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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES IV

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INTRODUCTION

Most of the determinations reported here were obtained with the 2 L counter described in our first date list (GSC I). All age calculations are based on a C^{14} half-life of 5568 $\pm$ 30 yr and 0.95 of the activity of the NBS oxalic-acid standard, and the ages are quoted in years before 1950. The age errors include: counting errors of sample, background, and standard, the error in the half-life of C^{14}, and an error term to account for the average variation of $\pm 1.5\%$ in the C^{14} concentration during the past 1100 yr. 'Greater than' ages are based on the 4 σ criterion (GSC II).

After extensive testing and modification a 5 L counter was brought into routine operation in April, 1964. Its more important counting characteristics are given in Table 1. The background increases somewhat with an increase in pressure, but the C^{14} and meson plateaus improve. The apparent non-linearity in the counting rate of the standard is probably due to the arbitrary choice of the operating point on the plateau.

The counter was constructed from a 5⅛ in. O.D., ⅛ in. wall copper tube having an overall length of 20 in. Approx. 30 mils were removed from the inner surface of the tube, by machining on a lathe, to provide a contamination-free surface. After rinsing the tube with distilled water and acetone, the ⅝ in.-thick copper end plates were welded in place. The insulators are of the quartz-sleeve type, but only the front insulator protrudes through the end plate. The back-end insulator was retained and centered by a hollow copper bolt and was introduced into the counter through the front end insulator opening with a specially constructed wrench. Initially teflon insulators were used; however, it was observed that the counting gas was readily poisoned by an electronegative impurity given off by the teflon. The anode guides consist of ⅛ in. copper tubing and the anode of 2 mil stainless steel. It was fastened at the back with a steel and lead slug and was soft soldered in front. The counter was placed inside the same shield as the 2 L counter and connected to an all metal vacuum line designed to operate at up to 5 atm.

The pressure was measured with a Bourdon tube gauge with a 12 in. dial (Heise Bourdon Tube Co., Inc., Brook Road, Newton, Connecticut, U.S.A.). The gaseous samples were stored in 300 cc stainless steel cylinders (Hoke #6 HS 300 with Hoke #256A valve). Sharp Low-Beta transistorized electronics were used to record the counts. Routinely this counter was operated at a pressure of 1 atm, where its dating range was found to be approx. 40,000 yr, using the 4 σ criterion. However, at 4 atm its age range increased to about 54,000 yr using the 4 σ criterion.

* The introductory part of this paper has been prepared by the first author, who operates the laboratory. The date list has been compiled by the second and third authors from descriptions of samples and interpretations of dates by the various collectors.

TABLE 1

5 L Counter Characteristics

Volume (Litres) *	Oper. Press. (atm)	Oper. Volt. (K.V.)	Background, B (c/m)	Standard, No (c/m)	Figure of Merit**	Meson c/m	Plateau Slopes*** Meson	Plateau Slopes*** C^{14}
5.68	1.0	4.55	2.30±.03	28.4±.1	15.7	269	1.2	3.6
(4.93)	2.0	6.30	2.53±.04	56.8±.5	28.0	271	0.6	1.4
	4.0	8.90	3.10±.05	111.0±.4	49.5	268	0.4	1.0

* The value in brackets is the sensitive volume of the counter, i.e. the volume between the anode sleeves.

** The figure of merit is calculated from the expression, Figure of merit $= C \times V \times No/\sqrt{B}$

where, C = counting efficiency = 90% (estimated)

$$V = \text{volume efficiency} = \frac{\text{sensitive volume} \times 100}{\text{total volume}} = 87\%$$

No = 0.95 × net counting rate of the NBS oxalic-acid standard

B = background counting rate.

*** The plateau slopes are expressed in % per 100 volts and were measured over a 500-volt interval.

Meson = total rate − (sample + background rate)

C^{14} = oxalic-acid standard + background

In Table 2 a series of samples measured in the 5 L counter operating at a pressure of 4 atm of CO_2 are compared with earlier results. The third column was added in order to show the sensitivity of the counter in a more conventional way.

The only change in routine sample-preparation and purification techniques from those previously described (GSC I, GSC II, GSC III) was the addition of a third water-removal trap, an ordinary cooling trap filled with copper-oxide wire, maintained at dry ice temperature during the passage of CO_2. It was effective in removing trace quantities of water, and thus simplified the purification of large samples (25 to 30 L of gas). Previously such samples required 6 to 8 passes through hot regenerated copper before an acceptable degree of purity was achieved; after installation 2 passes were sufficient. Further purification of the gas was achieved by precooling the sample storage cylinder in liquid nitrogen for about 35 sec just prior to filling the counter, indicating the presence of some easily condensable impurity in the sample. A slight increase in the concentration of some electronegative impurity in the sample was observed after storage of the sample in the steel cylinder for a week or so. The fact that passage over hot copper removed this impurity suggests the presence of oxygen and/or water.

Tests for C^{14} contamination of shell samples (cf. GSC II, GSC III) were continued during the past year, as shown in Part A of Table 3. It is evident that even a 20% pre-leach does not remove all C^{14} contamination. Column 4 lists the fractional counting rates expressed in per cent with respect to the corrected oxalic acid standard. The counting error of the standard is not included in the error of the fractions. Since the age error includes a ±120 yr term due to the ±1.5% variation of the zero age C^{14} concentration during the past 1100 yr, the figures in column 4 permit a more realistic comparison of the pairs.

TABLE 2

5 L Counter Ages*
(operating pressure 4 atm)

5 L Counter dates			Earlier dates		
Sample No.	Age (yr B.P.)	Net counting rate (% of standard)	Sample No.	Age (yr B.P.)	Reference
GSC-93	36,200 ± 500	1.11 ± 0.05	GSC-93	33,200 $\pm \frac{2300}{1800}$	GSC II
GSC-202	35,400 ± 400	1.22 ± 0.05	GSC-202	36,500 $\pm \frac{2400}{1900}$	(2 L counter)
			L-455B	35,400 ± 2200	Lamont VII
GSC-203	>49,700	0.09 ± 0.03		None	
GSC-217	47,700 ± 1200	0.26 ± 0.04	Gro-2597 and Gro-2601	47,500 ± 250	de Vries and Dreimanis, 1960
			Gro-2619	44,900 ± 1000	
GSC-237	>54,500	0.00 ± 0.03	L-221C	>26,000	Lamont III

* Detailed descriptions of all samples appear in this date list except for GSC-93 (GSC II) and GSC-202 (reported in Lamont VII as L-455B).

To gain information regarding humic contamination of peats in permafrost regions (cf. Olson and Broecker, 1958; Olsson and Kilicci, 1964; Blake, Olsson, and Środoń, 1965), a series of peat samples was dated in two fractions as listed in Part B of Table 3. The peats were separated into two fractions by leaching the sample with 2% NaOH after a preliminary acid leach. The soluble portion (generally 1/3 to 1/2) was separated from the solid residue by filtration using zeolite as a filter aid. Both fractions were then acidified, mixed with equal amounts of zeolite (approx. 25 g), filtered, and washed with water. With the exception of GSC-259, the base soluble portion of each of these samples has a slightly lower C^{14} activity than the insoluble fraction. However, all the differences were well within experimental errors. Thus, for the peats tested, the fraction removed by our standard base leach does not differ appreciably in age from the undissolved residue.

Dates comparing freshwater shells and marl with associated plant material make up Part C of Table 3. In addition to contamination, disagreement between fractions could also be due to isotopic effects and/or variation in the C^{14} concentration of the medium in which the dated material grew. The close agreement between GSC-215 (shells) and GSC-216 (wood) is of particular interest because the mollusk (*Crenodonta costata*) is a river-dwelling rather than a lacustrine species (cf. results of Keith and Anderson, 1963). Part of the discrepancy between the peat and marl-shell fractions of GSC-272 may be attributable to the concentration of plant material in the upper (younger) part of the sample and of shells and marl in the lower part.

The mold-free and moldy fractions of wood sample GSC-216 were pretreated in the normal way: base leach, acid leach, and two water leaches. The close agreement between the two dates supports the view that growth of modern

TABLE 3

Tests for C^{14} contamination*

Sample No.	Fraction	Age (yr B.P.)	Net counting rate (% of standard)
A. MARINE SHELLS			
GSC-207	0-20 %	$37{,}100\ ^{+1500}_{-1300}$	1.00 ± 0.17
	21-100	>37,400	0.28 ± 0.17
	21-100	>40,500	0.25 ± 0.10
GSC-212	21-53	$33{,}100\ ^{+1300}_{-1100}$	1.63 ± 0.24
	54-100	$35{,}900\ ^{+1400}_{-1200}$	1.14 ± 0.18
GSC-227	18-54	11,080 ± 160	25.13 ± 0.24
	55-100	11,300 ± 190	24.47 ± 0.38
GSC-243	20-100	8450 ± 140	34.88 ± 0.27
GSC-254	41-100 (Av.) see date list	8710 ± 140	33.80 ± 0.23
B. PEAT FROM PERMAFROST REGIONS			
GSC-121	no NaOH leach	10,740 ± 180	26.24 ± 0.30
	standard leach	10,800 ± 160	26.05 ± 0.25
GSC-233	less soluble†	7680 ± 140	38.41 ± 0.31
	more "	7820 ± 140	37.72 ± 0.24
GSC-240	less soluble	10,550 ± 160	26.87 ± 0.27
	more "	10,640 ± 150	26.58 ± 0.22
GSC-253	less soluble	6230 ± 150	46.00 ± 0.47
	more "	6510 ± 150	44.40 ± 0.45
GSC-259	less soluble	>38,800	0.27 ± 0.13
	more "	>36,400	0.35 ± 0.18
GSC-268	less soluble	>36,000	0.40 ± 0.18
	more "	>41,200	0.00 ± 0.15
C. FRESHWATER SHELLS, MARL			
GSC-272	peat	6920 ± 140	42.22 ± 0.34
	shells, marl	7600 ± 160	38.80 ± 0.41
GSC-215	shells	3650 ± 140	63.48 ± 0.38
GSC-216	wood (mold free)	3660 ± 130	63.35 ± 0.26
	wood (moldy)	3610 ± 130	63.73 ± 0.32

* Detailed descriptions of all samples appear in this date list except for GSC-121 (GSC III) and GSC-233, 253, and 259, deferred to a later list.

† Degree of solubility refers to solubility in 2% NaOH.

mold on ancient wood does not materially change the C^{14} age of the wood as determined by standard procedures.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Eastern Canada

GSC-176. Rivière-du-Loup bog, Quebec — **9520 ± 170 / 7570 B.C.**

Peat and gyttja from base of bog 3 mi SE of Rivière-du-Loup, Quebec (47° 48′ N Lat, 69° 28′ W Long), alt 350 ft. Sample coll. with piston sampler at 23 ft depth below bog surface. Organic sediments overlie stiff silty clay (till?). Coll. 1963 by J. Terasmae.* *Comment* (J.T.): bog is close to or above the marine limit and lies inside (N of) the St. Antonin moraine, which antedates marine invasion of the St. Lawrence Lowland. Since marine shells at alt 330 ft from near Rivière-du-Loup, also inside the moraine, are 10,340 ± 130 yr old (GSC-61, GSC-II), it appears that bog development did not begin until several hundred years after the ice retreated from the St. Antonin moraine. Pollen record in this bog extends somewhat beyond dated level. NaOH-leach omitted from sample pretreatment.

GSC-187. Kingsey Falls, Quebec — **11,410 ± 150 / 9460 B.C.**

Marine pelecypod shells (chiefly *Macoma calcarea*, *Mya truncata*, and *Hiatella arctica*) from stratified blue-gray silty fine sand and clay in road cut below surface of marine-clay plain near S side of Francoeur Brook, 1 mi S of Kingsey Falls, Quebec, (45° 50′ N Lat. 72° 05′ W Long). Surface of clay plain at section is at alt ca. 425 ft. Coll. 1963 by N. R. Gadd. *Comment* (N.R.G.): shells are from sediments of Champlain Sea where crest of the 'highland front' moraine (alt 475 ft) is unmodified by wave action (Gadd, 1964). This moraine is considered to represent last major stand of Laurentide ice before recession that allowed invasion of the Lowland by Champlain Sea. Date is minimum for Champlain Sea and for 'highland front' moraine at this point. Similarity of this age, which refers to a position of the strand at between 425 and 475 ft alt, to shells at higher levels in the vicinity of Montreal (e.g. Y-233, Yale II, 11,370 ± 360, 545 ft) indicates virtual contemporaneity of phenomena and suggests differential uplift over the 80 mi between Kingsey Falls and Montreal that is not recorded by published isobases related to Champlain Sea. Date based on one 4-day count.

GSC-248. St. Benjamin bog, Quebec — **9130 ± 150 / 7180 B.C.**

Gyttja from base of bog, alt ca. 1545 ft, 3 mi N of St. Benjamin, Quebec (46° 19′ N Lat, 70° 37′ W Long). Sample collected with 2-in. piston sampler at depth 430 to 435 cm where gyttja is underlain by sequence of 15 cm of marl, 100 cm of silty clay, and stiff silty, clayey till. Coll. 1964 by J. Terasmae. *Comment* (J.T. and N.R. Gadd): because of location 25 mi SE of the margin of Champlain Sea, it was anticipated that bog would provide material of an age greater than maximum dates for Champlain Sea and also a minimum date for

* 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.

morainic features, considered to be older than Champlain Sea, that occur in the vicinity of the bog. Date is much younger than expected; it serves mainly to provide reference point for pollen sequence in the bog. Pollen studies of sediments beneath the dated level indicate that the pollen record may extend somewhat beyond 10,000 yr B.P. Preliminary acid leach added to sample pretreatment.

GSC-177. Chalk River, Ontario **9540 ± 250**
7590 B.C.

Gyttja and peat from base of bog in river channel cut into Petawawa Sand Plain, assumed to be contemporaneous with highest stage of Champlain Sea. Sample, from near Chalk River, Ontario (46° 03′ N Lat, 77° 22′ W Long), coll. in 2-in. Shelby tube at 25 ft depth, where gyttja overlies sand at alt ca. 500 ft. Site is ca. 100 ft above Ottawa River. Coll. 1962 by P. J. Parsons; subm. by J. Terasmae. *Comment*: date is consistent with GSC-90: 10,780 ± 130 (GSC II) on marine shells from Champlain Sea deposits near Pembroke, ca. 20 mi SE. Sample mixed with dead gas for counting; NaOH-leach omitted.

GSC-203. Woodbridge, Ontario **>49,700**

Peat and wood from near base of silt below four lithologically distinct till sheets, and above a fifth till sheet, in a recent railway cut W of Humber River, Woodbridge, York Co., Ontario (43° 45′ 50″ N Lat, 79° 35′ 30″ W Long). Lowest of overlapping tills believed to be Early Wisconsinan Sunnybrook Till, but correlation of younger tills uncertain. Till under peaty silt considered to be York Till (Illinoian). Coll. 1963 by O. L. White; subm. by P. F. Karrow, Univ. of Waterloo, Waterloo, Ontario. *Comment* (P.F.K.): peats initially considered to be Wisconsinan interstadial deposit but now believed equivalent to Scarborough Formation. Climate inferred from pollen reported by J. Terasmae is cold. Dated in 5 L counter at 4 atm.

GSC-257. 'Thane Lake', Ontario **8590 ± 170**
6640 B.C.

Gyttja from base of lake sediments 640 to 650 cm below lake level and ca. 250 cm below lake bed in 'Thane Lake', 22 mi E of White River, Ontario (48° 20′ N Lat, 84° 59′ W Long), alt ca. 1200 ft. Lake occupies a kettle in outwash sand and gravel above level of highest late-glacial lake in Superior Basin. Coll. 1964 by J. Terasmae and R. J. Mott. *Comment* (J.T.): date is minimal for deglaciation north of Lake Superior. Kettle in pervious sand and gravel may have remained barren of organic sediment for considerable time after ice retreat. Sample mixed with dead gas for counting; preliminary acid leach added to sample pretreatment.

GSC-217. Port Talbot (shore), Ontario **47,700 ± 1200**
45,750 B.C.

Wood from peat balls on shore of Lake Erie at type locality of Port Talbot interstadial beds, near Port Talbot, Ontario (42° 38′ N Lat, 81° 23′ W Long). Coll. 1963 by A. Dreimanis, Univ. of Western Ontario. *Comment*: sample dated to check performance of 5 L counter. Earlier dates are as follows (de Vries and Dreimanis, 1960): Port Talbot gyttja, in place, 47,000 ± 2500 (Gro-2570)

and 47,500 ± 250 (Gro-2597 and Gro-2601); peat ball from shore, 44,900 ± 1000 (Gro-2619).

GSC-272. Frederickhouse Lake, Ontario — **6920 ± 140 / 4970 B.C.**

Peat and shelly marl from E side Frederickhouse Lake, Dundonald Township, Cochrane District, Ontario (48° 41.5′ N Lat, 80° 55′ W Long). Varved sediments of Glacial Lake Barlow-Ojibway grade upward through laminated silt into shelly marl and peat. Coll. 1956 by O. L. Hughes. Two fractions were dated from a zone ca. 1 in. thick straddling boundary between marl and peat.

organic fraction	6920 ± 140
inorganic fraction	7600 ± 160

Comment (O.L.H.): after drainage of glacial lake the marl was deposited when Frederickhouse Lake stood 25 to 30 ft above its present level. Organic fraction age is minimum for disappearance of glacial lake following Cochrane readvance.

GSC-247. Hawley Lake bog, Ontario — **5580 ± 150 / 3630 B.C.**

Peat from base of bog 2.2 mi W of N end of Hawley Lake, Ontario (54° 34′ N Lat, 84° 40′ W Long). Coll. with Hiller sampler at 290 to 294 cm depth where peat is underlain by marine clay at alt ca. 425 ft (alt of lake ca. 280 ft). Coll. 1957 by H. Sjörs; subm. by J. Terasmae. *Comment* (J.T.): date is minimum for sealevel recession below locality and for beginning of muskeg development. Basal peat in Attawapiskat River valley at alt 460 ft (S of Hawley Lake) is 5670 ± 110 yr old (GSC-31, GSC I). Marine shells at alt 465 ft, 55 mi SW of Churchill, Manitoba, are 7270 ± 120 yr old (GSC-92, GSC III). Sample mixed with dead gas for counting.

GSC-231. Cape Henrietta Maria, Ontario — **1210 ± 130 / A.D. 740**

Peat from base of deposit 4 ft thick, overlying sand and gravel, ca. 20 mi S of Cape Henrietta Maria, inland from Hudson Bay at alt ca. 46 ft (55° N Lat, 82° 20′ W Long). Coll. 1957 by A. E. Porsild; subm. by J. Terasmae. *Comment* (J.T.): date is minimum for postglacial emergence of site. Because the substratum is permeable, it is assumed that some time elapsed between emergence and muskeg development. Date based on one 3-day count.

B. Western Canada

Winnipeg, Manitoba series

Wood and freshwater shells from bank of Red River, lot 174, municipality of St. Vital (49° 45′ N Lat, 97° 08′ W Long). Collection site was 140 ft from river edge, and at bottom (730 ft alt) of Winnipeg Floodway diversion channel, 25 ft deep. Samples are from alluvial clayey silt overlain by similar inorganic silt 25 ft thick. Coll. 1963 by R. W. Klassen.

GSC-215. Winnipeg, Manitoba, shells — **3650 ± 140 / 1700 B.C.**

Freshwater shell (*Crenodonta costata*, id. by F. J. E. Wagner) from organic-silt zone.

GSC-216. Winnipeg, Manitoba, wood **3660 ± 130**
1710 B.C.

Wood from same stratum as GSC-215, taken from root of tilted tree. Two measurements were made:

mold-free wood	3660 ± 130
moldy wood	3610 ± 130

General Comment (R.W.K.): dates fall within an episode of aggradation by Red River that began ca. 6750 yr ago (Elson, 1962). Close agreement between dates for shell and wood indicates that dates for freshwater shells can be reliable. Moreover, the pair of dates for moldy and mold-free wood shows that moldy wood can yield a reliable date.

GSC-218. Riding Mountain, Manitoba **>30,000**

Wood chips from borehole ca. 2 mi NE of Inglis, Manitoba, sec. 10, tp. 23, rge. 27, W prin. mer. (50° 59′ N Lat, 101° 10′ W Long). Sample is from clay, between depths 196 and 212 ft, overlain by two tills and underlain by 75 ft of silt over shale. Coll. 1963 by R. W. Klassen. *Comment* (R.W.K.): silt may correlate with a stratified layer overlying a third till encountered in several other boreholes on SW slope of Riding Mountain Upland (tp. 18, rge. 20). Sample mixed with dead gas for counting; pretreatment included *cold* NaOH-leach.

GSC-280. Russell, Manitoba **6320 ± 140**
4370 B.C.

Wood from clayey alluvium exposed in diversion channel cut in Assiniboine River floodplain, 6 mi W of Russell, Manitoba, NE ¼ sec. 33, tp. 20, rge. 29, W prin. mer. (50° 46′ N Lat, 101° 26′ W Long). Sample from bottom of cut in organic clay zone containing twigs and bone fragments. Zone is overlain by 15 ft of silty clay including beds of pelecypod-bearing silt, sand, and gravel, and is underlain by 60 ft of clay, in part probably lacustrine. Coll. 1964 by R. W. Klassen. *Comment* (R.W.K.): date marks a late phase in valley filling. A bison skull (*Bison preoccidentalis?*) was collected from the wood-bearing zone by R. W. Sutton, Manitoba Mus.

GSC-205. Medicine Hat, Alberta **24,490 ± 200**
22,540 B.C.

From E bank South Saskatchewan River, ca. 4 mi N of Medicine Hat, Alberta, SE ¼ sec. 20, tp. 13, rge. 5, W 4th mer. (50° 06′ N Lat, 110° 38′ W Long). The rare small wood fragments are scattered ca. 10 ft below top of 100 ft of sand, silt, grit, and peat overlying preglacial sand and overlain by 80 ft of drift consisting chiefly of 3 tills. Coll. 1963 by A. M. Stalker. *Comment*: sample mixed with dead gas for counting; NaOH-leach omitted from sample pretreatment.

GSC-220. Southwest Blood Indian Reserve, Alberta **10,000 ± 130**
8050 B.C.

Humus from E bank Belly River ca. 14 mi NW of Cardston, Alberta, SW ¼ sec. 22, tp. 4, rge. 27, W 4th mer. (49° 18′ 30″ N Lat, 113° 34′ W Long). Sample from 8-in. layer of humus-rich alluvium, probably the A-horizon of a

soil, overlying till of latest (Laurentide) glacier, and overlain by ca. 18 ft of sandy, silty stream- and lake deposits enclosing a 3 in. bed of ash. Coll. 1962 by A. Dreimanis for A. M. Stalker. *Comment* (A.M.S.): date is minimum for last glacial retreat (cf. GSC-161, 10,620 ± 250, GSC III). NaOH-leach omitted from sample pretreatment.

GSC-236. Willow Creek, Alberta **9290 ± 260**
7340 B.C.

Freshwater gastropod shells from N bank Willow Creek, ca. 15 mi W of Stavely, Alberta, NE ¼ sec. 6, tp. 14, rge. 29, W 4th mer. (50° 09′ N Lat, 113″ 59′ W Long), alt ca. 4300 ft. Shells from base of alluvium 7 ft thick, overlying Laurentide till. Several humus beds and a 6-in. layer of ash occur in alluvium above dated horizon. Coll. 1963 by A. M. Stalker. *Comment* (A.M.S.): date is minimum for last glacial retreat. Mixed with dead gas for counting; outermost 5% discarded.

GSC-237. Oldman River, Alberta **>54,500**

Wood (spruce) from intertill strata on bank of Oldman River, Alberta, SW ¼, sec. 35, tp. 9, rge, 23, W 4th mer. (49° 46.5′ N Lat, 113° 01.5′ W Long). Sample is same as L-221C (Lamont III); stratigraphy is described for L-433B (Lamont VII). Coll. 1953 by A. M. Stalker. *Comment*: date supersedes that for L-221C, (Lamont III, >26,000) and dates for nearby samples from same deposit (L-433B, Lamont VII, >35,500; S-65, Saskatchewan II, >32,000). The intertill deposits are extensive, having been observed at intervals for 50 mi along the river. Preliminary acid leach added to sample pretreatment. Dated in 5 L counter at 4 atm.

GSC-219. Duncan Lake damsite, British Columbia **>39,700**

Peat from depth 40 ft in borehole at proposed damsite, Lardeau River near Duncan Lake, British Columbia (50° 14′ N Lat, 116° 58′ W Long), from interglacial or interstadial silt and sand beneath boulders and till. Coll. 1961 by H. W. Nasmith, R. C. Thurber and Associates, Victoria, B. C. *Comment*: peat contains sparse pollen, mainly of spruce and pine (id. by R. J. Mott). Date is markedly older than other dates for subtill deposits in region (GSC-173, 194, this list).

GSC-173. Boat Encampment, British Columbia **21,500 ± 300**
19,550 B.C.

Woody plant detritus from road cut on Big Bend Highway 2 mi SE of Boat Encampment, British Columbia (52° 06′ N Lat, 118° 23′ W Long), from laminated blue-gray micaceous sandy silt (interstadial or interglacial) beneath till. Coll. 1958 by H. W. Nasmith for Dept. of Mines and Petroleum Resources, Victoria, B. C. *Comment*: date suggests correlation with deposits represented by GSC-194. Date is maximum for last major Wisconsinan ice advance.

GSC-213. Lower Arrow Lake, British Columbia **8380 ± 150**
6430 B.C.

Fine plant detritus in sand, from Shelby-tube sample, depth 40 ft, at proposed damsite, mouth of Syringa Creek near outlet of Lower Arrow Lake,

British Columbia (49° 20′ N Lat, 117° 52′ W Long). The organic material, from sand, silt, and clay in a fan, lies 5 in. below layer of ash id. (R. E. Wilcox, U. S. Geol. Surv.) as from Mt Mazama. Coll. 1961 by H. W. Nasmith. *Comment*: Mt Mazama eruption dates 6600 B.P. (W-858, USGS V; Powers and Wilcox, 1964). Discrepancy may be due to slow deposition, a hiatus, or sample mixture. Date based on one 3-day count.

Deep Creek series, North Okanagan Valley, British Columbia

Fibrous clayey silt and organic muck from pit dug 3 mi N of Okanagan Lake, British Columbia (50° 23′ 10″ N Lat, 119° 16′ 40″ W Long), in bog formed in the large river channel occupied by Deep Creek. Upper 160 cm of fill is organic-rich silt; lower 235 cm is clayey silt with little organic material. Coarse sand underlies bog. Layers of volcanic ash lie at depths of 40 cm and 70 cm, a layer of marl at 50 cm. Channel was outlet of Shuswap Lake and of glacial lakes in Thompson River Valley (Fulton, 1963) prior to deglaciation of Fraser River Valley. Coll. 1963 by R. J. Fulton.

GSC-193. Deep Creek, organic silt **8900 ± 150**
6950 B.C.

Organic-rich silt from depth 160 cm. *Comment* (R.J.F.): date is minimum for termination of southward drainage of Shuswap Lake and hence for deglaciation of Fraser Valley. NaOH-leach omitted from sample pretreatment. Date based on one 3-day count.

GSC-206. Deep Creek, lower organic muck **7510 ± 150**
5560 B.C.

GSC-214. Deep Creek, upper organic muck **6270 ± 140**
4320 B.C.

Two samples of organic muck from 75 to 80 cm and 65 to 70 cm depth, respectively (below and above the ash at 70 cm). *Comment* (R.J.F.): dates suggest that ash is from Mt Mazama eruption in 6600 B.P. (Powers and Wilcox, 1961). GSC-206 mixed with dead gas for counting; NaOH-leach omitted from sample pretreatment.

GSC-194. Shuswap Lake, British Columbia **20,230 ± 270**
18,280 B.C.

Bark and twigs from road cut on N shore of Shuswap Lake, 2.4 mi W of Celista, British Columbia (50° 56′ 10″ N Lat, 119° 24′ 15″ W Long). Woody materials occur ca. 75 ft above lake and 5 ft above base of a 30-ft sequence of lacustrine sand and silt. Coll. 1963 by R. J. Fulton. *Comment* (R.J.F.): date is maximum for latest glacial advance. Date based on one 3-day count.

GSC-256. Otter Creek, British Columbia **9320 ± 160**
7370 B.C.

Mucky peat from base of a bog 395 cm thick, in valley of Otter Creek 34.2 mi N of Princeton, British Columbia, on Highway 5 (49° 53′ 00″ N Lat, 120° 37′ 30″ W Long). Coll. with Hiller borer. Section (top to bottom): 176 cm of mucky peat with ash at 85 cm, 189 cm of marl, 20 cm of peaty muck (loc of sample) and 10 cm of marl, overlying coarse-grained sand. Coll. 1964

by R. J. Fulton. *Comment* (R.J.F.): Otter Creek Valley was outlet of Glacial Lake Quilchena (Mathews, 1944). Date is minimum for draining of lake. Preliminary acid leach added to sample pretreatment.

GSC-258. Merritt, British Columbia **>37,200**

Freshwater shells (*Anodonta* sp., id. by F. J. E. Wagner), coll. from road cut on W side of Coldwater River 2.4 mi S of Merritt, British Columbia. (50° 04′ 55″ N Lat, 120° 48′ 15″ W Long). Shells lie immediately above and below tuffaceous sand 65 ft above base of a 165-ft sequence of poorly sorted, partially oxidized alluvial sand, silt, and gravel, underlain by unoxidized glacial-lacustrine(?) silt, and overlain by unoxidized sand and gravel capped by till. Top of alluvial material containing shells is ca. 800 ft above present valley floor. Coll. 1964 by R. J. Fulton. *Comment* (R.J.F.): shells date a thick valley fill deposited prior to last glaciation and preceded by a glaciation. Date based on one 3-day count.

Furry Creek series, British Columbia

Wood and marine shells from gravel pit above highway S of Furry Creek on E side of Howe Sound, British Columbia (49° 35′ N Lat, 123° 13′ W Long), from foreset part of a delta with top at alt 190 ft. Coll. 1963 by J. E. Armstrong.

GSC-185. Furry Creek, wood **10,690 ± 180**
8740 B.C.

Spruce wood (id. by R. J. Mott) from bed of stony, clayey silt, alt 135 ft, in gravelly foreset sequence. Mixed with dead gas for counting.

GSC-227. Furry Creek, shells **11,300 ± 190**
9350 B.C.

Mixed pelecypod shells from same bed as GSC-185. Outer and inner fractions of shells were dated separately after removal of the outermost 17%:

outer fraction (18-54% leach)	11,080 ± 160
inner fraction (55-100% leach)	11,300 ± 190

General Comment: delta originated during marine submergence shortly after ice retreat from N part of Howe Sound. Difference between shell and wood dates is somewhat larger than for earlier shell-wood pairs from the region (*e.g.* GSC-24, 38 in GSC I; L-391D, E in Lamont V).

GSC-226. Deas Island Highway **11,590 ± 280**
9640 B.C.

Coniferous wood at depth 8 to 10 ft in ditch bordering Deas Island Highway (499), Surrey Municipality, British Columbia (49° 02′ 30″ N Lat, 122° 47′ W Long), from stony, silty clay with marine shells beneath marine sand. Coll. 1963 by J. E. Armstrong. *Comment* (J.E.A.): deposit dates from post-Vashon marine submergence, probably prior to advance of Sumas ice in area to E. Shells from stony clay (presumed to be same deposit) nearby dated 12,625 ± 450 (I (GSC)-6, Isotopes I). Sample mixed with dead gas for counting.

GSC-186. County Line Road Overpass, British Columbia **11,680 ± 180 9730 B.C.**

Shells (several species of marine pelecypods and *Serpula*) from stony, silty clay at alt 310 ft, in excavation for Trans-Canada Highway near County Line Overpass, Lower Fraser Valley, British Columbia (49° 06′ N Lat, 122° 30′ W Long). Coll. 1963 by J. E. Armstrong. Shells accumulated during post-Vashon marine submergence, and probably prior to advance of Sumas ice. *Comment*: sample mixed with dead gas for counting. Outermost 10% removed before dating.

GSC-229. Pitt Meadows Airport, British Columbia **8290 ± 140 6340 B.C.**

Peaty silt from borehole at airport site, Pitt Meadows, British Columbia (49° 13′ N Lat, 122° 42′ W Long). Sample from organic layer 33.5 to 34.5 ft below sealevel, overlain by 33 to 35 ft of partly organic silt and clay and by 3 to 5 ft of modern peat. Coll. 1962 by A. McLean, Dept. of Transport, Vancouver; subm. by W. H. Mathews, Univ. of British Columbia, and by J. E. Armstrong. *Comment*: dated layer probably accumulated on floodplain of Fraser River only a few ft above sealevel. Thus sea is inferred to have risen ca. 35 ft relative to land since then. The inference agrees with GSC-225, this list, and S-99, Saskatchewan III (cf. Mathews and Shepard, 1962).

GSC-225. Sumas, British Columbia **8360 ± 170 6410 B.C.**

Wood fragments and plant detritus at depth 60 ft (ca. 35 ft below sealevel) in borehole in S part of Sumas Valley, British Columbia (49° 02′ N Lat, 122° 16′ W Long), from organic silt and clay in clayey to pebbly alluvium. Coll. 1964 by E. C. Halstead. *Comment*: assuming dated layer formed at or above sealevel, sea has since risen 35 ft or more relative to land (see GSC-229, above).

GSC-228. Piper Ave., Burnaby (peat) **9420 ± 180 7470 B.C.**

Limnic peat at alt 41 ft, depth 142 to 152 in. a few hundred ft W of Piper Ave., Burnaby, British Columbia (49° 15′ N Lat, 122° 56′ W Long), from lower part of 7-ft layer of sand, silt, and plant debris resting on marine clay and covered by 1 ft macerated peat and 6 ft sand and gravel. Coll. by auger in 1961 by W. H. Mathews, G. E. Rouse, and L. V. Hills; subm. by W. H. Mathews, Univ. of British Columbia, Vancouver. *Comment*: date is minimum for emergence. Shells from underlying clay (12,230 ± 200, GSC-74, GSC II) probably date time when site was still well below sealevel. Mixed with dead gas for counting.

GSC-221. Dunbar, Vancouver, British Columbia **32,580 ± 720 30,630 B.C.**

Wood from borehole, depth 151 to 155 ft (alt ca. 155 ft), Memorial Park, Dunbar District, Vancouver (city), British Columbia (49° 14′ 30″ N Lat, 123° 01′ 15″ W Long). The tiny wood fragments were concentrated from organic silty sand forming basal 4 ft of an intertill sand unit. Two tills above the sand are assigned to the Vashon Stade; underlying till is pre-Vashon. Coll.

1964 by J. E. Armstrong. *Comment*: this sample and GSC-81 (GSC II) were dated to try to correlate complex stratigraphy in Highbury St. Sewage Tunnel with shore exposures at Point Grey involving Quadra sediments with typical dates 24,000 to 36,000 yr (see GSC-108, 109, GSC II). GSC-81 was assumed to be Quadra but its "infinite" date and the underlying stratigraphy left doubt as to its stratigraphic position. Present sample also is believed Quadra and date, if reliable, supports this inference. Unfortunately sample contained modern plant material, and although every effort was made to remove it enough may have been missed to account for the slight C^{14} activity that gave the "finite" date. Sample pretreatment included *cold* NaOH leach.

GSC-246. Belinkinsop Lake, Victoria — **12,660 ± 160**
10,710 B.C.

Shells of *Mya truncata* from Maywood clay, alt 90 ft, 0.5 mi S of Belinkinsop Lake (Lost Lake), Victoria, British Columbia (48° 28.5′ N Lat, 123° 21′ W Long). Coll. 1910 by C. H. Clapp (Clapp, 1913). *Comment*: shells date from early in marine submergence following glacial retreat. Date based on one 3-day count.

GSC-200. Cowichan Head soil, Vancouver Island — **35,600 $^{+3000}_{-2200}$**
33,650 B.C.

Organic sandy silt 3 ft above high tide at base of 170-ft shore cliff at Cowichan Head, Saanich Peninsula, Vancouver Island, British Columbia (48° 34′ N Lat, 123° 22′ W Long). Soil is overlain by fluvial sand and gravel beneath till; traced N it is underlain by marine (?) sand and silt followed by stony silt and clay with wood and marine shells. Coll. 1958 by J. G. Fyles. *Comment*: sample was dated to check correlation with Quadra sediments (characteristic dates 24,000 to 36,000 yr). Although date falls within this range it may possibly be minimal in view of the large volume of soil processed and the exceedingly low C^{14} activity. Wood from lower in the succession has yielded infinite dates (GSC-94, GSC II; L-514C, Lamont V).

Cowichan River series, Vancouver Island

GSC-195. Skutz Falls — **21,070 ± 290**
19,120 B.C.

Twigs and other plant remains from 2-ft bed of silty, clayey sand overlain and underlain by till on bank of Cowichan River downstream from Skutz Falls (48° 46′ 30″ N Lat, 123° 56′ 50″ W Long). Coll. 1963 by E. C. Halstead. Date based on one 3-day count.

GSC-210. Marie Canyon — **19,150 ± 250**
17,200 B.C.

Organic silt 115 ft above Cowichan River at Marie Canyon (48° 46′ 43″ N Lat, 123° 53′ 36″ W Long). Sampled horizon is just above base of 50-ft section of silty clay beneath till and overlying gravel or gravelly till. Coll. 1963 by E. C. Halstead. Mixed with dead gas for counting; NaOH-leach omitted from sample pretreatment; date based on one 3-day count.

General Comment (E.C.H.): these dates, from two of several known occurrences of plant-bearing strata beneath till along Cowichan Valley, suggest

rences of plant-bearing strata beneath till along Cowichan Valley. Dates suggest correlation with Quadra sediments (typical dates 24,000 to 36,000 yr). Dates are youngest thus far assigned to subtill deposits on Vancouver Island (youngest earlier date is 22,600 ± 300, GSC-84, GSC II). GSC-210, based on a small amount of CO_2 extracted from a large amount of silt, probably gives only approx. age for deposit.

GSC-196. Icarus Point, Vancouver Island >36,650

Peat from sea cliff, Icarus Point, NW of Nanaimo, Vancouver Island, British Columbia (49° 14.5′ N Lat, 124° 00.5′ W Long). Sample is from peat in sand, silt, and clay tentatively assigned to upper intertill series represented by GSC-98 (>36,200, GSC III). Field relations suggest equivalence to Quadra sediments but the infinite dates do not support correlation. Coll. 1963 by E. C. Halstead.

GSC-232. North Thormanby Island 27,960 ± 420 / 26,010 B.C.

Wood isolated in ripple-marked silt ca. 5 ft above beach at SE end of North Thormanby Island, Strait of Georgia, British Columbia (49° 21′ 40″ N Lat, 123° 59′ 30″ W Long). Silt is in lower part of sandy alluvium overlain and underlain by till. Coll. 1958 by R. J. Mott for J. G. Fyles. *Comment*: date confirms assignment to Quadra sediments.

Dashwood series, Vancouver Island

In lower part of Quadra sediments, eastern Vancouver Island (Fyles, 1963a), marine stony clay is overlain by peat-bearing silt, sand, and gravel. Although no hiatus is visible, radiocarbon dates from several localities indicate the two units differ considerably in age. At Dashwood, near Qualicum Beach, British Columbia (49° 22′ N Lat, 124° 31′ W Long), shells from the stony clay dated >35,600 yr (L-475B, Lamont VII), whereas nearby peat from the overlying unit dated 25,000 yr (L-221A,B, Lamont V). Additional radiocarbon analyses listed below support original dates.

GSC-207. Dashwood shells >40,500

Mixed mollusc shells from stony clay, coll. in 1963 by J. G. Fyles to duplicate L-475B. The following determinations were made:

outer fraction (0-20% leach, 2 L counter)	$37{,}100\ ^{+1500}_{-1300}$
inner fraction (21-100% leach, 2 L counter)	>37,400
inner fraction (21-100% leach, 5 L counter)	>40,500

GSC-263. Dashwood peat 27,670 ± 410 / 25,720 B.C.

Peat coll. 1958 by J. G. Fyles from same locality as L-221A, B. *Comment*: original sample, coll. 1953, became moldy before it was dated; present sample is not moldy. Close agreement between dates indicates that moldy wood or peat can yield satisfactory C^{14} dates. Nonetheless, new date is slightly older than the three dates of moldy peat. Earlier peat dates are: L-221B (lignin): 23,450 ± 300, L-221B (cellulose): 25,050 ± 300 (Lamont V); OWU-71: 23,382 ± 400

(Ohio Wesleyan I). Dates on twigs from earlier sample are L-221A (lignin): 25,850 ± 500, L-221A (cellulose): 25,900 ± 300 (Lamont V); GSC-14: 26,000 ± 600 (GSC I).

C. Northern Canada

GSC-181. Snake River, Yukon **>31,000**

Wood near base of organic silt 10 ft thick, overlying 10 ft of boulder gravel and overlain by 55 ft of gravel; sequence lies on bedrock terrace ca. 150 ft high on W side of Snake River, Yukon Territory (65° 41′ N Lat, 133° 26′ W Long). Coll. 1962 by O. L. Hughes. *Comment* (O.L.H.): locality is in unglaciated terrain N of inferred late Wisconsinan limit of montane glaciers and W of inferred late Wisconsinan limit of Laurentide ice; overlying gravel may correlate in part at least with Wisconsinan montane glaciation.

GSC-199. Porcupine River, Yukon, wood **>41,300**

Wood from S bank Porcupine River, Yukon Territory (67° 28′ N Lat, 139° 54′ W Long), 25 ft below top of silt, sand, and gravel 144 ft thick, overlain by 29 ft of gray silt and clay and 4 ft of peat. Coll. 1962 by O. L. Hughes. *Comment* (O.L.H.): locality is not glaciated, but gray silt and clay is believed to have been deposited during one of two glacial stages when meltwater discharged into area from E and S. Peat from base of uppermost unit is 10,740 ± 180 yr old (GSC-121, GSC III).

GSC-192. Miner River, Yukon **6670 ± 140**
4720 B.C.

Basal peat from bog near headwaters of Miner River, Northern Ogilvie Mountains, Yukon Territory (65° 30′ N Lat, 140° 07′ W Long). Bog borders a pond impounded against a bedrock spur by a late Wisconsinan moraine. Coll. 1962 by O. L. Hughes. *Comment* (O.L.H.): age is minimum for widespread late Wisconsinan glaciation in Ogilvie and Mackenzie Mountains. Peat from bog on a distinctly older moraine at nearby 'Gill' Lake is 12,550 ± 190 yr old (GSC-128, GSC III), and peat from bog on a moraine at North Fork Pass, considered correlative with moraine at present locality, is 7510 ± 100 yr old (GSC-50, GSC I). NaOH-leach omitted from sample pretreatment.

GSC-204. Rat River, Northwest Territories, organic silt **>38,300**

Organic silt from W side Rat River, W of Mackenzie River, Northwest Territories (67° 39.5′ N Lat, 135° 28′ W Long), from near top of 40-ft section of silt with organic layers which overlies till over gravel. Coll. 1962 by O. L. Hughes. *Comment* (O.L.H.): no till was seen above silt in poorly exposed upper part of section, but evidence from surrounding area suggests that Laurentide ice covered the site and extended several miles W in (classical?) Wisconsinan time. Wood from near base of silt unit is >38,600 yr old (GSC-120, GSC III). NaOH-leach omitted from sample pretreatment.

GSC-240. Thesinger Bay, Banks Island **10,660 ± 170**
8710 B.C.

Plant debris from depth 4.5 ft in 5-ft layer of alluvium overlying sand terrace, SW coast Banks Island, 9 mi N of Masik River (71° 40′ N Lat, 123°

50′ W Long). Dated layer yielded pelvis of muskox (*Ovibos moschatus*, id. A. W. F. Banfield, Nat. Mus. Canada). Terrace (alt 35 ft) is NW extremity of single emerged delta (?) of Masik River. Coll. 1960 by J. G. Fyles. *Comment*: terrace probably is same as that covered by alluvium dated 10,600 ± 320, ca. 10 mi to SE (I (GSC)-185, Isotopes II). The following determinations have been made:

soluble in NaOH (2 L counter; one 3-day count)	10,640 ± 150
not dissolved in NaOH (2 L counter)	10,550 ± 160
not dissolved in NaOH (5 L counter)	10,660 ± 170

GSC-222. Nelson Head, Banks Island >41,600

Willow wood 40 ft above sea shore in wave-cut cliff on proximal (SE) side of moraine 3 mi N of Nelson Head, Banks Island, Northwest Territories (71° 09′ N Lat, 122° 42′ W Long), from sand, gravel and silt beneath ca. 150 ft of till and glaciofluvial gravel and sand. Moraine dates from last glaciation (classical Wisconsin ?). Wood-bearing deposit is interstadial or interglacial. Coll. 1960 by J. G. Fyles.

GSC-238. Duck Hawk Bluff, Banks Island >40,600

Peat and willow stems ca. 10 ft below top of shore cliff 125-ft high, on SW coast Banks Island, Northwest Territories, few hundred ft W of Duck Hawk Bluff (71° 58′ N Lat, 125° 45′ W Long), from organic silt beneath colluvium or till and overlying till over Beaufort Formation. Silt contains sparse pollen including alder, willow, rare spruce, and herbaceous plants (id. J. Terasmae). Coll. 1959 by J. G. Fyles. *Comment*: deposits probably are interglacial; possible correlatives are (I(GSC)-19, I(GSC)-28, >35,000, >38,000 resp., Isotopes I).

GSC-255. Lauchlan River, Victoria Island 9540 ± 150 / 7590 B.C.

Shells and fragments of *Mya truncata* and *Hiatella arctica* from surface of esker at alt ca. 500 ft, 40 mi NW of Byron Bay, Victoria Island, Northwest Territories (69° 14′ N Lat, 109° 53′ W Long). Location shown in Fyles, 1963b, fig. 1. Coll. 1959 by R. L. Christie for J. G. Fyles. *Comment*: marine limit probably 50 to 100 ft above site. Date fits into a series of high shell dates that decrease progressively from 12,000 to 8000 yr NW to SE across Victoria Island and adjacent mainland (Fyles, 1963b, p. 35; Blake, 1963, p. 8).

GSC-269. Hadley Bay, Victoria Island 9400 ± 150 / 7450 B.C.

Shells of *Mya truncata* from surface, associated with whale skeleton, alt ca. 340 ft, 8 mi E of Hadley Bay, Victoria Island, Northwest Territories (72° 07′ N Lat, 107° 15′ W Long). Location shown in Fyles, 1963b, fig. 1. Site probably ca. 50 ft below marine limit. Coll. 1959 by R. Thorsteinsson for J. G. Fyles. *Comment*: date agrees with others from region, recording early phases of marine inundation that accompanied retreat of Laurentide Ice Sheet (see GSC I and III).

GSC-235. Crooked Lake, Prince of Wales Island **6740 ± 150 / 4790 B.C.**

Marine pelecypod shells (*Astarte montagui* var. *warhami*) from fine sand in bank of old river channel, alt 60 ft, Crooked Lake (Craig, 1964, loc 71) (72° 37′ N Lat, 98° 27′ W Long). Coll. 1962 by B. G. Craig. *Comment* (B.G.C.): shells, assumed to have been deposited near sealevel, date a relative sealevel, only a few ft above site. Sample mixed with dead gas for counting.

Stuart River series, Bathurst Island

Marine pelecypod shells and peat coll. along S side of Stuart River, Bathurst Island, Northwest Territories (76° 11′ N Lat, 99° 08′ W Long), ca. 0.6 mi W of mouth of Cut Through Creek. Coll. 1963 by W. Blake, Jr.

GSC-164. Stuart River, shells **9040 ± 170 / 7090 B.C.**

Whole shells and fragments of *Hiatella arctica* and *Mya truncata* from shaly slope above prominent terrace, at alt ca. 305 to 335 ft.

GSC-165. Stuart River, peat **>36,000**

Uppermost peat in layer 4 ft thick, beneath marine silt in prominent terrace, alt ca. 280 ft. Date based on one 3-day count.

General Comment (W.B., Jr.): shells, the highest found except for some at ca. 350 ft, indicate area was ice free by 9000 yr ago. The peat, overlain by postglacial marine silt, is interstadial or interglacial.

Goodsir Inlet series, Bathurst Island

Marine pelecypod shells and peat, vicinity of Goodsir Inlet, Bathurst Island, Northwest Territories. Coll. 1963 by W. Blake, Jr.

GSC-166. Goodsir Inlet, shells **25,000 ± 500 / 23,050 B.C.**

Shell fragments, including *Hiatella* sp. and *Mya* sp., from surface of flat hilltop ca. 3 mi W of head of Goodsir Inlet (75° 44′ N Lat, 98° 09′ W Long), at alt ca. 285 to 305 (avg 300) ft. Shells are above highest obvious emerged beaches at 270 to 275 ft alt.

GSC-178. Goodsir Inlet, peat **>35,000**

Uppermost peat in deposit, more than 3 ft thick, exposed along unnamed creek ca. 4 mi SW of head of Goodsir Inlet (75° 41.5′ N Lat, 98° 11′ W Long), at alt ca. 230 ft. Peat occurs under, and as pods in, till. Date based on one 3-day count.

General Comment (W.B., Jr.): shells, which occur with erratic pebbles, probably have been emplaced by glacier ice. Likewise, glacier ice overriding peat has incorporated some of the peat into till. It is not known whether the finite date gives the true age of the shells; they may be older. Both shells and peat are presumed interstadial or interglacial (Blake, 1964). Date based on one 3-day count; pretreatment included *cold* NaOH leach.

Walker River series, Bathurst Island

Marine pelecypod shells and peat, S side Walker River ca. 3 mi W of Driftwood Bay, Bathurst Island, Northwest Territories (75° 57′ N Lat, 97° 52′ W Long). Coll. 1963 by W. Blake, Jr.

GSC-179. Walker River, shells **9660 ± 210**
7710 B.C.

Fragments of *Hiatella arctica*, *Mya truncata*, and *Astarte* sp. from surface of sand terrace, alt ca. 300 ft. Date based on one 3-day count. Sample mixed with dead gas for counting.

GSC-201. Walker River, peat **7100 ± 140**
5150 B.C.

Peat at surface of deposit more than 5 ft thick, alt ca. 260 ft, on a lower terrace at locality of GSC-179. Date based on one 3-day count.

General Comment (W.B., Jr.): highest part of terrace with shells is at alt ca. 310 ft; no higher evidence of marine action was seen. Shell date is minimum for deglaciation (Blake, 1964). As basal peat must be more than 7100 yr old, and because terrace with peat is lower and hence younger than 300-ft terrace, the peat date indirectly supports shell date.

'Dartmouth Bight' series, Bathurst Island

Peat and marine pelecypod shells from ridge along S side of 'Dartmouth Bight', Bathurst Island, Northwest Territories (75° 38.5′ N Lat, 99° 20′ W Long). Site is 1.5 mi S of 'Dartmouth Bight', 7 mi E of Bracebridge Inlet. Coll. 1963 by W. Blake, Jr.

GSC-180. 'Dartmouth Bight', peat **9210 ± 170**
7260 B.C.

Basal peat 102.8 to 103.9 in. below surface in a depression near top of ridge, alt ca. 450 ft. Sample frozen and coll. with coring auger. NaOH leach omitted from sample pretreatment.

GSC-212. 'Dartmouth Bight', shells **35,900 $^{+1400}_{-1200}$**
33,950 B.C.

Fragments and whole shells (mainly *Hiatella arctica*) on the surface of, and imbedded in, till covering top of ridge, alt ca. 475 ft. Outer and inner fractions of sample were dated separately after removal of outermost 20% of shells:

outer fraction (21-53% leach)	33,100	$^{+1300}_{-1100}$
inner fraction (54-100% leach)	35,900	$^{+1400}_{-1200}$

General Comment (W.B., Jr.): age of basal peat, similar to several dates on shells, is minimum for deglaciation (Blake, 1964). The shells, well above the highest obvious beaches in area, probably were transported by glacier ice. Age differences between the two fractions of GSC-212 are assumed to result from varying degrees of contamination with young carbon; thus both dates are probably minima (cf. GSC-165, GSC-166, and GSC-178, this list).

GSC-182. Shamrock Bay, Bathurst Island **9240 ± 160**
7290 B.C.

Marine pelecypod shell fragments (*Hiatella arctica*) from ground surface on hilltop 0.5 mi S of Shamrock Bay, Bathurst Island, Northwest Territories (76° 35′ N Lat, 99° 47′ W Long), at alt ca. 420 ft. Coll. 1963 by W. Blake, Jr. *Comment* (W.B., Jr.): shells are the highest found on Bathurst Island; thus ice may have been thickest over northern part of the island (Blake, 1964).

GSC-191. Round Hill, Bathurst Island **8520 ± 150**
6570 B.C.

Marine pelecypod shell fragments (*Mya truncata*) from surface on NW side of Round Hill, Bathurst Island, Northwest Territories (75° 11.5′ N Lat, 98° 04′ W Long), at alt ca. 320 ft. Coll. 1963 by W. Blake, Jr. *Comment* (W.B., Jr.): shells, the highest found in southeastern Bathurst Island, suggest that area became ice free later than northern part of island. Outermost 30% removed before dating.

GSC-223. Grant Point, Bathurst Island **>28,000**

Marine pelecypod shell fragments (*Hiatella* sp., *Mya* sp., and *Astarte* sp.) from surface on ridge 3 mi E of Grant Point, Bathurst Island, Northwest Territories (76° 05.5′ N Lat, 100° 33′ W Long), at alt ca. 460 to 470 ft. Coll. 1963 by W. Blake, Jr. *Comment* (W.B., Jr.): shells, coll. above highest visible beaches, probably were emplaced by glacier action. Sample mixed with dead gas for counting; outermost 10% removed before dating.

GSC-167. 'Rens Lake', Axel Heiberg Island **8250 ± 140**
6300 B.C.

Shells of *Mya truncata* from marine silt beneath alluvium in gully of small river entering 'Rens Lake' (between Nansen Sound and Rens Fiord), Axel Heiberg Island, Northwest Territories (81° 05′ N Lat, 92° 15′ W Long). Site is 26 ft above lake and ca. 100 ft above sealevel; upper limit of emerged beaches nearby is ca. 200 ft. Coll. 1961 by F. Müller, McGill Univ., Montreal (Müller, 1963, p. 172). *Comment*: date agrees with most others for shells at comparable alt in the region, but contrasts with nearby 'old' shell samples GSC-139 and GSC-149 (GSC III).

GSC-268. Slidre River, Ellesmere Island **>41,200**

Sedge and moss peat from gravel, 8 ft below boulder-strewn terrace, in valley of tributary of Slidre River, 28 mi SE of Eureka, Ellesmere Island, Northwest Territories (79° 43′ N Lat, 84° 25′ W Long). Terrace, at alt 850 ft, is ca. 200 ft above river, 25 ft below main terrace in valley, and 50 ft below preglacial(?) gravel bench. Coll. 1961 by J. G. Fyles. *Comment*: boulders on terrace probably indicate it has been glaciated. Two fractions were dated:

soluble in NaOH (2 L counter)	>36,000
not dissolved in NaOH (5 L counter)	>41,200

Blue Man Cape series, Ellesmere Island

GSC-243. first preparation **8450 ± 140**

GSC-254. second preparation **8710 ± 140**

Paired valves of *Hiatella arctica* from silt at alt 460 ft, 3 mi E of Blue Man Cape, Ellesmere Island, Northwest Territories (79° 48′ N Lat, 86° 15′ W Long). Coll. 1961 by J. G. Fyles. *Comment*: shells and silt (max alt 470 ft) are highest known evidence of marine inundation S of Eureka. Shell fragments at alt 500 ft to more than 2,000 ft are much older and probably are glacial erratics (GSC-111, GSC III; GSC-51, GSC I; L-548, Lamont VII). The first preparation involved a standard leach that removed 20% of the shells. During the second preparation, some shells were given the standard leach, but some were leached further to remove secondary carbonate coatings (average leach, 40%).

GSC-244. Bauman Fiord, Ellesmere Island **8480 ± 140**
6530 B.C.

Shell fragments (including *Hiatella arctica* and *Mya truncata*) from surface of emerged beach, alt 380 ft, ca. 1 mi N of Bauman Fiord and 6 mi W of of Trold Fiord, Ellesmere Island, Northwest Territories (78° 06′ N Lat, 85° 52′ W Long). Highest beach nearby is at 400 ft. Coll. 1961 by J. G. Fyles. *Comment*: shells date from early in marine submergence closely following glacial retreat.

GSC-241. McBean Bay, Baffin Island **9280 ± 150**
7330 B.C.

Marine pelecypod shells (*Hiatella arctica*) from surface of highest beach of a series, alt ca. 265 ft, 4 mi N of McBean Bay, Prince Regent Inlet, Baffin Island (72° 46′ N Lat, 89° 31′ W Long). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): date of sample, from within 20 ft vertically of delta close to marine limit, is minimum for withdrawal of ice and entry of sea along W coast of northern Brodeur Peninsula.

Bernier Bay series, Baffin Island

Marine shells from various alts within area ca. 32 mi in diam on both sides of Bernier Bay, N Baffin Island. In addition to the following two dates, series includes date I-1254 (7576 ± 500, Bernier Bay [285 ft]) to appear in a future Isotopes list. Coll. 1963 by B. G. Craig.

GSC-189. Bernier Bay (330 ft) **>30,580**

Marine shells from surface of till knoll ringed with beaches, alt 330 ft, 4 mi inland and 12 mi NW of head of Bernier Bay, Baffin Island (71° 07′ N Lat, 87° 24′ W Long). *Comment* (B.G.C.): site lies close to marine limit and shells were dated to confirm or deny postglacial age. However, shells antedate last glaciation and may be indigenous or redeposited. Sample mixed with dead gas for counting.

GSC-183. Bernier Bay (390 ft) **8830 ± 170**
6880 B.C.

Marine pelecypod shells (*Hiatella arctica* and *Mya truncata*) from bare surface of marine silt deposit, alt 390 ft, at or close to marine limit, 3.5 mi inland and 26 mi WSW of head of Bernier Bay, Baffin Island (70° 53′ N Lat, 88° 06′ W Long). *Comment* (B.G.C.): the above sample, together with I-1254,

was dated to aid in determining alt of marine limit and to fix time of ice withdrawal from morainal zones bordering Bernier Bay. Local geology indicates the moraines were formed by a tongue of ice flowing west into Bernier Bay after land to the S had become ice free or was covered only by inactive ice. Marine limit inside the moraines is ca. 100 ft lower than outside, also indicating that ice persisted later in the Bernier Bay depression than it did to the N or S. The two dates support this contention; they show that ice may have remained inside the moraines until ca. 7600 yr ago, but that area to the S became ice free at least 8800 yr ago (Craig, in preparation). Sample mixed with dead gas for counting.

GSC-239. Thiboult Bay, Baffin Island — **940 ± 130** / **A.D. 1010**

Spruce wood (id. by R. J. Mott) from log, 4 in. diam, partly imbedded in ground, alt 9 ft, ca. 835 ft from present coast near mouth of small creek, Thiboult Bay, Gulf of Boothia, Baffin Island (70° 55′ N Lat, 89° 11′ W Long). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): probably sample was deposited when sealevel was a few ft higher relative to the land than at present.

GSC-184. Navy Board Inlet, Baffin Island — **34,200 $^{+3400}_{-2400}$** / **32,250 B.C.**

Fragments of pelecypod shells from surface of kame, alt 415 ft, 4.5 mi SE of mouth of Mala River (72° 53′ N Lat, 80° 46′ W Long). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): shells coll. ca. 150 ft. above marine limit determined by alt of nearby delta. Area is one of kame- and morainal hills possibly formed by ice from Bylot Island; shells were redeposited. Date based on one 3-day count.

GSC-190. Jungersen Bay, Baffin Island — **3480 ± 130** / **1530 B.C.**

Marine pelecypod shells (*Astarte borealis*) from frost boil in beach 8 ft above high tide and 450 ft from present coast near mouth of unnamed creek 10 mi SSE of mouth of Magda River (71° 31′ N Lat, 84° 33′ W Long). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): shells assumed to have been deposited at time of beach formation when sealevel was slightly higher relative to the land than at present. However, they may have been redeposited from higher elevation or may have been deposited in bottom sediments in deeper water and brought to surface by frost action. Outermost 40% removed before dating.

GSC-188. Tablerotit Hill, Jungersen Bay, Baffin Island — **35,400 $^{+2100}_{-1600}$** / **33,450 B.C.**

Marine pelecypod shells (*Hiatella arctica*) from sand in terrace remnant on side of hill, alt ca. 396 ft, 6 mi N of mouth of Magda River (71° 45′ N Lat, 84° 45′ W Long). Coll. 1963 by B. G. Craig. *Comment* (B.G.C.): sample coll. in terrace remnant of doubtful origin in area where little information is available on alt of marine limit. Old date indicates shells not postglacial; hence

terrace probably of alluvial, not deltaic, origin. Outermost 35% removed before dating.

GSC-209. Bruce Mountains, Baffin Island >39,600

Wood (*Salix* sp., id. by R. J. Mott) from surface of low moraine ridge, alt 545 ft, 100 ft N of glacier S5, 1.5 E of Duart Lake, Bruce Mountains, Baffin Island (71° 20′ N Lat, 72° 30′ W Long). The pieces of willow were flattened and associated with dead moss but may not have been rooted in place. Coll. 1963 by D. A. Harrison. *Comment* (D.A.H.): date is much older than expected, especially for an area subjected to mountain glaciation. Date is, however, similar to those of wood and peat coll. from near NW margin of Barnes Ice Cap (I-1240), >35,000 yr, and I-1241, >30,000 yr; Isotopes, unpub.).

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