dyke): Whole and a few paired valves from a fresh cut in bottomset deltaic silts overlain by foreset sands and topset gravels forming a terrace at 90 m a.s.l.

Comment (W. Blake, Jr.): Some valves (aragonitic) were slightly encrusted on the interiors, with minor staining on the exteriors. Only the cleanest shells, with internal lustre, were used for dating; 20 left and 13 right valves comprised the sample with the largest measuring 3.5 x 1.8 cm. Date based on one 4-day count in the 2 L counter.

GSC-2570. Creswell River (IV) 6180 ± 80
$\delta^{13}C = -0.2$ ‰

Marine pelecypod shells (sample DCA-77-S16; 28.5 g; **Serripes groenlandicus**; identified by W. Blake, Jr.) from sand 9 km north of the mouth of Creswell River, Somerset Island, Northwest Territories (72°52'30"N, 93°30'W), at an elevation of 10 m. Collected 1977 by A.S. Dyke.

Comment (A.S. Dyke): Whole valves (aragonitic), some with periostracum intact, from horizontally bedded sands exposed in a fresh river cut. The sands extend to an extensive flat surface at 14 m a.s.l.; however, sea level was higher than that at 6180 years B.P. (Dyke, 1979b). Date based on two 1-day counts in the 2 L counter.

GSC-2542. Creswell River (V) >38 000

Driftwood (sample DCA-77-WD1; 11.5 g; identified as **Larix sibirica** Lbd. by H. Zalasky, Canadian Forestry Service, Edmonton) from the eroded foreslope of a perched delta, 16 km northwest of the mouth of Creswell River, Somerset Island, Northwest Territories (72°53'N, 93°42'W), at an elevation of 160 m. Collected 1977 by A.S. Dyke.

Comment (A.S. Dyke): This sample of splintered wood, 20 x 7 cm in size, as collected from an inactive stream cut in a delta whose topsets form a terrace at 180 m a.s.l. The delta is considered to be an ice-marginal feature because it occupies the headwaters of the present drainage system and its topset gravels contain many erratic boulders (Dyke, 1978). The surface of the wood was covered with planktonic microorganisms (H. Zalasky, personal communication, 1978).

Comment (W. Blake, Jr.): The sample was originally identified as **Picea** sp. by L.D. Farley-Gill, but in view of the difficulty in distinguishing between spruce and larch, especially in "old" wood samples, this difference is not surprising. Date based on one 3-day count in the 5 L counter.

Northern Somerset Island Series

Five dated samples are described below. All relate to the Holocene emergence of northern Somerset Island and are discussed, along with 26 other dates, by Dyke (1979b). Except for GSC-2233, all elevation measurements were made with a surveying altimeter; high tide line was used as datum.

GSC-2660. Cape Anne 9000 ± 90
$\delta^{13}C = +1.2$ ‰

Marine pelecypod shells (sample DCA-77-S19; 47.0 g; **Mya truncata**; identified by W. Blake, Jr.) from slightly fossiliferous topset gravels and the upper 3 m of foreset sand in a delta 10 km south-southwest of Cape Anne, Somerset Island, Northwest Territories (74°01'19"N, 93°45'W), at an elevation of 95 to 99 m. Collected 1977 by A.S. Dyke.

Comment (A.S. Dyke): The shells relate to a relative sea level position marked by the delta topset gravels at 99 m a.s.l. The sample included a few **Hiatella arctica** valves as well as **Mya truncata**; the latter were aragonitic, some had pitting, iron staining, and encrustations; pieces of periostracum remained on some shells. Eight left valves and 4 right valves, all whole or nearly whole, were utilized for dating after scraping and cleaning with distilled water in a sonic bath. Date based on one 3-day count in the 5 L counter.

GSC-2732. Cunningham Inlet, shells 8990 ± 210
$\delta^{13}C = +1.9$ ‰

Marine pelecypod shells (sample NJ-75-55; 7.1 g; **Mya truncata**; identified by W. Blake, Jr.) from the surface of deltaic topset gravels 16.9 km southeast of the mouth of Cunningham River, Somerset Island, Northwest Territories (73°59'N, 93°20'W), at an elevation of 102 m. Collected 1975 by A.S. Dyke and J.J. Veillette.

Comment (A.S. Dyke): The sample consisted of shell fragments with little periostracum and some encrustations. The date is probably related to a relative sea level of 102 m as the delta appears to mark the local marine limit.

Comment (W. Blake, Jr.): The collection also contained fragments of **Hiatella arctica**, although these were not used for dating. Among the **Mya truncata** shells there were no intact valves. The encrusted fragments were carefully avoided in the sample sent to the laboratory. The material utilized consisted of 15 fragments, 14 of which included the truncated posterior end. The shells were aragonitic, not more than 2 mm in thickness, and not chalky; a little pitting was present on a few valves. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

GSC-2666. Cape Anne 8680 ± 90

Marine pelecypod shells (sample DCA-77-S18; 47.1 g; **Mya truncata**; identified by W. Blake, Jr.) at an elevation of 60 to 65 m in highly fossiliferous foreset sands immediately below topset gravels forming a terrace at 67 m a.s.l., 10 km southwest of Cape Anne, Somerset Island, Northwest Territories (74°01'25"N, 94°53'W). Collected 1977 by A.S. Dyke.

Comment (A.S. Dyke): The shells were thin and mostly whole valves; a few retained the periostracum and most had iron stains, but none were pitted. They lived when relative sea level was 67 m above present. Date based on one 3-day count in the 5 L counter.

GSC-2233. Cunningham Inlet, wood (I) 3580 ± 60
$\delta^{13}C = -23.1$ ‰

Wood (sample TU-75-5; 11.4 g; **Picea** sp.; identified by R.J. Mott) in sandy gravel from 9 km west of Cunningham Inlet, on the north coast of Somerset Island, Northwest Territories (74°08'N, 94°09'20"W), at an elevation of 12.6 m above mean high tide (as determined with a levelling instrument). Collected by R.W. Cameron for R.B. Taylor.

Comment (W. Blake, Jr.): The age of this sample collected 166.5 m from the shore is in general agreement with the ages of two driftwood samples from the west side of Cunningham Inlet (GSC-2080, 5300 ± 70 years, at ca. 20.8 m; GSC-2081, 4930 ± 70 years, at ca. 17.3 m; both in Blake, 1975a; Taylor, 1975; GSC XVI, 1976, p. 15). Date based on one 2-day count in the 5 L counter.

GSC-2704. Cunningham Inlet, wood (II) 1420 ± 50

Driftwood log (sample NJ-75-60; 11.7 g; **Picea** sp., identified by R.J. Mott) 70 per cent embedded in the crest of a shingle beach ridge 2.2 km southwest of the mouth of Cunningham River, Somerset Island, Northwest Territories (74°04'N, 93°34'W), at an elevation of ca. 5 m. Collected 1975 by A.S. Dyke and J.J. Veillette.

Comment (A.S. Dyke): The sample provides the age of a beach 5 m above present high tide and 1.6 km from the nearest point on the coast; it agrees well with other dates on

driftwood from Cunningham Inlet (Taylor, 1975; Lowdon and Blake, 1976; Dyke, 1979b). Ten rings were used for the dated sample after all outside wood was cut away on this log (75 cm long and 13 cm in diameter). Date based on two 1-day counts in the 5 L counter.

Russell Island

Northwestern Russell Island Series

GSC-2240. Russell Island (I) 3630 ± 60
$\delta^{13}C = -22.9‰$

A 3.1 m long piece of driftwood (sample TU-75-4; 11.0 g; **Picea** sp.; identified by R.J. Mott) was found on a raised beach ridge 14.3 m above approximate high tide level and 14.8 m above water level at 1330 h (CDT) on August 2, 1975. The driftwood lay a distance of 452.5 m from water level on a beach terrace within the same embayment as sample GSC-2300, northwestern Russell Island, Northwest Territories (73°57'30"N, 98°58'W). Collected 1975 by J. Savelle for R.B. Taylor

GSC-2300. Russell Island (II) 1800 ± 50
$\delta^{13}C = -25.1‰$

A small piece of driftwood, 0.5 m long (sample TU-75-3b; 11.0 g **Picea** sp.; identified by R.J. Mott), from a frost crack 5.4 m above approximate high tide level and 5.68 m above water level at 1330 h (CDT) on August 2, 1975. The sample was located on a raised beach in an embayment of northwestern Russell Island, Northwest Territories (73°57'25"N, 98°58'30"W) at a distance of 182.5 m from water level. The sample was buried 5 to 10 cm in the frost crack. Several other pieces of driftwood were present at a similar elevation. Collected 1975 by R.B. Taylor.

Comment (R.B. Taylor): Samples GSC-2240 and -2300 were collected from the same embayment on the north coast of Russell Island. These samples provide ages for the lower and middle elevations of a flight of raised beaches which separates Barrow Strait from a large lake which nearly divides Russell Island. The higher sample at 14.3 m above high tide level is slightly older than a sample (GSC-2233; 3580 ± 60 years; this list) collected at 12.6 m above high tide level on northern Somerset Island. Although not dated, large pieces of whalebone were also levelled at 2.7 m and 13.8 m a.s.l. on northern Russell Island. GSC-2240 and -2300 based, respectively, on two 1-day counts and one 2-day count, both in the 5 L counter.

Lowther Island

GSC-2224. Lowther Island 4410 ± 70
$\delta^{13}C = -22.6‰$

A piece of driftwood (sample TU-75-1; 11.1 g; **Picea** sp.; identified by R.J. Mott) from the surface of a raised beach terrace on the west coast of Lowther Island, Northwest Territories (74°34'N, 97°35'30"W). The wood, firmly imbedded 1 to 2 cm in raised beach gravels, was located ca. 490 m from the approximate high tide level, at an elevation of 20.97 m above the ice foot surface or 21.46 m above approximate high tide on July 20, 1975. Collected 1975 by J. Savelle for R.B. Taylor.

Comment (R.B. Taylor): This sample is part of a series of driftwood samples collected along the shores of Barrow Strait. It provides an age for the raised beaches at 21.4 m a.s.l. which is just slightly younger than the date of a sample collected at 22.3 m a.s.l. (GSC-2405; 4540 ± 70 years; this list) on southeastern Bathurst Island. On northern Somerset Island, however, a sample from the raised beaches at 20.8 m a.s.l. was older, 5300 ± 70 years (GSC-2080; Taylor, 1976; GSC XVI, 197, p. 15), a fact that suggests that uplift was more rapid on western Lowther Island than around Cunningham Inlet (cf. Dyke, 1979b). Date based on two 1-day counts in the 5 L counter.

Bathurst Island

Cape Capel Series

Driftwood samples from near Cape Capel, Bathurst Island. Collected 1976 by R.B. Taylor.

GSC-2405. Cape Capel (I) 4540 ± 70
$\delta^{13}C = -24.6‰$

A log 1.5 m long (sample Bathurst-76-3; 11.6 g; **Picea** sp.; identified by R.J. Mott) was found buried 10 to 15 cm in a lemming mound partially covered by moss on a major raised beach terrace 22.3 m above high tide limit. The distance from high tide level was 405 m. The sample location was just west of the small stream west of Cape Capel on southeastern Bathurst Island, Northwest Territories (75°01'58"N, 98°02'W).

Comment (R.B. Taylor): This sample provides an age estimate for one of the larger raised beach terraces which encloses a valley behind Cape Capel. The height above sea level and the age of this sample correspond closely with those of driftwood sample GSC-2224 (4410 ± 70 years; this list) collected on western Lowther Island; the latter sample was 21.4 m above the approximate high tide level. Date based on two 1-day counts in the 5 L counter.

GSC-2437. Cape Capel (II) 180 ± 50

A small piece of driftwood 30 cm long (sample Bathurst-76-1; 11.5 g; **Picea** sp.; identified by L.D. Farley-Gill) was found at ca. 59.4 m above water level on August 2, 1976. The sample lay within the large valley to the north of Cape Capel, Bathurst Island, Northwest Territories (75°02'20"N, 97°58'30"W). Elevation was measured using a helicopter altimeter.

Comment (R.B. Taylor): Although the wood was partially covered by moss and other vegetation, it is evident from the age that the wood is much younger than its location originally would suggest. The wood has obviously been moved by man or animal to a higher altitude above sea level. This sample provides evidence that some pieces of driftwood embedded in raised beaches may well have been transported since they were first deposited on land by littoral processes. Date based on one 1-day count in the 5 L counter.

Cornwallis Island

Cornwallis Island Series

Basal peat samples from three sites on Cornwallis Island. Collected 1975 by C. Tarnocai, then Canada-Manitoba Soil Survey, Winnipeg, Manitoba, now Agriculture Canada, Ottawa.

GSC-2321. Cornwallis Island (I) 1700 ± 40

Moderately decomposed moss peat (sample C39; 50.8 g) from an eroding, lowland, high centre (peat) polygon located 20 km west of Eleanor Lake, northern Cornwallis Island, Northwest Territories (75°23'N, 94°42'W), at an elevation of 61 m.

Comment (C. Tarnocai): The sample was taken from the basal peat of the deposit, 130 cm below the surface, and thus the date indicates the approximate time at which peat began to develop in this peatland. This is, however, a relatively recent peatland compared to the other two sites on Cornwallis Island, GSC-2476 (4670 ± 60 years) and GSC-2532 (6590 ± 100 years; both in this series). Date based on one 3-day count in the 5 L counter.

GSC-2476. Cornwallis Island (II) 4670 ± 60

Moderately decomposed moss peat (sample C40; 25.0 g) from ca. 50 cm behind an eroding face of a lowland, high centre ice wedge (peat) polygon located 22 km west of Eleanor Lake, northern Cornwallis Island, Northwest Territories (75°23'N, 94°47'W), at an elevation of ca. 61 m.

Comment (C. Tarnocai): The sample was taken from the basal peat of the deposit, 110 cm below the surface, and thus the date indicates the approximate time at which peat began to develop in this peatland. Date based on one 4-day count in the 2 L counter.

Comment (W. Blake, Jr.): The wet sample (280 g) was dried in an electric oven, reducing the weight to 120 g. After stones and shell fragments were removed, 25 g were selected for dating. Some sand remained in this material. The date also provides a minimum age for the time at which the site emerged from the sea (cf. GSC-2532 and -2321, this series).

GSC-2532. Cornwallis Island (III) 6590 ± 100

Undecomposed moss peat (sample C34; 12.7 g) from ca. 50 cm behind an eroding face of a lowland, high centre ice wedge (peat) polygon located near the west side of Coal River, 7 km north of the head of Intrepid Bay, western Cornwallis Island, Northwest Territories (75°05'N, 96°09'W), at an elevation of ca. 46 m.

Comment (C. Tarnocai): The sample was taken from the basal peat of the deposit, 75 cm below the surface, and thus the date indicates the approximate time at which peat began to develop in this peatland. This date corresponds closely with dates on other basal peat samples from both Bathurst Island (GSC-253; 6510 ± 150 years; GSC VI, 1967, p. 189; Blake, 1974b) and Somerset Island (GSC-2339; 6280 ± 80 years; GSC XVII, 1977, p. 19). Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Comment (W. Blake, Jr.): Of the three determinations reported in this series, GSC-2532 is the most valuable with regard to movements of the shoreline, since it is both the oldest sample and the one that occurs at the lowest elevation.

Coburg Island

GSC-2064. Coburg Island 5990 ± 130
$\delta^{13}C = -23.9‰$

Driftwood (sample AA-1973-1; 5.1 g; **Picea** sp.; identified by L.D. Farley-Gill) exposed in shore cliffs developed in beach gravel and sand on the east coast of Coburg Island, Northwest Territories (75°54.1'N, 79°04.5'W), at an elevation of ca. 3 m above mean sea level. The sample is part of a larger log or tree imbedded ca. 0.75 m below the surface of the beach. Collected 1973 by A. Allan, then with North Water Project, McGill University, Montreal, now Centre for Cold Oceans Resources Engineering, St. John's.

Comment (W. Blake, Jr.): This sample is the only piece of driftwood recovered from Coburg Island, although in places marine shells are abundant (Blake, 1976b). The location of the wood and its elevation suggest that the shoreline of 5000 years ago is close to present sea level on Coburg Island (Blake, 1975a). Date based on one 3-day count in the 2 L counter.

Ellesmere Island

Cape Storm Series (IV)

Driftwood and organic detritus from a sequence of raised beaches near Cape Storm, Ellesmere Island, Northwest Territories. All elevations were determined with a levelling instrument using the surface of the ice foot as high tide level.

GSC-1419. Cape Storm, wood, 7.0 m 2390 ± 130
$\delta^{13}C = -26.4‰$

Wood (sample BS-70-74; 15.8 g; **Picea** or **Larix**, probably **Larix** sp.; identified by R.J. Mott) ca. 4.8 km north-northeast of Cape Storm.

GSC-1441. Cape Storm, wood, 10.0 m 3280 ± 140
$\delta^{13}C = -24.7‰$

Wood (sample BS-70-72; 9.6 g; **Picea** or **Larix**, probably **Larix** sp.; identified by R.J. Mott) ca. 4.8 km north-northeast of Cape Storm.

GSC-1459. Cape Storm, organic detritus, 29.5 m 5230 ± 520
$\delta^{13}C = -29.7‰$

Organic detritus (sample BS-70-106; 0.5 g) from 3 m above river level and 4.5 m below the surface, ca. 6.4 km north-northeast of Cape Storm. The sample was dominated by leaves of **Dryas integrifolia**; also present were the mosses **Hypnum** sp. cf. **condensatum**, **Orthothecium chryseum**, and **Tortula ruralis** (unpublished GSC Bryological Report No. 67 by M. Kuc), as well as a catkin of **Salix arctophila** (determined by G. Argus, National Museum of Natural Sciences, Ottawa).

Comment (W. Blake, Jr.): The driftwood samples provide two important points on the emergence curve constructed for Cape Storm (Blake, 1975a, c). The organic detritus is too young for its elevation; no satisfactory explanation has been found for this age except the difficulty in dealing with very small samples (Blake, 1975a). GSC-1419 and -1441 each based on two 1-day counts in the 5 L counter. GSC-1459 mixed with dead gas for counting. Date based on one 5-day count in the 1 L counter. The ages reported in Blake (1975a) have smaller error terms than are reported here (cf. footnote 2, Table 1, p. 18 in that report).

Cape Storm Series (V)

A whalebone sample (BS-70-55) imbedded and frozen in near the upper limit of a sequence of raised beaches 8.0 km north of Cape Storm, Ellesmere Island, Northwest Territories (76°25'N, 87°33'W), at an elevation of 118 m (as determined by a levelling instrument using the surface of the ice foot as high tide level). All determinations were based on an unidentified piece of bone, >1 m in length and with a diameter of up to 30 cm (probably a mandible). Collected 1970 by W. Blake, Jr.

GSC-1496-A. Cape Storm, whalebone, first determination 9040 ± 170
$\delta^{13}C = -16.2‰$

An 1100 g subsample was treated with 3N HCl; after the initial reaction it was placed in an aspirator and treated for one hour with 0.1N NaOH, then neutralized and dried. The collagen thus recovered was burned on four separate occasions; for GSC-1496-A, 15.3 g was utilized in a high oxygen flow rate. This sample was contaminated by air leakage due to a small explosion during burning. Date based on one 1-day count in the 2 L counter. Uncorrected age 8900 ± 170 years.

GSC-1496-B. Cape Storm, whalebone, second determination 9230 ± 140
$\delta^{13}C = -15.9‰$

The second portion of the sample described under GSC-1496-A; for GSC-1496-B, 15.0 g was burned in a standard oxygen flow rate. Date based on one 3-day count in the 5 L counter. Uncorrected age 9080 ± 140 years.

GSC-1496-C. Cape Storm, whalebone, third determination — 9410 ± 150; $\delta^{13}C = -15.4‰$

The third portion of the sample described under GSC-1496-A; for GSC-1496-C, 20.5 g was first heated while passing nitrogen through the tube to reduce the possibility of explosion, then the sample was burned in oxygen. Sample mixed with dead gas for counting. Date based on one 3-day count in the 5 L counter. Uncorrected age 9260 ± 150 years.

GSC-1496-2. Cape Storm, whalebone, fourth determination — 9040 ± 180; $\delta^{13}C = -13.5‰$

A subsample weighing 552 g was treated with acetic acid to obtain the bone apatite fraction; this fraction was then treated with H_3PO_4 in the shell apparatus to obtain the CO_2. The same gas was counted in two counters:

GSC-1496-2. 8770 ± 260

Date based on two 1-day counts in the 1 L counter. Uncorrected age 8590 ± 260 years.

GSC-1496-2. 9040 ± 180

Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter. Uncorrected age 8860 ± 180 years.

GSC-1496-3. Cape Storm, whalebone, fifth determination — 9340 ± 80; $\delta^{13}C = -16.6‰$

The fourth portion of the sample described under GSC-1496-A; for GSC-1496-3, 15.0 g was burned and then the KOH method was used (cf. Lowdon et al., 1977). Date based on one 3-day count in the 5 L counter. Uncorrected age 9200 ± 80 years.

GSC-1496-4. Cape Storm, whalebone, sixth determination — 9590 ± 120; $\delta^{13}C = -17.8‰$

For this determination a 438.5 g sample was treated in a pressure cooker; no pretreatmnet with HCl or NaOH was used. The collagen recovered (7.8 g) was burned and the KOH method was used. Date based on one 1-day count in the 2 L counter. Uncorrected age 9450 ± 120 years.

Comment (W. Blake, Jr.): Determinations GSC-1496-A, -B, -C, and -2 were reported in Blake (1975a), and GSC-1496-3 was referred to in Blake (1979). In addition, a sample of about 150 g of this same whalebone was dated at the Uppsala Laboratory using the EDTA treatment (cf. Olsson et al., 1974). The result was 9600 ± 120 years (U-2510; Uppsala XII, 1978, p. 470), the $\delta^{13}C$ value was -17.2 ‰ , and the uncorrected age was 9470 ± 120 years. This bone was not as well preserved as the whalebones at lower elevations on the beaches at Cape Storm, and most of the bone was characterized by a brownish stain. The outer parts of the bone were hard; the inside parts (softer and more porous) were removed in the field by axe and, after the sample was air dried, by cutting with a band saw in the laboratory. The age values for GSC-1496-A, -B, -C, and -2 reported earlier are given with smaller error terms (see footnote to Table 1 in Blake, 1975a). Determination GSC-1496-3 (9340 ± 80 years) is the one with the smallest error term, and the age is identical to that of high level marine mollusc shells nearby (Blake, 1979). It is also clear that the bone apatite fraction is younger than several of the determinations on organic material in the bone (especially when the revised error terms are used).

GSC-1223. Cory Glacier, shells — >37 000

Marine pelecypod shell fragments (sample BS-127-68; 46.5 g; **Mya truncata**; identified by W. Blake, Jr.) from the ground surface on the southwest side of Cory Glacier, Ellesmere Island, Northwest Territories (76°14'N, 80°04'W), at an elevation of ca. 20 m (altimeter determination). Collected 1968 by W. Blake, Jr.

Comment (W. Blake, Jr.): These shell fragments were all robust and thick (maximum thickness 7 mm); they had the typical appearance of "old" shells. Dating was carried out primarily to determine what sort of age the thick shells would give. Seventeen fragments sufficed to give 46.5 g, and each fragment included part of the truncated posterior end that is typical of **Mya truncata**. The sample was collected in an abandoned stream channel on the distal side of the main moraine ridge adjacent to Cory Glacier, but inside the outermost ridge which marks the maximum advance of Cory Glacier since the nearby beaches (of Holocene age) developed. The shells would appear to derive from older marine deposits which occur beneath Cory Glacier (cf. Blake, 1975a, 1978b). Date based on two 1-day counts in the 5 L counter.

Makinson Inlet Series (II)

Shells and wood from near the southern coast of Swinnerton Peninsula facing Piliravijuk Bay, the western arm of Makinson Inlet, Ellesmere Island, Northwest Territories. Elevations determined by traverses with surveying altimeters.

GSC-2692. Swinnerton Peninsula (I) — 8090 ± 70; $\delta^{13}C = +1.4‰$

Aragonitic pelecypod shells (sample BS-77-277; 46.4 g; **Hiatella arctica**; identified by W. Blake, Jr.) from the ground surface north of the western end of Piliravijuk Bay (77°19.4'N, 82°08.5'W) at an elevation of ca. 82 m. This sample was the highest collection of marine shells made along the southern coast of Swinnerton Peninsula. Collected 1977 by R.J. Richardson. Date based on one 3-day count in the 5 L counter.

GSC-2701. Swinnerton Peninsula (II) — 8090 ± 100; $\delta^{13}C = +1.7‰$

Aragonitic pelecypod shells (sample BS-77-253B; 59.2 g; identified by W. Blake, Jr.) from stony silt in a section of marine sediments exposed along a south-flowing river draining into Piliravijuk Bay (77°19.2'N, 82°01'W), at an elevation of ca. 42 m. Collected 1977 by W. Blake, Jr. Two determinations were made:

GSC-2701. Outer Fraction — 8040 ± 110; $\delta^{13}C = +1.8‰$

Outer fraction of shells (11 to 55 per cent) after outermost 10 per cent removed by HCl leach. Date based on two 1-day counts in the 2 L counter.

GSC-2701. Inner Fraction — 8090 ± 100; $\delta^{13}C = +1.7‰$

Inner fraction of shells (56 to 100 per cent). Date based on one 3-day count in the 2 L counter.

GSC-2712. Swinnerton Peninsula (III) — 7920 ± 110; $\delta^{13}C = -28.3‰$

Wood (sample BS-77-249; 7.3 g; **Salix** sp.; identified by L.D. Farley-Gill) from the base of the same stony silt unit from which GSC-2701 (this series) came, north of Piliravijuk Bay (77°19.2'N, 82°01'W), at an elevation of ca. 42 m. Collected 1977 by W. Blake, Jr. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Comment (W. Blake, Jr.): The sea first reached this area 8930 ± 100 years ago (GSC-2519; Blake, 1978a; GSC XVIII, 1978, p. 15). Determinations GSC-2701 and -2712 provide an interesting comparison of terrestrial and marine materials, and GSC-2692 shows that the stony silt unit in which they occur was deposited in at least 40 m of water (Blake, 1979). The sample used for GSC-2701 comprised 10 intact and well preserved pairs of **Mya truncata;** all had the periostracum intact and most retained a portion of the siphon sheath (this organic material was submitted for dating separately, but 5.9 g only gave 1.3 cm of gas, so counting of GSC-2702 was not attempted). These pelecypods were still in living position at the time of collection.

GSC-1755. Ella Bay 6000 ± 150

Driftwood (sample JHE-22-1972; 11.1 g; **Larix** sp.; identified by L.D. Farley-Gill) from marine silt ca. 2 km south of the head of Ella Bay, Archer Fiord, Ellesmere Island, Northwest Territories (81°04'N, 70°02'W), at an elevation of ca. 50 m. The upper surface of the silt was at ca. 63 m, below gravel. Collected 1972 by J.H. England, then University of Colorado, Boulder, Colorado; now University of Alberta, Edmonton.

Comment (J.H. England): Sample likely dates local marine limit at ca. 81 m and provides a minimum estimate for the time of deglaciation at the head of Ella Bay. Along with GSC-1614 (this list), GSC-1755 indicates that Robeson Channel, Lady Franklin Bay, and Archer Fiord were sufficiently free of summer sea ice as to allow the penetration of driftwood to the fiord heads which, by this time (6000 to 6500 years ago), were also free of glacial ice (Blake, 1972; England, 1974a). Date based on two 1-day counts in the 5 L counter.

Beatrix Bay Series

Driftwood samples from raised marine deposits at the head of Beatrix Bay, Ellesmere Island, Northwest Territories (81°11'N, 70°22'W). Collected 1971 by J.H. England.

GSC-1610. Beatrix Bay (I) 5950 ± 140

A piece of driftwood (sample FG-33-1971(JHE); 13.5 g; **Larix** sp.; identified by R.J. Mott), 14 cm long and ca. 6 cm in diameter, collected on the ground surface behind a raised beach at an elevation of 55 m.

Comment (J.H. England): The raised beach behind which GSC-1610 was collected, on a steep slope leading to the marine terrace at 82 m, was dated by GSC-1614 (this series). The age of GSC-1610 appears old for this relative sea level (55 m); hence the possibility that it has been redeposited from a higher elevation must be considered. If GSC-1610 does date the 55 m beach, then (along with GSC-1614) a more rapid rate of initial postglacial uplift is suggested than do other uplift curves in the area (England, 1972, 1974a, b). Date based on two 1-day counts in the 5 L counter.

GSC-1614. Beatrix Bay (II) 6430 ± 150

A driftwood log (sample FG-34-1971(JHE); 11.2 g; **Picea** sp., identified by R.J. Mott), 1 m long, 20 cm in diameter, embedded in the silt/sand matrix underlying a marine terrace graded to ca. 82 m. The sample elevation was ca. 33 m.

Comment (J.H. England): The sample dates a relative sea level of at least 82 m and possibly adjacent marine limit at 84 to 88 m. The sample also provides a minimum age estimate on the local deglaciation of this site (England, 1972, 1974a). Date based on two 1-day counts in the 5 L counter.

Ida Bay Series

Marine pelecypod shells collected from silt/clay near the surface of a terrace at 83 m, on the side of lower Dodge River, 5 km southwest of the head of Ida Bay, Ellesmere Island, Northwest Territories (81°31'N, 69°07'W) at an elevation of 83 m. The surface of the terrace was at ca. 91 m, and the limit of postglacial marine submergence in the area is at ca. 104 m.

GSC-1668. Ida Bay (I) 8380 ± 420

Shells (sample FG-28-1971(JHE); 3.3 g; **Portlandia (Yoldia) arctica;** identified by W. Blake, Jr.). Collected 1971 by J.H. England.

Comment (J.H. England): Because the sample submitted for dating weighed so little, a relatively large error term resulted. Due to the importance of the date and the excellent stratigraphic position of the sample, another larger collection was made in 1972 from the same site (see GSC-1775, this series). Sample GSC-1668 provided the first estimate on the time of deglaciation at this site and of the age of a relative sea level at 104 m (cf. Christie, 1967).

Comment (W. Blake, Jr.): Most of the thin and fragile valves making up the collection were fragmented, although a few were whole. Nearly all retained the periostracum. Adhering clay was scraped off manually. 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 1 L counter.

GSC-1775. Ida Bay (II) 8130 ± 200
$\delta^{13}C = +0.6$ ‰

Shells (sample JHE-23-1972; 8.7 g; **Portlandia (Yoldia) arctica;** identified by W. Blake, Jr.). Collected 1972 by J.H. England.

Comment (J.H. England): Due to the sizeable error term (±420 years) on sample GSC-1668 (this series), a second sample of the same species, at the same location, was collected in 1972; GSC-1775, with a smaller standard error, is considered the better date for the relative sea level at 104 m. Adjacent to, and superimposed on, this marine limit terrace, in several localities, is a system of prominent, low-elevation lateral and end moraines referred to as Hazen Moraines (England, 1974a). Hazen Moraines are considered to be contemporaneous with the terrace dated by GSC-1775 and, hence, they are correlative with Cockburn Moraines of eastern Baffin Island (Andrews and Ives, 1972, 1978; England, 1974a, c).

Comment (W. Blake, Jr.): As with the shells comprising GSC-1668, the shells used for GSC-1775 were mostly fragmented, but many valves retained an intact periostracum. All valves were <1 cm in length. Sample mixed with dead gas for counting. Date based on two 1-day count in the 2 L counter.

Sun Cape Peninsula Series

Marine pelecypod shells from two sites near the eastern end of Sun Cape Peninsula, north-central coast of Lady Franklin Bay, Ellesmere Island, Northwest Territories. Collected 1971 by J.H. England.

GSC-1616. Sun Cape Peninsula (I) 5250 ± 180

Shells (sample FG-6-1971(JHE); 4.5 g; **Astarte** sp. (probably **Astarte borealis**); identified by W. Blake, Jr.) from silt/clay in a terrace at the eastern end of Sun Cape Peninsula (81°39'40"N, 65°27'W), at an elevation of ca. 12 m.

Comment (J.H. England): The terrace where sample GSC-1616 was collected grades laterally upward to the marine limit at 78 m. The stratigraphic relationship of this sample to the marine limit is unknown; however, it must date a relative sea level lower than 78 m and higher than 12 m. The age of the local marine limit is better approximated by sample GSC-1706 (this series).

Comment (W. Blake, Jr.): The shells comprising this sample were washed clean of silt in distilled water and dried in an electric oven. One whole valve (3.5 x 3.1 cm) plus parts of 2 or 3 others, all with intact periostracum, were submitted to the laboratory. **Hiatella arctica** and **Mya truncata** were also present in the collection. Because of the small sample size the HCl leach was omitted. Sample mixed with dead gas for counting. Date based on one 4-day count in the 2 L counter.

GSC-1706. Sun Cape Peninsula (II) 6910 ± 170

Single marine pelecypod valve (sample FG-3-1971(JHE); 9.9 g; **Mya truncata**; identified by W. Blake, Jr.) from marine silt at the eastern end of Sun Cape Peninsula (81°39'40"N, 65°25'W), at an elevation of ca. 61 m.

Comment (J.H. England): The sample was collected in the immediate vicinity of GSC-1616 (this series) and it provides an improved minimum estimate for the time of deglaciation at this location. GSC-1706 dates the overlying silts up to at least 69 m; however, marine deposits, obscured by slope debris, extended laterally up to the marine limit (at 78 m), which is probably older (cf. England, 1974a).

Comment (W. Blake, Jr.): Some adhering silt was removed manually, then the sample was soaked in distilled water and dried in an electric oven. Only a single left valve (5.1 x 3.8 cm), intact and with some periostracum near the hinge, was used for dating. Due to 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.

The Bellows Series

Driftwood samples from lower Bellows Valley, northwest from the head of Discovery Harbour, Ellesmere Island, Northwest Territories. Collected 1971 by J.H. England.

GSC-1632. The Bellows (I) >41 000

A driftwood log (sample FG-19-1971(JHE); 11.3 g; **Larix** sp.; identified by R.J. Mott) from the base of the uppermost delta (67 m) in lower Bellows Valley, ca. 9 km from the head of Discovery Harbour, Lady Franklin Bay, Ellesmere Island (81°42'30"N, 66°27'W), at an elevation of ca. 50 m.

Comment (J.H. England): The sample could be an ice- or stream-transported deposit of Tertiary age, or, reworked driftwood from an earlier interglacial marine transgression. Another sample of "old" wood was collected nearby on the same Holocene terrace (see GSC-1678, this series). Hence, the wood in lower Bellows Valley is unrelated, age-wise, to the postglacial relative sea level where it was collected (cf. Blake, 1972; England, 1974a).

Comment (W. Blake, Jr.): The small wood sample, measuring 14 x 6 x 3 cm, was soaking wet and was a dark grey-brown when received. After drying in an electric oven all the outside wood and wood along cracks was cut away to remove adhering silt and sand. Date based on one 3-day count in the 5 L counter.

GSC-1678. The Bellows (II) >40 000

Driftwood (sample FG-18-1971(JHE); 6.2 g; **Larix** sp.; identified by L.D. Farley-Gill) from a gully on the surface of the uppermost delta (67 m) in lower Bellows Valley, ca. 12.8 km from the head of Discovery Harbour, Ellesmere Island (81°42'30"N, 66°30'W), at an elevation of ca. 61 m.

Comment (J.H. England): Driftwood collected in the immediate vicinity of sample GSC-1632 (this series). Both dates indicate that "old" wood has been incorporated into Holocene terraces. The comment for GSC-1632 also applies to GSC-1678.

Comment (W. Blake, Jr.): This dry sample consisted of a single piece, 14 cm long and with a maximum diameter of 4 cm. It was somewhat rounded on the ends and had a fractured surface. All outside wood and wood along cracks was cut off. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 5 L counter.

GSC-1812. Chandler Fiord 7340 ± 180
$\delta^{13}C = +0.3‰$

Marine pelecypod shells (samples FG-22-1971(JHE) and JHE-25-1972; 8.3 g total; **Portlandia (Yoldia) arctica**; identified by W. Blake, Jr.) from silt/clay in a terrace along the lower, west side of Ruggles River, 2 km northwest from the head of Chandler Fiord, Ellesmere Island, Northwest Territories (81°43'N, 69°23'W), at an elevation of 46 m. The terrace surface rises to the marine limit at ca. 67 to 68 m. Collected 1971 and 1972 at the same site by J.H. England.

Comment (J.H. England): The date is a minimum estimate for the time of deglaciation and for the establishment of the marine limit.

Comment (W. Blake, Jr.): The shells comprising the 1971 collection (1.6 g) retained more periostracum than those collected in 1972. Both collections were washed in distilled water and dried in an electric oven. Because of the small sample size only the outer 10 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.

GSC-1655. Fort Conger 6010 ± 220

Marine pelecypod shells (sample FG-4-1971(JHE); 8.1 g; **Mya truncata**; identified by W. Blake, Jr.) from bottomset beds of silt and sand overlain by glaciomarine foreset beds in a terrace graded to ca. 67 m along the north side of the creek immediately behind the historic site of Fort Conger, Discovery Harbour, Ellesmere Island, Northwest Territories (81°44'N, 64°45'W), at an elevation of 22.5 m. Collected 1971 by J.H. England.

Comment (J.H. England): The shells likely date a relative sea level at ca. 67 m. Local marine limit is at ca. 78 m; hence, initial postglacial emergence and deglaciation probably occurred prior to 6010 ± 220 years B.P.

Comment (W. Blake, Jr.): The shells were mostly whole when collected, but were fragmented by the time they were received in the laboratory. The sample submitted comprised two whole valves of **Mya truncata** (one left and one right, not a pair) plus two fragments. All retained some periostracum. Other species present in the sample included **Hiatella arctica, Macoma calcarea, Astarte** sp., and fragments of an unidentified gastropod. Because of the small sample size only the outer 10 per cent was removed by HCl leach. Date based on two 1-day counts in the 1 L counter. This age determination supersedes an earlier determination, utilizing the same gas, of 6410 ± 280 years, based on one 1-day count in the 1 L counter.

Eugene Glacier Series

Peat samples collected from the bank of a stream channel marginal to a 20 m high ice cliff on the east side of Eugene Glacier, Ellesmere Island, Northwest Territories (82°17'N, 66°18'W), at an elevation of ca. 610 m. The exposure, relatively fresh, is ca. 60 m from the ice cliff.

Collected 1972 by G. Hattersley-Smith, then Defence Research Establishment Ottawa; now at Cranbrook, Kent, England. Two determinations were made on each of two peat layers.

GSC-1813. Eugene Glacier, upper peat (I) — 4970 ± 60; $\delta^{13}C$ = -23.1 ‰

Peat (sample DRB 15/7-1; 80 g dry) from ca. 4 m above stream level and beneath 30 cm of glacial outwash and morainic material. The 80 g sample was given the standard treatment with NaOH, HCl, and distilled water rinses. Following pretreatment a 15 g subsample was burned. Date based on two 1-day counts in the 5 L counter.

GSC-1813-2. Eugene Glacier, upper peat (II) — 4900 ± 60; $\delta^{13}C$ = -24.6 ‰

A portion of the original, treated sample was used for this new determination; a 17.7 g sample was burned, and then the KOH method was utilized (cf. Lowdon et al., 1977). Date based on two 1-day counts in the 5 L counter.

GSC-1864. Eugene Glacier, lower peat (I) — >43 000

Peat (sample DRB 15/7-2; 53 g dry) from ca. 3 m above stream level and covered by 2 m of glacial outwash and morainic debris. Standard sample pretreatment as listed for GSC-1813, this series. Date based on one 3-day count in the 5 L counter.

GSC-1864-2. Eugene Glacier, lower peat (II) — >49 000

A 100 g portion of the same lower peat layer. Pretreatment included leaching with hot HCl and hot NaOH for one hour each, plus distilled water rinses. Date based on three 1-day counts and one 3-day count in the 5 L counter at 4 atm.

Comment (W. Blake, Jr.): The dates indicate that some time prior to 49 000 years ago there was an ice-free interval, following which there was deposition of outwash and/or till. A second ice-free interval occurred approximately 4900 years ago, after which there was again deposition of outwash. The submitter stated (G. Hattersley-Smith, personal communication, 1972) that at this site Eugene Glacier has advanced ca. 15 m in the interval between 1953 and 1972. The upper peat was classified by M. Kuc (unpublished GSC Bryological Report No. 214) as a complex peat, typical of arctic and hummocky moss deposits. Wet tundra, characterized by the moss **Tomenthypnum nitens**, dominated in depressions; on hummocks or dry tundra the mosses **Distichium** sp. and **Timmia** sp. were characteristic; and in mesic tundra **Hypnum hamulosum** was found. The lower peat, characteristic of moss bog tundra (unpublished GSC Bryological Report No. 249 by M. Kuc), was dominated by **Tomenthypnum nitens** var. **involutum** and by **Carex** sp. rhizomes; seeds and leaf fragments of **Salix** sp. and fragments of **Equisetum** sp. were also present. The lower horizon is one of a series of peat deposits in the Queen Elizabeth Islands on which infinite ages have been obtained (Blake, 1974a, 1975b; Blake and Matthews, 1979).

GSC-1815. Alert Weather Station — 10 100 ± 210; $\delta^{13}C$ = -0.2 ‰

Marine pelecypod shells (sample JHE-31-1972; 8.6 g; **Portlandia (Yoldia) arctica**; identified by W. Blake, Jr.) collected in silt 7 km inland to the southwest of Alert Weather Station, northeasternmost Ellesmere Island, Northwest Territories (82°27'N, 62°45'W), at an elevation of ca. 113 to 116 m. Collected 1972 by J.H. England, then at University of Colorado, Boulder, Colorado; now University of Alberta, Edmonton.

Comment (J.H. England): The sample relates to a relative sea level at ca. 120 m adjacent to Kirk Lake. This is the highest marine limit observed so far in northeastern Ellesmere Island. The age of the sample is problematic due to its uniqueness in the region, i.e. it is the only date of ca. 10 000 years amongst the existing finite dates (more than 100) from northern Greenland and Ellesmere Island. It is also dissimilar to other dates bearing on the initial time of emergence; these range between ca. 7500 and 8100 years (England, 1974a, 1976, 1978). The date may represent either (1) an event not yet sufficiently documented (an earlier date of emergence towards the north coast of Robeson Channel) or (2) an apparent age which is erroneous.

Comment (W. Blake, Jr.): As indicated in Blake (1976a), "there is no reason to doubt the accuracy of the determination on these well preserved shells from a laboratory point of view; the sample was collected at a higher elevation than any of the other postglacial shells in the region, hence its greater age seems reasonable to the present writer." The shells were washed in distilled water and then dried in an electric oven. Most valves were whole and many still were paired with intact periostracum. Because of the small sample size the HCl leach was reduced to 10 per cent. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Melville Island/Byam Channel

Byam Channel, First Series

Pelecypods collected in cores, by SCUBA diving, in Byam Channel ca. 1 km east of Rea Point, Melville Island, Northwest Territories (75°22'N, 105°35'W), in 11 m of water. Collected 1975 by P. McLaren.

GSC-2288. Byam Channel (I) — 840 ± 100; $\delta^{13}C$ = +1.2 ‰

Complete pelecypod specimen (sample BCS5A R1; 5.2 g; **Astarte borealis**; identified by W. Blake, Jr.) taken from 26 cm below the top of a core collected in an embankment flanking the side of an ice scour track. The track appeared old, in that there was no sharp relief and it was well covered with benthic communities.

GSC-2303. Byam Channel (II) — 630 ± 90; $\delta^{13}C$ = +0.8 ‰

Complete pelecypod specimen (sample BCS7 R1; 6.8 g; **Astarte borealis**; identified by W. Blake, Jr.) taken from 18 cm below the top of a core collected in the bottom of an old ice scour track.

GSC-2336. Byam Channel (III) — 1040 ± 80; $\delta^{13}C$ = +1.0 ‰

Complete pelecypod specimen (sample BCS6 R1; 6.05 g; **Astarte borealis**; identified by W. Blake, Jr.) taken from 13 cm below the top of a core collected in the bottom of an old ice scour track.

Comment (P. McLaren): These samples were collected from the same ice scour track. Since **Astarte borealis** is not a burrower and lives in the first few millimetres of sediment (Stanley, 1970), it is likely that the random depths of these shells are the result of sediment disturbance and burial by ice scouring.

Comment (W. Blake, Jr.): GSC-2303 and -2336 were still articulated, and GSC-2288 presumably was articulated at the time of collection. The periostracum was intact, as was the internal lustre on these aragonitic shells. Because of the small sample size the HCl leach was omitted throughout, and each sample was mixed with dead gas for counting.

GSC-2303, -2288, and -2336 are based, respectively, on one 2-day count, one 3-day count, and one 4-day count in the 2 L counter.

Byam Channel, Second Series

Pelecypods collected in cores, by SCUBA diving, in Byam Martin Channel at sites near those listed in Byam Channel, first series.

GSC-2358. Byam Channel (IV) 600 ± 110
$\delta^{13}C = +0.8$ ‰

Complete pelecypod specimen (sample BCS11 R1; 5.75 g; **Astarte borealis**; identified by W. Blake, Jr.) taken from the top 4 cm of a core collected in Byam Channel, 1 km east of Rea Point on the east coast of Melville Island, Northwest Territories (75°22.5'N, 105°35'W), in 11 m of water. The core was collected in freshly made ice scour lateral embankment within 5 m of the grounded ice block that had churned up the sediment. Collected 1975 by P. McLaren.

Comment (W. Blake, Jr.): This intact pair measured 3.4 cm in length, 2.8 cm in height. The periostracum was intact on the aragonitic shells. 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.

GSC-2095. Byam Channel (V) 1760 ± 200

Single pelecypod valve (sample DH-9S5; 2.6 g; probably **Mya truncata**; identified by W. Blake, Jr.) taken from 15 cm below the top of a core collected in Byam Channel near the east coast of Melville Island, Northwest Territories (75°58'N, 106°31'W), in 20 m of water. The core was collected 1974 in an undisturbed sandy mud bottom by P. McLaren.

Comment (P. McLaren): These samples are two of five from cores collected in the nearshore environment of Byam Channel (cf. GSC-2288, GSC-2303, and GSC-2336; this list). The dates are reported in McLaren (1977) and are used as a supplementary indication that the sediment in these environments is being reworked constantly by grounding ice and that little or no present day deposition is taking place.

Comment (W. Blake, Jr.): The assorted shell fragments all fitted together and were part of a left valve that measured >2.3 cm in length and >3.4 cm in height. The shell size and the form of the anterior adductor muscle scar suggest that **Mya truncata** was the species. The shell was chalky but had bits of rusty periostracum adhering to the shell margin. The shell interior retained its lustre. 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.

GSC-2097. Offshore, Nelson Griffiths Point 0 ± 70

Wood (sample DHS2; 6.1 g; **Picea** sp.; identified by L.D. Farley-Gill) collected in Byam Channel near the east coast of Melville Island at Nelson Griffiths Point (75°03'N, 105°57'W), in 11 m of water. The sample was lying on the sea bottom, not imbedded in sediment. Collected 1974 by D. Frobel; submitted by P. McLaren.

Comment (W. Blake, Jr.): Although a number of 'modern' wood samples have been collected close to high tide level on storm beaches in the Canadian Arctic Archipelago (Blake, 1975a), and one has been found on sea ice (cf. Lowdon and Blake, 1978), this is the first piece collected on the sea bottom. The 53 cm long sample was saturated with sea water on receipt by the laboratory. During drying in an electric oven its weight decreased from 131.4 to 42.0 g. Date based on one 1-day count in the 2 L counter.

GSC-2089. Nelson Griffiths Point 5400 ± 410

Organic tundra debris (sample DSD-4; 2.7 g) from a river cut through an uplifted delta at Nelson Griffiths Point on the east coast of Melville Island, Northwest Territories (75°04'N, 106°06'W), at an elevation of 14.6 m above mean high tide. Sample taken ca. 20 cm below the surface of a delta plain from steeply dipping foreset sands. Collected 1973 by D.L. Shearer, then at the University of South Carolina, Columbia, South Carolina; now City Service Oil Company, Oklahoma City, Oklahoma; submitted by P. McLaren.

Comment (P. McLaren): Only discrete twigs, some with bark still attached, were used for dating. The sample is reported in Shearer (1974) and McLaren (1977), and is used as part of a series to establish an emergence curve for the east coast of Melville Island (McLaren and Barnett, 1978).

Comment (W. Blake, Jr.): The sample was classified by M. Kuc (unpublished GSC Bryological Report No. 294) as organic tundra debris in sand – a bioproduct of dry dwarf-shrub tundra. Vascular plant species included: **Salix** sp. cf. **arctica, Papaver** sp., **Dryas intergrifolia,** and unidentified fragments, including seeds. The main mosses present were: **Ditrichum flexicaule** and **Hylocomium splendens;** also **Rhacomitrium lanuginosum, Drepanocladus uncinatus,** and **Hypnum** sp. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Consett Head River Series

Wood in organic detritus from a river cut through an uplifted delta at Consett Head on the eastern coast of Melville Island, Northwest Territories (75°20'N, 106°16'W).

GSC-2092. Consett Head River (I) 5940 ± 150

Wood (sample CH Bed 14; 7.1 g; **Salix** sp.; identified by M. Kuc) from an elevation of ca. 13 m. Collected 1974 by J. Boothroyd, then at the University of South Carolina Columbia, South Carolina; submitted by P. McLaren.

Comment (P. McLaren): This sample is reported in McLaren (1977) and is used as part of a series to establish an emergence curve for the east coast of Melville Island (McLaren and Barnett, 1978).

Comment (W. Blake, Jr.): Together with GSC-2114 (6630 ± 100 years; this series), this sample provides information on the rate of sedimentation. The dated sample was composed of 13 twigs (up to 23 cm in length), all with at least part of the bark still attached; rootlets and winter buds were also present. The well preserved nature of all fragments suggests only limited transport. Date based on two 1-day counts in the 2 L counter.

GSC-2114. Consett Head River (II) 6630 ± 100

Wood (sample CHS1B; 4.3 g; mostly **Salix** sp.; identified by M. Kuc) from at an elevation of ca. 6 m. Collected 1974 by P. McLaren.

Comment (P. McLaren): This sample was collected at the same section and 7 m below GSC-2092 (5940 ± 150 years; this series). It is reported in McLaren (1977), and the two dates provide an estimate of the rate of delta progradation: approximately 2.95 cm/year. The plants represented in the sample indicate that they were derived during alluvial-deltaic accumulation in a seasonally wet environment (M. Kuc, unpublished GSC Bryological Report No. 311). The date has been used as part of a series to establish an emergence curve for the east coast of Melville Island (McLaren and Barnett, 1978).

Comment (W. Blake, Jr.): M. Kuc reported leaves and stems of **Dryas integrifolia** and **Salix** sp., as well as at least 25 species of mosses, of which the most common are: **Rhacomitrium lanuginosum, Polytrichum juniperinum, Timmia austriaca,** and **Ditrichum flexicaule** (xeric); **Hylocomium splendens** (xero-mesic); **Aulacomnium turgidum, Oncophorus virens** (meso-hydric); **Orthothecium chryseum** and **Tomenthypnum nitens** var. **involutum** (hydric: hydro-mesic). Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-1652. Sherard River 4880 ± 140

Part of a driftwood log (sample BDA-71-W5; 24 g; **Picea** sp.; identified by R.J. Mott) from 3 km south-southwest of the Sherard Bay airstrip buildings, on the north bank of Sherard River, Melville Island, Northwest Territories (76°03'N, 108°28'W), at an elevation of 16 m. The log was about 80 per cent buried in a raised beach parallel to the shore. Collected 1971 by D.M. Barnett, then Geological Survey of Canada, now Department of Indian and Northern Affairs, Ottawa.

Comment (D.M. Barnett): The date gives the approximate age of the 16 m shoreline and provides an important point on the emergence curve for the east coast of Melville Island (McLaren and Barnett, 1978). Other dates on driftwood, postglacial and "old", are reported in Barnett (1973) and in GSC XIII (1973, p. 44-45).

Comment (W. Blake, Jr.): This sample contained many rootlets, but the dated sample was taken from the more solid portion of the log; the sample received by the laboratory was 30 cm long and 10 to 11 cm in diameter. After removal of the outermost wood, a slice comprising about 10 annual rings was used for dating. Date based on two 1-day counts in the 5 L counter.

United States of America

Maine

Unknown Pond Series

Unknown Pond (sample MS-69-1) is a small lake in a steep-walled bedrock basin. The lake occupies a gorge that served as a spillway for a glacial lake. This lake formed between the drainage divide and the ice front when the latter retreated to the northwest of the divide. It is located 0.7 km southeast of the Quebec-Maine border (45°36.5'N, 70°38'W), at an elevation of 489 m. Cores were collected with a Livingstone sampler in 2 m of water; 608 cm of gyttja with abundant coarse plant fragments (sedge remains) overlies 85 cm of silty gyttja with abundant pebbles at intervals 608 to 617 cm and 678 to 683 cm. This silty gyttja overlies calcareous marly gyttja to a depth of 701 cm; moss layers are present at 693 to 695 cm and 697 to 698 cm. Below 701 cm is noncalcareous dark grey clay. Collected 1969 by R.J. Mott and W.W. Shilts.

GSC-1929. Unknown Pond, 117.5-122.5 cm 2810 ± 180 $\delta^{13}C = -23.0‰$

Gyttja (36 g wet) from 117.5 to 122.5 cm below the sediment/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-1907. Unknown Pond, 512-518 cm 4970 ± 140 $\delta^{13}C = -26.0‰$

Gyttja (58 g wet) from 512 to 518 cm below the sediment/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-1404. Unknown Pond, 685-688 cm 12 600 ± 280 $\delta^{13}C = -31.2‰$

Silty algal gyttja (54 g wet) from 685 to 688 cm below the sediment/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on two 1-day counts in the 5 L counter.

GSC-1339. Unknown Pond, 695-700 cm 14 800 ± 220 $\delta^{13}C = -33.4‰$

Basal silty gyttja (13.6 g burned) from 695 to 700 cm below the sediment/water interface. No NaOH treatment because of small sample size. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Comment (R.J. Mott): The radiocarbon dates for this core appear to be anomalous when compared with those obtained from the neighbouring Boundary Pond site (this list; cf. also Gadd et al., 1972). Dates GSC-1339 and GSC-1404, from near the base of the core, appear to be in error by the greatest amount. Marl present in the lower sediments suggests contamination by older carbonates. The upper samples may have been contaminated to a lesser degree, but the dates are also spurious. Comparison with other pollen profiles and radiocarbon dates is made in Mott (1977).

Boundary Pond Series

A small lake (sample MS-69-10) in a bedrock basin, Boundary Pond is located in a spillway across the drainage divide about 18 km east of Lac Mégantic, Quebec and 0.8 km inside the Maine border (45°34'N, 70°40.5'W), at an elevation of 603 m. Cores were taken with a Livingstone sampler in 6 m of water; 392 cm of coarse detritus gyttja and silty gyttja overlies stiff grey clay. Collected 1969 by R.J. Mott and W.W. Shilts.

GSC-1954. Boundary Pond, 82.5-88.5 cm 1390 ± 80 $\delta^{13}C = -26.8‰$

Coarse detritus gyttja (70 g wet) from 82.5 to 88.5 cm below the sediment/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. Uncorrected age 1420 ± 80 years.

GSC-1934. Boundary Pond, 167.5-172.5 cm 3080 ± 120

Gyttja (44 g wet) from 167.5 to 172.5 cm below the sediment/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-1895. Boundary Pond, 257.5-262.5 cm 5720 ± 130 $\delta^{13}C = -25.5‰$

Gyttja (46 g wet)257.5 to 262.5 cm below the sediment/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 coutner. Uncorrected age 5730 ± 130 years.

GSC-1932. Boundary Pond, 341-344 cm 7750 ± 150 $\delta^{13}C = -25.0‰$

Gyttja (57 g wet) from 341 to 344 cm below the sediment/water interface. NaOH leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on three 1-day counts in the 2 L counter. Uncorrected age, same as above.

GSC-1248. Boundary Pond, 387-392 cm — 11 200 ± 200

Basal gyttja (118 g wet) from 387 to 392 cm below the sediment/water interface. NaOH omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

Comment (R.J. Mott): GSC-1248 dates the transition from a spruce **(Picea)** – herb and shrub pollen zone to a birch pollen dominated zone occurring at the base of the organic sediment. The white pine **(Pinus strobus)** pollen maximum and the rise in hemlock **(Tsuga canadensis)** pollen are dated by GSC-1932. The end of the lower hemlock pollen zone is dated by GSC-1895; the end of the second hemlock pollen zone is dated by GSC-1934; and the increase in spruce pollen is dated by GSC-1954. Palynological details are outlined in Mott (1977), and a general outline of the pattern and chronology of deglaciation has been provided in Gadd et al. (1972).

New York

GSC-2338. Peru — 11 900 ± 120
$\delta^{13}C = -0.6$ ‰

Pelecypod shells (sample 18; 26.1 g; **Macoma balthica**; identified by T.M. Cronin) from pebbly sand in a gravel pit 1.9 km north of Lapham Mills and 3.2 km southeast of Schuyler Falls, New York (44°36'45"N, 72°31'10"W), at an elevation of 101 m. Some shells were dug from fresh exposures, others had washed out of the sediment onto the floor of the pit. Collected 1975 by T.M. Cronin, then Harvard University, Cambridge, Massachusetts; now U.S. Geological Survey, Reston, Virginia.

Comment (T.M. Cronin): This radiocarbon date appears to be the oldest age obtained for Champlain Sea material from the United States, and the **Macoma balthica** shells were collected from one of the highest elevations at which fossiliferous Champlain Sea deposits have been discovered in Champlain Valley. This sample is closer to the inferred marine limit than any other in the region. Together with dates GSC-2366 (11 800 ± 150 years; this list) and QC-200 (11 665 ± 175 years; Cronin, 1977), it dates the earliest phase of the marine inundation. GSC-2338 indicates that marine water entered Champlain Valley at least as early as 11 900 ± 120 radiocarbon years ago. Cronin (1977) discussed late Wisconsin paleoenvironments of Champlain Valley and proposed the term "Transitional Phase" for the earliest phase of the Champlain Sea in this region. The mixed brackish and freshwater microfaunal and macrofaunal assemblages associated with Transitional Phase deposits are interpreted as indicating a lacustrine-marine transition – that is, a mixing of postglacial Lake Vermont freshwater with the earliest influx of marine waters from St. Lawrence Valley. The fauna inhabiting the Champlain Sea indicate that frigid climatic conditions were characteristic about 11 900 years ago; GSC-2338 provides further documentation of the age of this phase of the Champlain Sea.

Comment (W. Blake, Jr.): The submitter noted the general good condition of the shells, but suggested that some post-mortem transport had taken place as many shells were abraded. Nearly the entire sample was composed of intact valves, although they were thin and fragile. The exteriors were somewhat chalky, but the internal lustre was preserved in many of the aragonitic shells. Date based on two 1-day counts in the 2 L counter.

GSC-2366. Plattsburg — 11 800 ± 150
$\delta^{13}C = -0.2$ ‰

Pelecypod shells (sample 10; 18.5 g; **Macoma balthica**; identified by T.M. Cronin) from a freshly exposed bank of silty sand in a small borrow pit, within 1.5 m of the ground surface. The site is on a south bend of Kennon Brook, on the north side of Wallace Hill Road, 4.3 km northwest of Plattsburg, New York (44°43'20"N, 73°30'35"W), at an elevation of 96 m. Collected 1975 by T.M. Cronin.

Comment (T.M. Cronin): This date accompanies GSC-2338 (11 900 ± 120 years; this list) and similarly dates the early phase (Transitional Phase of Cronin, 1977) of Champlain Sea in Champlain Valley. The shell sample was collected from deposits about 5 m lower in elevation than GSC-2338. The associated faunal assemblage indicates frigid climatic conditions and probably brackish water with fluctuating salinities ca. 11 800 ± 150 years ago.

Comment (W. Blake, Jr.): The submitter noted the general good condition of the the shells comprising this sample; valves were unbroken for the most part, and articulated valves were present. Transport after death was probably minimal. Many of these aragonitic valves still retained the periostracum, and internal lustre was common. The reader is referred to Cronin (1977) for a discussion of another date near Plattsburg, QC-200 (11 665 ± 175 years), as well as to a pair of dates from Champlain Sea sediment (a blue-grey silt and clay unit, 4 cm below the surface) in Vermont: W-2309 (10 950 ± 300 years, wood) and W-2311 (11 420 ± 350 years, pelecypod shells; cf. Wagner, 1972; Spiker et al., 1978). GSC-2366 mixed with dead gas for counting. Date based on two 1-day counts in the 2 L counter.

Wisconsin

GSC-2166. Two Creeks forest bed — 11 810 ± 100
$\delta^{13}C = -25.0$ ‰

Wood (sample Two Creeks – 21.10.72; 11.0 g; **Picea** sp., identified by L.D. Farley-Gill) from an exposure along the western shore of Lake Michigan approximately at the junction of Kewaunee and Manitowoc counties, Wisconsin (between sec. 35, tp. 22N, rge. 24E and sec. 2, tp. 21N, rge. 24E; approximately 44°17'N, 87°34'W), at an elevation of 185.5 m and 9.2 m above lake level. The sample came from the top of a 2 m thick lacustrine sand unit overlying the Two Creeks forest bed and beneath the reddish Two Rivers till. Collected dry and submitted 1972 by A.V. Morgan, University of Waterloo, Waterloo.

Comment (W. Blake, Jr.): This age determination was carried out as an inter-laboratory check with the newly established laboratory at the University of Waterloo. An estimated 85 ± 5 rings were present in the sample submitted; a slice of approximately 50 rings was used for dating; the collector had removed the outer layers prior to submission to the laboratory. The value obtained by Waterloo was 11 860 ± 110 years (Wat-57; Morgan and Morgan, 1979), and the age of the Two Creeks forest bed as determined by Broecker and Farrand (1963) was 11 850 ± 100 years. Date GSC-2166 based on one 4-day count in the 5 L counter.

Alaska

Lost Chicken Gold Mine Series

Samples from a placer mine (64°3.2'N, 141°52.6'W) located at Mile 69 on the Taylor Highway and 43.5 km west of the Alaska-Yukon border; the elevation of the ground surface at the mine is ca. 500 m.

GSC-2130. Lost Chicken Gold Mine (lower cut) — 6410 ± 120

Organic detritus (sample NMC-25892-A; 5.6 g; plant and insect fragments) from organic silt filling the cranium of a **Symbos cavifrons** skull (NMC-25892). The organic constituents were separated by wet sieving; the sample is the >0.45 mm fraction. Collected 1974 by C.R. Harington, National Museum of Natural Sciences, Ottawa; submitted by J.V. Matthews, Jr.

Comment (J.V. Matthews, Jr.): The skull, dated at 20 500 ± 390 years (I-10649) (Harington, in press) was not found in place, but it was hoped that the cranial contents might indicate the approximate age of the fossil. GSC-2130, analyzed first, suggested that the cranial contents were contaminated by modern organic material, and subsequent examination of macrofossils isolated from the sample submitted for dating revealed the presence of some seeds that probably entered the cranium after it was exposed by mining activity (unpublished GSC Plant Macrofossil Report No. 79-1 by J.V. Matthews, Jr.). The radiocarbon age of bone from the skull proves that GSC-2130 is spurious; this date has no significance except as a caution to future attempts at dating cranial contents of mammalian fossils. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2118. Lost Chicken Gold Mine (upper cut) 53 000 ± 1800

Wood (sample MRA 8-17-74-6; 44 g; **Picea** sp.; identified by L.D. Farley-Gill) from an upright stump, buried by 30 cm of peat and located approximately 15 m below the top of the section. Collected 1974 by J.V. Matthews, Jr.

Comment (J.V. Matthews, Jr.): An uninterrupted horizon of volcanic ash, designated as the Lost Chicken Tephra, occurs a few centimetres above the peat and dated stump. Fission-track analyses of a sample of the Lost Chicken Tephra (UA-771) from the horizon at the stump site shows it to be 1.70 ± 0.15 million years old (Briggs and Westgate, 1978); therefore, even though stated as finite, the radiocarbon date is obviously a minimum estimate. A pollen sample from a peat presumed to be identical at another part of the exposure contains significant quantities of pine, which does not grow in the area today. Originally this information was used to infer an interglacial age for the peat (Matthews, 1970, sample "Lost Chicken-1"); but if such, it would have been an early Pleistocene interglacial. The tephra date suggests that the peat and associated wood are possibly Late Pliocene. Date based on three 1-day counts and one 3-day count in the 5 L counter at 4 atm.

ARCHEOLOGICAL SAMPLES

Northern Canada, Mainland and Offshore Islands

Yukon Territory

Bluefish Cave Series

Charcoal and bone from Bluefish Cave I (MgVo-1), approximately 54 km southwest of the village of Old Crow, northern Yukon Territory (67°03'N, 140°48'W), at an elevation of ca. 600 m. The site is situated at the base of a high ridge (limestone-dolomite) overlooking, from the east, the right bank of the mid-upper course of Bluefish River.

GSC-2844. Bluefish Cave I, charcoal 2420 ± 80

Charcoal (sample C-14-N.Y.R.P. 1979-1; 3.5 g) obtained from an isolated lens found in two adjacent, arbitrary levels corresponding to part of an upper stratigraphic unit (III) of Cave I deposit. Collected 1978 by J. Cinq-Mars, then Northern Yukon Research Programme, University of Toronto, Toronto; now Archaeological Survey of Canada, National Museum of Man, Ottawa.

Comment (J. Cinq-Mars): Because of its apparent association with slightly charred bone fragments, thermally altered limestone-dolomite clasts, and a chert artifact, the charcoal lens initially was seen in the field as a possible hearth feature. Further work at the site in 1979 has yielded information indicating that the charcoal concentration may well be part of a cryoturbated, burnt root system, itself part of what appears to be an extensive local or even regional forest fire horizon. The date can be seen as providing an age for the latter without forcing us to reject our estimate of ca. 10 000 years (based on palynological evidence – **Picea** rise) for a portion of the charcoal-bearing Unit III (Cinq-Mars, 1979).

Comment (W. Blake, Jr.): The original 5.64 g sample contained many rootlets and much inorganic material. Several pieces of bone were extracted also. This "charcoal" sample also contains charred wood and may well include some charred bone. Sample mixed with dead gas for counting. Date based on one 3-day count in the 2 L counter.

GSC-2881. Bluefish Cave I, horse bone 12 900 ± 100 $\delta^{13}C = -23.1$ ‰

Fragments (526.9 g) of a single **Equus** sp. femur (identified by B.F. Beebe, Northern Yukon Research Programme, University of Toronto, Toronto) obtained from a bone concentration located in a loess-rich, lower stratigraphic unit (VII) of a cave deposit; this unit, as well as others, contained traces of cultural activity in the form of lithic (chert) artifacts. Collected 1978 by R. LeBlanc, NYRP, University of Toronto, submitted 1979 by J. Cinq-Mars.

Comment (J. Cinq-Mars): Preliminary palynological analysis indicates that most of the observed depositional sequence is Late Pleistocene, post-Late Wisconsin maximum in age; this is confirmed by paleontological and sedimentological data. Pollen from the lower unit (VII) suggests that this horizon may be representative of a herb-rich zone immediately preceding a **Betula** rise which, in this portion of eastern Beringia, is thought to have occurred around 14 000 years B.P. This determination confirms our estimate of Late Pleistocene age, provides us with the youngest date on horse (likely to be **Equus lambei**) obtained so far from eastern Beringia, and can be taken to suggest that the demise of the herb-rich tundra may have occurred later in some of the upland environments. It further serves to date more precisely an increasingly complex faunal accumulation that incorporates a wide range of species, including a proboscidian, and that appears to be, in part, culturally induced (Cinq-Mars, 1979).

Comment (W. Blake, Jr.): The bone fragments making up this sample were well preserved, with no rootlets. The fragments were sawed into smaller pieces on a band saw. The collagen fraction was recovered by treating the crushed bone with 3N HCl and 0.1N NaOH, plus distilled water rinses; 50.0 g was burned, giving 100 cm of CO_2. Date based on one 3-day count in the 5 L counter.

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