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RADIOCARBON DATES FROM THE ICE-FREE CORRIDOR

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ABSTRACT. The Ice-Free Corridor has been hypothesized as the main migration route into the Americas since the 1930s. Radiocarbon dates have been used by archaeology, geology, and palynology to date the corridor. A total of 564 ^{14}C dates ranging between 20,000 and 8000 BP from the corridor area were gleaned from the published literature**.** After assessing these dates for suitability, 255 were plotted over four time periods. The results indicate that the corridor was not feasible as an early human migration route until after 11,000 BP, or after the appearance of Clovis south of the continental glaciers.

INTRODUCTION

The hypothesized Ice-Free Corridor has provided archaeology with a convenient explanation to account for the initial colonization of the Americas south of the Late Wisconsin ice sheets. Defined as an unglaciated area along the eastern slopes of the Rocky Mountains between the westward advancing Laurentide ice sheet and the eastward flowing Cordilleran and mountain glaciers (Figure 1), it was first proposed by Johnson (1933:22) to account for the then recently discovered Folsom points.

Debate over whether it was a deglaciation or a glacial maximum corridor has continued over the decades with an entire issue of *Quaternary International* (Volume 32; Mandryk and Rutter 1996) dedicated to this discussion (the following list of publications provides an introduction to the literature on the Ice-Free Corridor and should not be considered exhaustive: Antevs 1934; Bryan 1969; Reeves 1973; Fladmark 1979; Rutter 1980; Holloway et al. 1981; Hickman et al. 1983; Jackson 1983; White and Mathewes 1986; Schweger and Hickman 1989; Bobrowsky and Rutter 1992; Mandyrk 1992; Meltzer 1993; Beaudoin et al. 1996; Burns 1996; Catto et al. 1996; Levson and Rutter 1996; Mandryk 1996; Wilson 1996; Driver 1998; Schwegar 1989b). Mandryk (1992:20–53) provides a chronology of the debate. To summarize briefly, prior to the advent of radiocarbon dating, the last glacial maximum was estimated to have occurred about 25,000 years ago (Johnson 1933:24; Antevs 1935:304,306,307) with the formation of the corridor occurring sometime between 20,000 and 15,000 years ago. Despite the lack of archaeological evidence at this time for Clovis or Folsom age sites in Alaska or northeast Asia, the corridor was seen as the route of entry for Palaeoindian cultures south of the glacial ice. ^{14}C dating revised these interpretations by showing that Clovis, Folsom, and the Late Wisconsin glaciation were more recent than previously assumed. According to Mandryk (1992:31–2), because archaeology was unwilling to accept a Mid-Wisconsin human entry into the New World, archaeologists redefined Johnson's deglaciation corridor as a glacial maximum corridor. Mandryk (1992:38) characterizes post-1960s corridor research as continuing to focus on the physical existence and timing of the corridor, with less debate on its environment.

This paper re-evaluates the ^{14}C dates from the corridor, what they suggest about the timing of its appearance and the potential role of the corridor in the settlement of the Americas.

METHOD

The study area is shown in Figure 2 with its western limits defined by the Rocky Mountain Trench extending north from the Canada/United States border along the Columbia, Fraser, and Kenchika river valleys in British Columbia. This western limit is extended in the Yukon Territory along the Liard, Frances, and Pelley river valleys and follows the Yukon River to the Alaska/Yukon border where it proceeds north along the border to the Beaufort Sea. The northern limit is the northern coast

Canada (and immediate offshore islands) east from the Alaska/Yukon border to its intersection with the eastern limit in Queen Maude Gulf. The eastern limit begins with the political boundary between the Canadian provinces of Manitoba and Saskatchewan and extends north from the 60th parallel to Queen Maude Gulf. The southern limit of the study area runs along the Canada/United States border. This study area covers the eastern slopes of the Rocky Mountains, the potential northern staging area in the present-day Yukon and the southern outlet area in southern Alberta, Canada. ^{14}C dates from within this study area and bracketed between 20,000 and 8000 BP were collected from a variety of published sources including journals, books, dissertations, theses, and databases. A total of 574 ^{14}C dates from 343 separate sites were gleamed from the published literature.

Assessing these ^{14}C dates follows Nelson (1998). These dates were assessed based on the ^{14}C event of the sample dated, the samples relationship to its stratigraphic provenance, and whether it conformed to a standard ^{14}C date as defined by Stuiver and Polach (1977:356). This process reduced the original 574 dates to 255 dates from 164 locations. Figures 3A and 3B display the distributions of

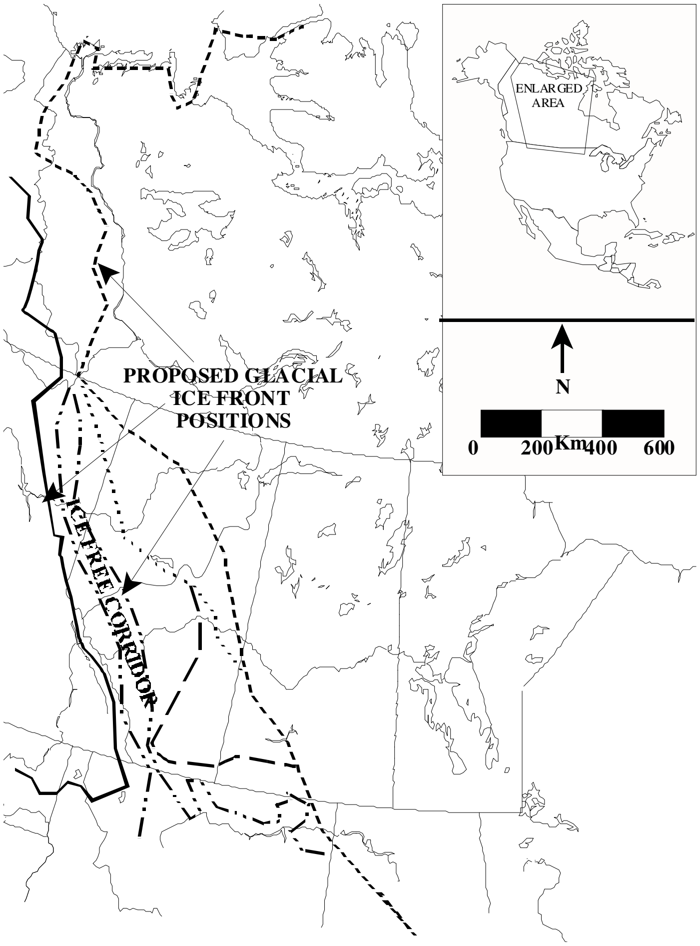

Figure 1 Traditional view of the Ice-Free Corridor (after Reeves 1973)

dated locations before and after assessment. The reasons for rejected dated samples being eliminated from the study were:

1. The ^{14}C event could not be identified or was known to provide unreliable dates (e.g., freshwater shell, plants or lake sediment samples are known to be affected by hard water in the study area).
2. The dated sample is not closely related to its stratigraphic provenance. The sample was from the surface, was redeposited, or the sample came from wide stratigraphic context.
3. Dated sample were not pretreated properly or did not correspond to other dates from the same stratigraphic context.

Figure 4 notes physiographic features mentioned in the text and Figures 5–9 illustrate the distribution of these dated locations through time. Table 1 (see Appendix) lists the name, date, 1 standard deviation, and reference for each site location.

Figure 2 Location of study area

Prelude to Late Wisconsin Maximum

Prior to the last glacial maximum the study area was devoid of ice as evident by dated plant and animal remains (Vincent 1989:112–3; Hughes et al. 1981:338; Burns1996:108; Burns and Young 1994: 394; Young et al. 1992:1576, 1994:685). As the Mid-Wisconsin drew to a close the Laurentide continental glacier advanced. In the north the glacier advanced west of the Mackenzie River and was

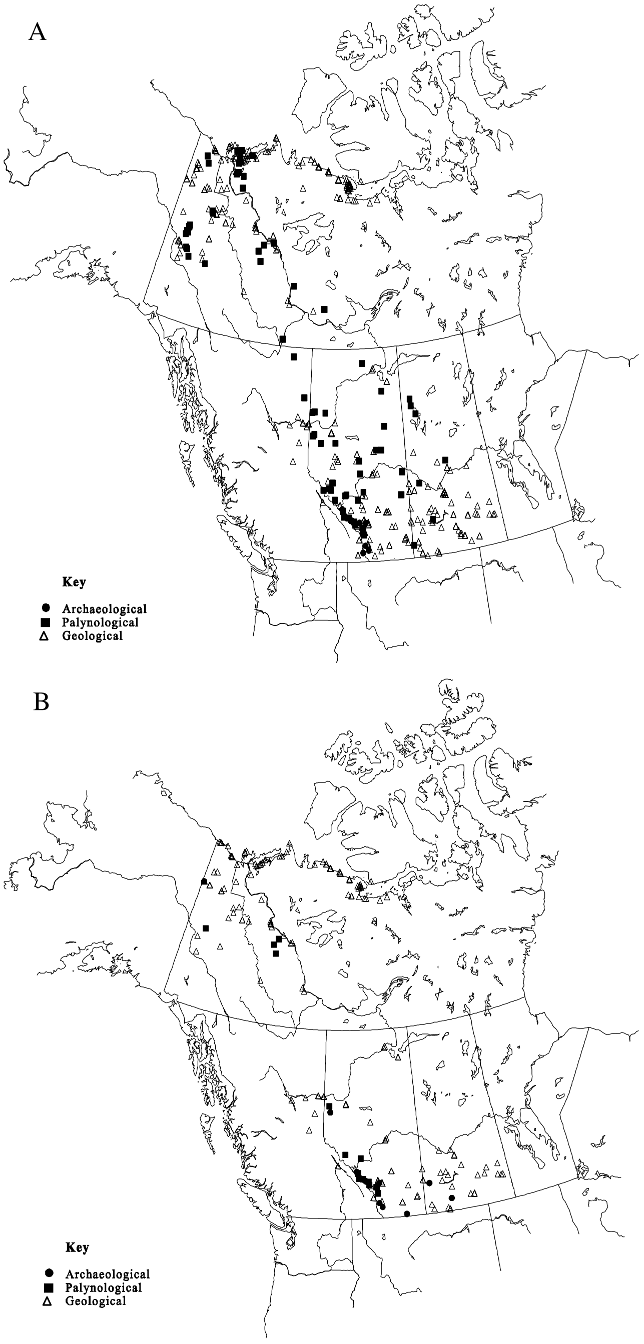

Figure 3 Radiocarbon dated site locations before (A) and after (B) assessment

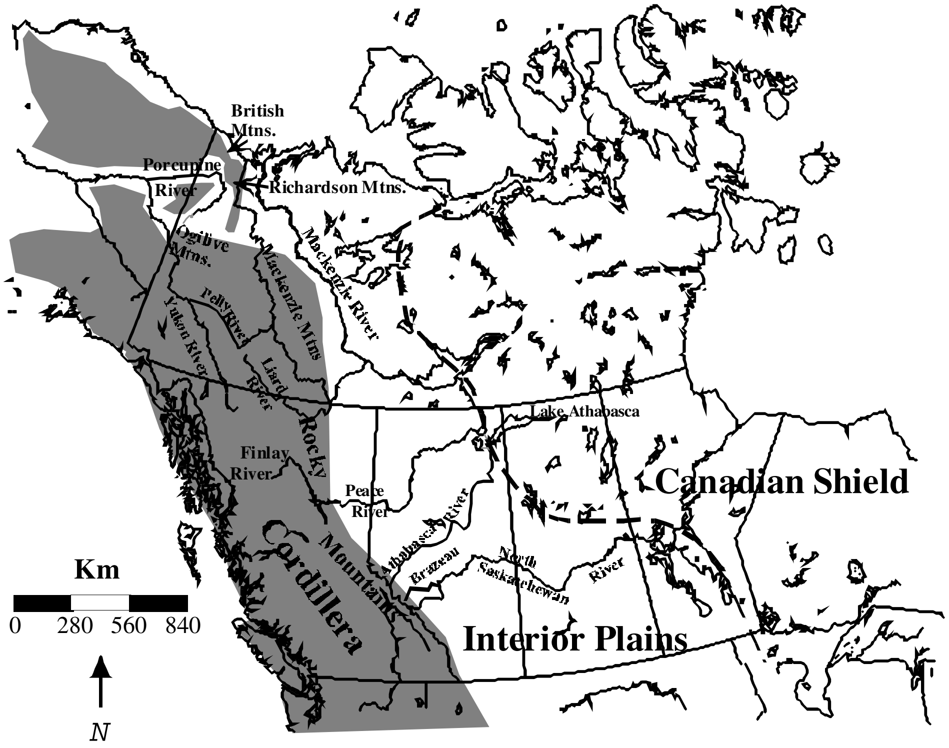

Figure 4 Geographical features of the study areas (after Driver 1998)

blocked by the Richardson and Mackenzie Mountains (see Figure 4 for place names) (Vincent 1989: 129–30; Hughes et al. 1981:329–65). In some instances ice lobes reached 40 km up some river valleys in the Mackenzie Mountains but it was only during the retreat of the Laurentide ice that some mountain glaciers appear to have coalesced with continental ice (Vincent 1989:130). In the Laird River valley, in southeast Yukon, a date of 23,900 ± 1140 BP (GSC-2811) from the upper zone of a silt unit was overlain by till indicating that Cordilleran and mountain glaciers advanced through the Laird Plain after this time (Klassen 1987:8; Klassen 1978:1884). No evidence for coalescence between the Laurentide and Montane or Cordilleran glaciers exists on the eastern slopes of the mountains.

Further south in the northern Rocky Mountains of northeastern British Columbia, the sedimentary successions indicate that Late Wisconsin Laurentide ice reached no higher then 950 m asl in the mountains or foothills in the Peace River district and that it occurred after 22,000 BP (Catto et al. 1996:24–6; Liverman et al. 1989:266–74). Montane glaciers did not reach the eastern slopes of the Rocky Mountains until after the Laurentide began to recede. This was evident by the presence of ^{14}C dates west of the Finlay River of 18,750 ± 120 (TO-709) and 15,180 ± 100 (TO-708) (Catto et al. 1996:23–29; Bobrowsky and Rutter 1992:16–19).

Recent geological research south of the Athabasca River indicated that coalesced glaciers, at the height of the Late Wisconsin, blocked southwestern and central Alberta. Subtill and paleontological studies by Young et al. (1994:683–6, 1999:1567–81) indicated that only Late Wisconsin ice advanced from the north and east and flowed south and west across Alberta up to 1400 m asl. Levson and Rutter (1996:33–51), citing lithologic, stratigraphic, and morphologic evidence, concluded that

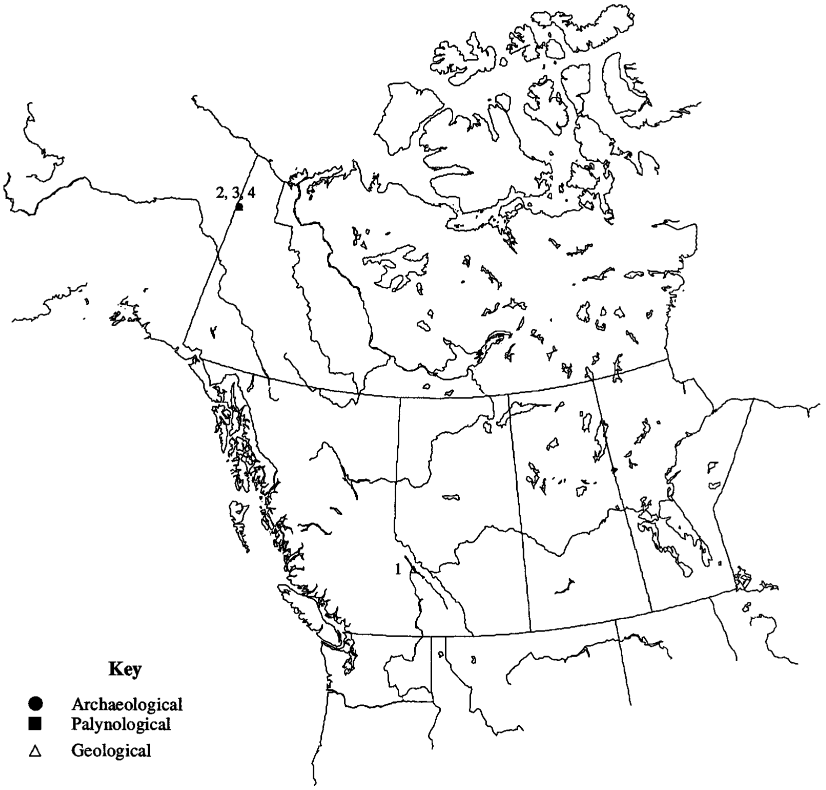

Figure 5 Period 1 site locations, 20,000–17,001 BP

the advancing Laurentide ice coalesced with combined valley and Cordilleran glaciers flowing east out of the Athabasca, Brazeau, and North Saskatchewan river valleys and flowed to the southeast. Since the natural flow out of these valleys was to the northeast, downhill, only the advancing Laurentide ice sheet could have provided the diversion necessary to deflect the east flowing glaciers upslope (Levson and Rutter 1996:44–46, 48) to the south.

Period I: 20,000–17,001 BP

This time period is represented by only four dates from three sites ranging from 19,650 BP to 17,880 BP (Figure 5). The sites are at opposite ends of the study area and confirm that the height of the glaciation occurred during this time period. The environment was either too severe or the landscape was covered by glaciers to permit plants or animals to survive. The three dates from the two Bluefish Cave sites confirm that eastern Beringia remained unglaciated at the height of glaciation. The lone date from the Rocky Mountain Trench in the south suggests that Cordilleran glaciers reached their maximum extent sometime after 18,500 BP since the sample came from a sand and silt unit that underlay two separate tills (Berry and Dimmie 1982:70).

Period II: 17,000–14,001 BP

There is an increase in the number of sites during this post-glacial maximum period (Figure 6). Their distribution suggests that deglaciation was occurring simultaneously at either end of the corridor. In the south one dated sample, on badly weathered bone (AECV-681C), appears to be from

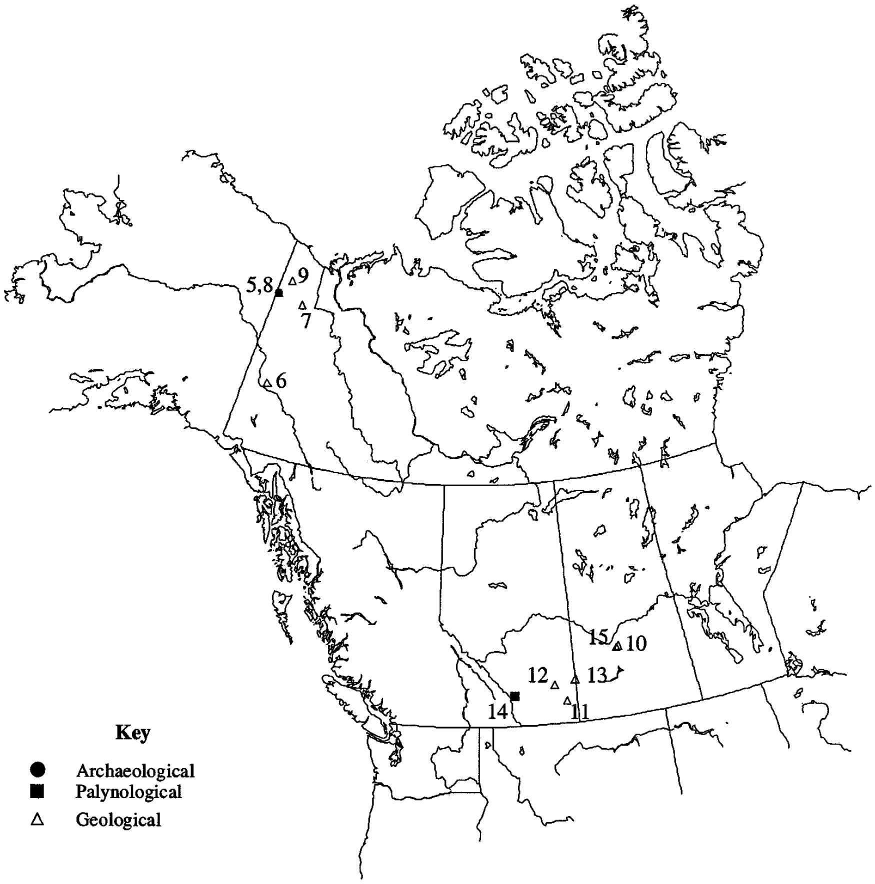

Figure 6 Period 2 site locations, 17,000–14,001 BP

lacustrine sediments overlying bedrock and may represent the earliest glacial lake sediments in the region (Evens 2000:940). Other bone sample dates that have been identified as mammoth (GCS-1199) and the genus *Equus* (S-1305) came from possible lacustrine or riverine sands or gravels (Lowdon et al 1975:16; Rutherford et al. 1979:54). The wood sample from the base of the Cartwright Lake core indicates that trees or shrubs were again present in the foothills of the Rocky Mountains. In the north, dated samples indicated the environment supported mammoth (GSC-1893 and GSC-3053) and muskox (RIDDL-557). The latter sample was from a lower loess layer from Bluefish Cave 3 (Cinq-Mars in Morlan 2001) and indicated a dry wind blown environment. Dated wood samples from Old Crow River (GSC-730-2) and the Upper Porcupine River (GSC-2431) indicate trees or shrubs were also present at this time.

Period III: 14,000–11,001 BP

Fifty-three dated site locations occurred in this time period (Figure 7). As with Period II, the dated site locations occurred in two groups at opposite ends of the study area but the extent of the site distribution has increased. In the north three sub-groups or clusters were indicated along the coast, the Mackenzie River and eastern Beringia (Yukon). The dated samples from the Coastal and Northeastern cluster were all conducted on plant material (wood, grass, moss) except for two marine shell dates from along the eastern coast. With the exception of the marine shells, which came from finegrained marine sediments, the remaining Coastal Cluster dates derive from a variety of geological context including outwash plain, glaciofluvial gravels, and peat deposits. The Northeastern Cluster sample material came mainly from deltaic deposits along the Mackenzie River associated with Glacial Lake Mackenzie (Smith 1992; 1994; Lemmen et al. 1995). The lone exception, Andy Lake (TO-2295) (Szeicz et al. 1995), came from a small lake in the Mackenzie Mountains to the west indicating this had become ice-free by this time. The Northwest Cluster sample material included a wider range of material including faunal remains. The latter included horse, mammoth, caribou, moose, mountain sheep, saiga antelope, owl, and bison, which suggested a rich diverse environment in this area. Identified floral samples included willow and possible birch.

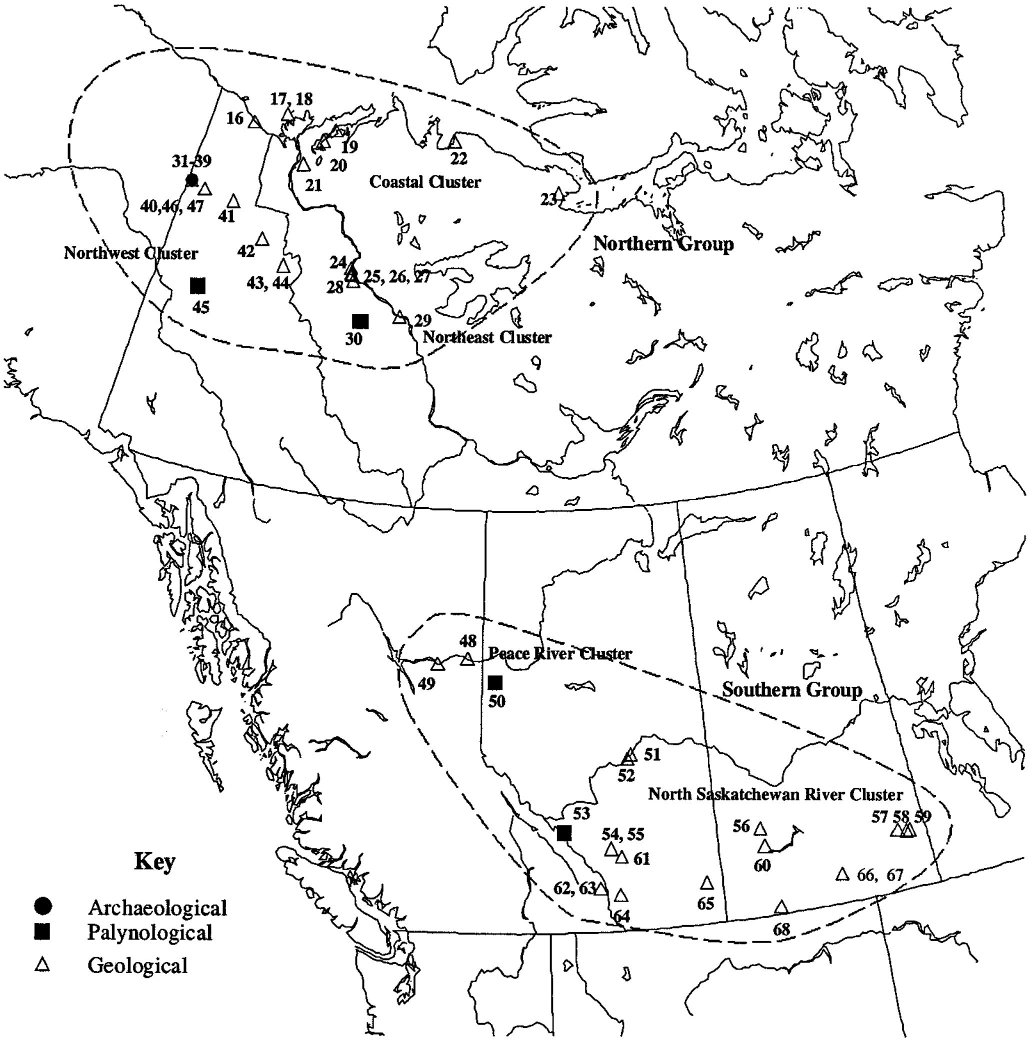

Figure 7 Period 3 site locations, 14,000–11,001 BP

In the south, the large cluster south of the North Saskatchewan River has grown and sites were present throughout Alberta and Saskatchewan. Dated faunal remains included mammoth, bison, and horse while willow was the only identified floral remain dated. To the northwest of this cluster was the small (3 dated site locations) Peace River Cluster. These two southern clusters appear separated by an area containing no dated site locations. This suggests a second area able to support plants and animals was developing independently of the older and more southern North Saskatchewan Cluster.

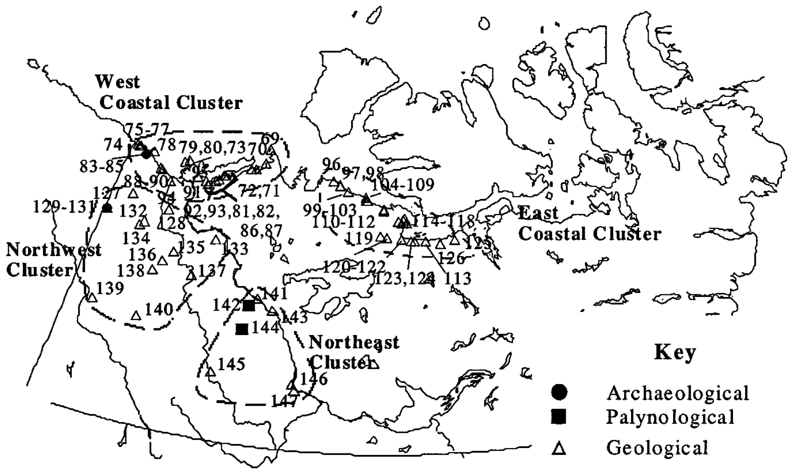

Figure 8 Period 4 northern group site locations, 11,000–8000 BP

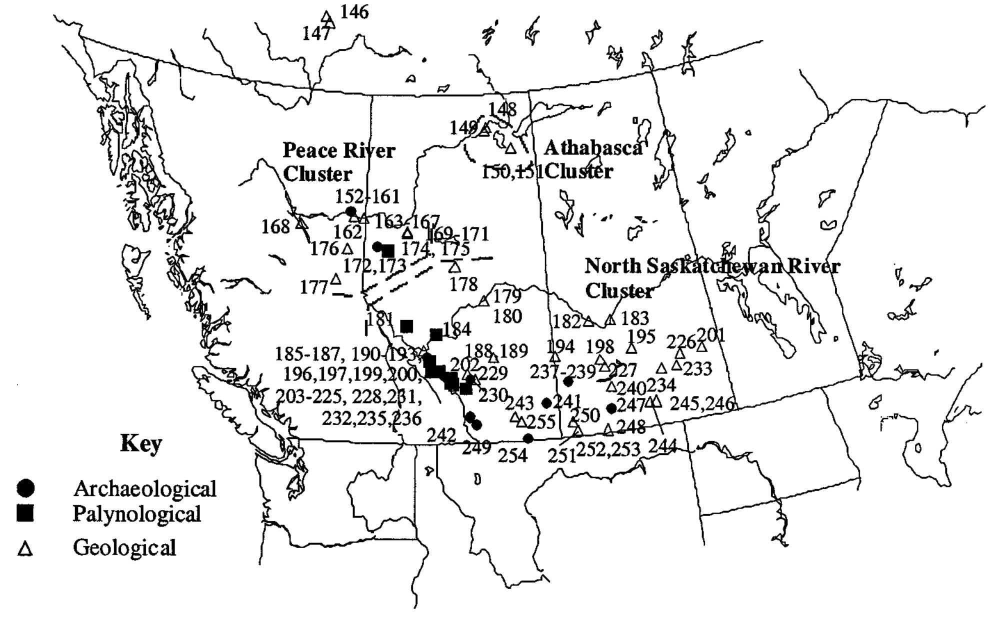

Figure 9 Period 4 southern group site locations, 11,000–8000 BP

Period 4: 11,000–8000 BP

One hundred and eighty-seven dated samples from 165 separate site locations were included in this period (Figures 8 and 9). These included 51 archaeological dates (from 16 sites), 115 geological dates (from 102 sites), and 18 palynological dates (from 11 sites). It was during this period that the distribution of dated sites came closest to encompassing the entire length of the ice-free corridor, from the northern coast and Beringian Refugia to the Canada/United States border. Several gaps appeared in this distribution that may reflect a sporadic or patchy colonization process of recently deglaciated landscape. These gaps exist between the Peace Cluster and the Athabasca Cluster and between the Athabasca Cluster and the Northeastern Cluster. The area in between these clusters may not necessarily have been devoid of all plants and animals but were substantially more barren to the point that the preservation of datable material was more unlikely.

DISCUSSION

I have interpreted these distributions as representing evidence of areas able to support plant and animal life while those areas devoid of dated samples could not. Such an interpretation has been proposed by other researchers (e.g. Burns 1996:107–12; Wilson 1996:97–105). An alternative interpretation could involve a lack of research in areas devoid of dated samples, a lack of exposure of appropriate sediment layers, or a lack of preservation.

Figure 3A should dispel the notion that a lack of research has greatly influenced the distributions. It shows that dated samples have been recovered from throughout the study area. In addition, date lists (e.g. Clague 1980; Jackson and Pawson 1984; Bobrowsky and Rutter 1992:16–17; Lemmen et al. 1995; Liverman et al. 1989; Burns and Young 1994; Burns 1996; Young et al. 1999; Young et al. 1994) that include dates both younger and older than the dates included in this study provide additional evidence that a lack of research is not an acceptable explanation. Similarly, the presence of dated samples from geological contexts older than 20,000 BP indicates that a lack of exposure of appropriate geological sections cannot explain the distribution. Finally, I would argue that the lack of preservation supports the interpretation presented above because the areas lacking dated samples were barren only in the sense that they could not support sufficient plant or animal populations to leave evidence in the geological record, not that they were necessarily devoid of all life (Wilson 1996: 97–105).

Palynology provides support for such an interpretation. In palynology, pollen grains are counted within a specified volume of sediment. For these counts to be statistically meaningful, a minimum number of grains must be counted per volume analyzed (Berglund and Ralska-Jasiewiczowa 1986: 462). This means that layers of sediment that do not reach these minimum counts can be considered barren. I would argue, by rough analogy, that the same is true for geological layers in areas that have not as yet provided dated samples.

I would further argue that if the environment were not productive enough to leave evidence in the geological record than it could not support human populations. Although future research may add new dated sample locations, the most parsimonious explanation of the present evidence indicates that the corridor could not have been used as an early human migration route until after 11,000 BP. This is too late to account for Clovis, which first appears about 11,500 BP (Taylor et al. 1996). Thus, alternative migration routes or time periods must be considered to explain the appearance of Clovis and Folsom at the end of the Pleistocene.

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APPENDIX

Table 1: Site Identification (Site Name, Date±error (1 SD), Lab No., Reference)

1. Rocky Mnt. House, 18430±340, WAT-130, Berry and Dimmie 1982
2. Blufish Cave 2, 19640±170, RIDDL-330, Morlan ±2001
3. Bluefish Cave 3, 18970±14 90, TO-1266, Morlan 2001
4. Bluefish Cave 2, 17880±330, CRNL-1221, Morlan 2001

5. Bluefish Cave 3, 14370±130, RIDDL-557, Morlan 2001
6. Scroggie Creek, 16200±70, GSC-1893, Blake 1988
7. Upper Porcupine River, 15920±110,GSC-2431, Lowdon and Blake 1980
8. Bluefish Cave 2, 15540±70, GSC-3053, McNeely 1989
9. Old Crow River, 14390±80, GSC-730-2, Blake 1988
10. Sutherland, 14040±470, S-685, Rutherford et al. 1979; Christiansen 1979
11. Medicine Hat, 15200±130, GSC-1399, Lowdon and Blake 1975
12. Provincial Park, 16790±270, AECV-681C, Evans and Campbell 1992
13. Empress CPR Pit, 14200±560, GSC-119, Lowdon and Blake 1975
14. Cartwright Lake, 15670±960, TO-5190, Beierle and Smith 1998
15. Riddell series, 15340±500, S-1305, Rutherford et al. 1979
16. King Point, 11300±50, GSC-3982, Blake 1987
17. Garry Island, 11300±190, S-278, Lowdon et al. 1971
18. Garry Island, 11700±250, S-277, Lowdon et al. 1971
19. Eskimo Lakes, 13000±70, GSC-1995, Blake 1987
20. Eskimo Lakes, 12900±80, GSC-1784-2, Blake 1987
21. Twin Lakes, 11470±70, GSC-1514, Lowdon and Blake 1973
22. Pearce Point, 11790±170, AECV-643Cc, McNeely and Johnson 1992
23. Coppermine, 11170±80, TO-1231, McNeely and Johnson 1992
24. Mountain River, 11440±90, TO-1191, Smith 1992; Lemmen et al. 1995
25. Mountain River, 11530±170, I-3734, Smith 1992; Lemmen et al. 1995
26. San Sault Rapid, 11200±110, GSC-1573, Lowdon and Blake 1979

27. Mountain River, 11140±160, TO-1190; Smith 1994; Smith 1992

28. Mountain River, 11760±90, I-3913, Smith 1994; Smith 1992
29. Little Bear River, 11550±180, I-15020, Smith 1994; Lemmen et al. 1995

30. Andy Lake, 12060±80, TO-2295, Szeicz et al. 1995

31. Bluefish Cave 1, 12900±50, GSC-2881, Cinq-Mars 1991
32. Bluefish Cave 1, 12845±250, CRNL-1220, Morlan 2001
33. Bluefish Cave 1, 12830±60, CAMS-23468, Morlan 2001
34. Bluefish Cave 1, 11570±60, CAMS-23472, Morlan 2001

35. Bluefish Cave 1, 12210±210, RIDDL-277, Morlan 2001
36. Bluefish Cave 1, 13580±80, CAMS-23473, Morlan 2001
37. Bluefish Cave 3, 13390±180, RIDDL-279, Harington and Cinq-Mars 1979
38. Bluefish Cave 3, 12370±440, CRNL-1236, Morlan 2001
39. Bluefish Cave 3, 13350±100, BETA-129151, Morlan 2001
40. Old Crow, MkVl-9, 11990±90, I-7765, Morlan 1980
41. Upper Porcupine, 13500±160, GSC-2553, Lowdon and Blake 1980
42. Caribou River, 12400±60, GSC-3691, McNeely and McCuaig 1991
43. Snake River, 11800±70, GSC-2745, McNeely 1989
44. Snake River, 11700±50, GSC-2693, McNeely 1989
45. North Fork Pass, 11250±80, GSC-470, Lowdon and Blake 1968
46. Old Crow, MkVl-9, 12220±750, QU-783, Morlan 1980
47. Old Crow, MkVl-9, 12460±220, I-3574, Morlan 1980
48. Rocky Mtn Portage, 11600±1000, I-2244A, Mathews 1980
49. Fort St. John, 13970±170, TO-2742, Catto et al. 1996
50. Boone Lake, 11700±260, SFU-223, White and Mathewes 1986
51. Clover Bar S & G, 11620±170, AECV-1203C, Burns and Young 1994
52. North Sask River, 11430±420, S-2385, Rains and Welch 1988
53. Crowfoot Lake, 11330±220, CAMS-3065, Reasoner et al. 1994
54. Clark Gravel Pit, 11370±90, GSC-613, Lowdon et al 1967
55. Clark Gravel Pit, 11100±80, GSC-989, Lowdon and Blake 1970
56. Gunworth, 12160±250, S-198, McCallum and Wittenberg 1965

57. Marieval, 12030±210, S-553, Christiansen 1979

58. Camp Mackay, 11120±150, S-793, Rutherford et al. 1979
59. Esterhazy, 11260±150, S-794, Rutherford et al. 1979

60. Kyle, 12080±200, S-246, MaCallum and Wittenberg 1968

Table 1: Site Identification (Site Name, Date±error (1 SD), Lab No., Reference)

61. Gallelli Gravel Pit, 11300±290, RL-757, Wilson and Churcher 1978
62. Elk Valley, 11920±120, GSC-2142, Harrison 1976
63. Elk Valley, 12200±80, GSC-2275, Harrison 1976
64. Oldman Drainage, 11220±60, BETA-79915, Morlan 2001
65. Lindo Bluff, 11200±100, GSC-805, Lowdon and Blake 1968
66. Scrimbit, 11720±310, S-83, Rutherford et al. 1979
67. Scrimbit, 11520±310, S-80, Rutherford et al. 1979
68. Frenchman Valley, 11480±260, S-2932, Christiansen and Sauer 1983
69. Baillie Island, 9580±70, GSC-2030, Lowdon and Blake 1978
70. Cape Monte Casino, 9020±40, GSC-1989, Lowdon and Blake 1978
71. Nicholson Point, 9020±80, GSC-4362, McNeely and McCuaig 1991
72. Liverpool Bay, 9180±80, GSC-1327, Lowdon and Blake 1973
73. Pelly Island, 9180±60, GSC-2197, Lowdon and Blake 1979
74. Backhouse River, 10900±40, GSC-1853, Lowdon and Blake 1976
75. Komakuk Beach, 10200±60, GSC-1838, Lowdon and Blake 1976
76. Komakuk, 9900±100, GSC-4342, McNeely and Jorgensen 1992
77. Komakuk, 10580±370, TO-651, McNeely and Jorgensen 1992
78. Pauline Cove, 9380±90, GSC-1483, Lowdon and Blake 1976
79. Garry Island, 9500±150, S-276, McCallum and Wittenberg 1968
80. Garry Island, 9730±70, GSC-575, Lowden et al. 1971
81. Eskimo Lakes, 9180±50, GSC-2023, Blake 1987
82. Eskimo Lakes, 10300±60, GSC-1936, Blake 1987
83. Engigstciak, 9870±80, RIDDL-362, Cinq-Mars 1991
84. Engigstciak, 9770±180, RIDDL-281, Cinq-Mars 1991
85. Engigstciak, 9870±180, RIDDL-319, Cinq-Mars 1991
86. Eskimo Lakes, 9130±140, GSC-1653, Blake 1987
87. Eskimo Lakes, 10700±130, GSC-1710, Blake 1987
88. Sabine Point, 8980±50, GSC-3914, Blake 1987
89. Sabine Point, 11000±50, GSC-3986, Blake 1987
90. Sabine Point East, 9940±50, GSC-2022, Lowdon and Blake 1976
91. Tuktoyaktuk Pen., 9560±80, GSC-1169, Lowdon and Blake 1973
92. Zed Lake, 9640±180, GSC-1469-3, Lowdon and Blake 1976
93. Zed Lake, 9790±90, GSC-1469-2, Lowdon and Blake 1976
94. Coal Mine Lake, 10300±60, GSC-3729, McNeely and Jorgensen 1992
95. Holmes Creek, 9340±130, GSC-1495, Lowdon and Blake 1978
96. Keats Point, 10840±180, AECV-644Cc, McNeely and Jorgensen 1992
97. Clinton Point, 10340±140, AECV-642CC, McNeely and Jorgensen 1992
98. Clinton Point, 10410±140, AECV-645CC, McNeely and Jorgensen 1992
99. Buchanan River, 9810±60, GSC-4347, McNeely and McCuaig 1991
100. Buchanan River, 10700±50, GSC-4318, McNeely and McCuaig 1991
101. Tinney Point, 10000±170, AECV-462CC, McNeely and Jorgensen 1992
102. Tinney Point, 10620±160, AECV-444CC, McNeely and Jorgensen 1992
103. Buchanan River, 10600±60, GSC-4339, McNeely and Jorgensen 1992
104. Clifton Point, 10700±50, GSC-4390, McNeely and McCuaig 1991
105. Clifton Point, 8890±60, GSC-4425, McNeely and McCuaig 1991
106. Clifton Point, 10300±50, GSC-4402, McNeely and McCuaig 1991
107. Clifton Point, 10400±50, GSC-4424, McNeely and McCuaig 1991
108. Clifton Point, 9300±540, AECV-712CC, McNeely and Jorgensen 1992
109. Clifton Point, 9600±140, AECV-473CC, McNeely and Jorgensen 1992
110. Harding River, 10530±260, I(GSC)-25, Walton et al. 1961
111. Dolphin Strait, 10420±540, AECV-713Cc, McNeely and Jorgensen 1992
112. Dolphin Strait, 10040±240, AECV-474Cc, McNeely and Jorgensen 1992
113. Kugaryuk River, 9100±180, I(GSC)-16, Walton et al. 1961
114. Coppermine, 9540±40, GSC-4696, McNeely and Jorgensen 1992
115. Basil Bay, 9480±60, GSC-4930, McNeely and Jorgensen 1992
116. Coppermine, 10700±50, GSC-4916, McNeely and Jorgensen 1992
117. Coppermine, 9190±80, GSC-4709, McNeely and Jorgensen 1992
118. Basil Bay, 9120±60, GSC-4845, McNeely and Jorgensen 1992
119. Richardson River, 10300±120, GSC-3663, Blake 1983
120. Coppermine, 9800±140, AECV-403Cc, McNeely and Jorgensen 1992
121. Cox Lake, 9430±60, GSC-3941, Blake 1987
122. Coppermine River, 9820±50, GSC-3327, Blake 1983
123. Coronation Gulf, 9801±50, AECV-404Cc, McNeely and Jorgensen 1992
124. Coronation Gulf, 9560±130, AECV-472Cc,McNeely and Jorgensen1992
125. Coronation Gulf, 9620±70, GSC-3584, Blake 1983
126. Tree River, 10215±220, I(GSC)-17, Walton et al. 1961

Table 1: Site Identification (Site Name, Date±error (1 SD), Lab No., Reference)

127. Old Crow Basin, 10400±90, GSC-2773, Blake 1984
128. Rat River, 9970±90, GSC-147, Dyck and Fyles 1964
129. Blue Fish Cave 1, 10230±140, RIDDL-559, Morlan 2001
130. Blue Fish Cave 2, 10230±140, RIDDL-561, Morlan 2001
131. Blue Fish Cave 3, 10820±60, CAMS-23467, Morlan 2001
132. Whitefish Lake, 9530±90, GSC-1829, Lowdon et al. 1977
133. Grandview Hills, 9560±60, GSC-2298, Lowdon and Blake 1979
134. Upper Porcupine, 9190±50, GSC-3573, Lowdon and Blake 1980
135. Caribou River, 9780±60, GSC-3573, McNeely 1989
136. Peel River, 10600±90, GSC-2393, Lowdon and Blake 1979
137. Many Beaver Lake,8910±70, GSC-1865, McNeely 1989
138. Hungry Creek, 8980±50, GSC-2341, Hughes et al. 1981; McNeely 1989
139. Hunker Creek, 9520±70, GSC-73, Dyck and Fyles 1963
140. Corkery Creek, 9000±50, GSC-4020, McNeely and McCuaig 1991
141. Norman Wells, 9320±50, GSC-2206, Lowdon and Blake 1979
142. Bell's Lake, 10230±150, TO-2375, Szeicz et al. 1995
143. Great Bear River, 10600±130, GSC-2328, Lowdon and Blake 1979
144. Keele Lake, 9560±70, TO-3989, Szeicz et al. 1995
145. Howard=s Pass, 9610±50, GSC-3532, Blake 1983
146. Root River, 10290±180, AECV-917C, Smith 1992; Smith 1994
147. Fort Simpson, 9110±240, AECV-916C, Smith 1994
148. Peace Delta, 9830±80, WAT-2662, Smith 1994
149. Peace Delta, 9850±80, WAT-2661, Smith 1994
150. Athabasca Delta, 9710±130, AECV-1183C, Smith 1994
151. Athabasca Delta, 9910±50, GSC-4302, Smith 1994
152. Charlie Lake Cave, 10770±120, SFU-454, Fladmark et al. 1988
153. Charlie Lake Cave, 10380±160, SFU-378, Fladmark et al. 1988
154. Charlie Lake Cave, 10290±100, CAMS-2137, Fladmark et al. 1988
155. Charlie Lake Cave, 10100±210, RIDDL-392, Fladmark et al. 1988
156. Charlie Lake Cave, 10450±150, SFU-300, Fladmark et al. 1988
157. Charlie Lake Cave, 10560±80, CAMS-2134, Fladmark et al. 1988
158. Charlie Lake Cave, 9670±150, CAMS-2136, Fladmark et al. 1988
159. Charlie Lake Cave, 9760±160, SFU-355, Fladmark et al. 1988
160. Charlie Lake Cave, 9490±140, CAMS-2318, Driver et al. 1996
161. Charlie Lake Cave, 10500±80, CAMS-2129, Fladmark et al. 1988
162. Ostero Gravel Pit, 10240±160, AECV-1206C, Lowdon and Blake 1979
163. Clayhurst Pit, 10580±210, CAMS-398, Apland and Harington 1994
164. Clayhurst Pit, 10600±160, AA-1219, Apland and Harington 1994
165. Clayhurst Pit, 10340±150, CAMS-150, Apland and Harington 1994
166. Clayhurst Pit, 10230±140, AECV-1558C
167. Clayhurst Pit, 10750±180, RIDDL-220
168. Finlay-Parsnip, 9280±100, GSC-1497
169. Watino, 10200±50, GSC-2895, Lowdon and Blake 1979
170. Watino, 10200±50, GSC-2902, Lowdon and Blake 1979
171. Wakaluk Quarry, 9080±310, S-2614, Burns 1986
172. Saskatoon Mtn., 9380±360, AECV-1474C, Beaudoin et al. 1996
173. Saskatoon Mtn, 9360±60, CAMS-12365, Beaudoin et al. 1996
174. Wood Bog, 9630±650, AECV-470C, Beaudoin et al 1996
175. Wood Bog, 9730±110, AECV-1620C, Beaudoin et al 1996
176. Tumbler Ridge, 10380±100, BETA-44201, Woolf 1993
177. Summit Creek, 10000±50, GSC-2964, Lowdon and Blake 1980
178. Freeman River, 10900±80, GSC-859, Lowdon et al. 1971
179. Whitemud Creek, 8195±1090, S-1798, Rains and Welsh 1988
180. North Sask. River, 10740±470, S-1923, Lowdon and Blake 1979
181. Lorraine Lake, 9180±320, AECV-591C, Beaudoin 1991
182. Denholm Testhole, 10880±660, S-1374, Christiansen 1983
183. Eagle Testhole, 10760±780, S-2097, Christiansen 1983
184. Nordegg Pond, 8930±150, BETA-252261, Mandryk 1992
185. North Sask. Crossing, 9330±90, GSC-332, Dyck et al. 1966
186. James Pass, 9750±80, TO-2999, Ronaghan 1993
187. James Pass, 10140±80, TO-3000, Ronaghen 1993
188. Three Hills, 9670±60, I-8579, Shackleton and Hills 1977
189. Three Hills, 9720±150, GSC-1894, Shackleton and Hills 1977
190. Crowfoot Lake, 9060±370, CAMS-3064., Reasoner et al. 1994
191. Crowfoot Lake, 10070±420, CAMS-3177, Reasoner et al. 1994
192. Crowfoot Lake, 10020±70, CAMS-3063, Reasoner et al. 1994

Table 1: Site Identification (Site Name, Date±error (1 SD), Lab No., Reference)

193. Crowfoot Lake, 9470±70, CAMS-6843, Reasoner et al 1994
194. Green, 10800±160, S-227, McCallum and Wittenberg 1965
195. Kenaston, 10150±200, S-97, McCallum and Wittenberg 1962
196. Lake O=hara, 10100±200, RIDDL-433, Reasoner and Hickman 1989
197. Lake O=hara, 10060±160, RIDDL-511, Reasoner and Hickman 1989
198. Wiseton, 10600±140, S-232, Rutherford et al. 1973
199. Copper Lake, 10490±160, RIDDL-664, White and Osborn 1992
200. Copper Lake, 9650±150, RIDDL-88, White and Osborn 1992
201. Yorkton, 10300±80, GSC-1356, Lowdon and Blake 1976
202. Griffen Gravel Pit, 10760±80, GSC-612, Lowden et al. 1967
203. Vermilion Lakes, 10180±130, RIDDL-73, Fedje et al. 1995
204. Vermilion Lakes, 9700±130, RIDDL-83, Fedje et al. 1995
205. Vermilion Lakes, 10040±160, RIDDL-72, Fedje et al. 1995
206. Vermilion Lakes, 10040±200, RIDDL-71, Fedje et al. 1995
207. Vermilion Lakes, 10100±210, RIDDL-81, Fedje et al. 1995
208. Vermilion Lakes, 10570±150, RIDDL-85, Fedje et al. 1995
209. Vermilion Lakes, 9570±150, RIDDL-75, Fedje et al. 1995
210. Vermilion Lakes,9870±230, RIDDL-317, Fedje et al. 1995
211. Vermilion Lakes, 10310±190, RIDDL-528, Fedje et al. 1995
212. Vermilion Lakes, 10060±220, RIDDL-84, Fedje et al. 1995
213. Vermilion Lakes, 10010±180, RIDDL-82, Fedje et al. 1995
214. Vermilion Lakes, 10210±130, RIDDL-282, Fedje et al. 1995
215. Vermilion Lakes, 10390±140, RIDDL-70, Fedje et al. 1995
216. Vermilion Lakes, 9840±60, GSC-3804, McNeely and McCuaig 1991
217. Vermilion Lakes, 10660±650, RIDDL-216, Fedje et al. 1995
218. Vermilion Lakes, 9880±140, AECV-121C, Fedje et al. 1995
219. Vermilion Lakes, 9840±200, RIDDL-77, Fedje et al. 1995
220. Vermilion Lakes, 10310±230, RIDDL-318, Fedje et al. 1995
221. Vermilion Lakes, 10270±100, RIDDL-79, Fedje et al. 1995
222. Vermilion Lakes, 10090±130, AECV-124C, Fedje et al. 1995
223. Vermilion Lakes, 10780±180, RIDDL-215, Fedje et al. 1995
224. Vermilion Lakes, 11000±1600, RIDDL-217, Fedje et al. 1995
225. Second Lake, 9455±450, S-2759, Fedje 1986
226. Kelliher, 9600±120, S-182, McCallum and Wittenberg 1965
227. Dinsmore, 10300±140, S-110, McCallum and Wittenberg 1962
228. Johnson Lake, 9440±230, TO-5186, Beierle and Smith 1998
229. Aquitaine Pit, 10200±140, GSC-3065, Blake 1986
230. EgPn-480, 9540±70, BETA-127235, Head 1999
231. Lower Burstall Lake, 9180±60, CAMS-20358, Beierle and Smith 1998
232. Kananakis Valley, 10400±60, GSC-2965, Lowdon and Blake 1980
233. Sioux Crossing, 10110±190, S-1304, Rutherford et al. 1979
234. Earl Grey, 10280±230, S-165, McCallum and Wittenberg 1965
235. Toboggan Lake, 10400±70, TO-149, MacDonald et al. 1991
236. Toboggan Lake, 9100±360, TO-211, MacDonald et al. 1991
237. Heron Eden, 9290±110, S-3308, Morlan 2001
238. Heron Eden, 9010±120, S-3114, Morlan 2001
239. Heron Eden, 10290±100, S-3118, Morlan 2001
240. Herbert, 10000±300, S-41, McCallum and Dyck 1960
241. EaPo-100, Lindo Site, 9790±190, GAK-5097, Rutherford et al. 1984
242. The Gap, 9520±240, GX-0956, Reeves and Dormaar 1972
243. Taber Provincial Park, 10500±100, GSC-3, Dyck and Fyles 1962
244. Crane Valley, 10800±300, S-128, McCallum and Wittenberg 1962
245. Scrimbit, 10400±250, S-85, Rutherford et al. 1979
246. Scrimbit, 10000±250, S-81, Rutherford et al. 1979
247. Niska, 8475±650, S-2510, Meyer and Liboiron 1990
248. Niska, 10880±70, TO-956, Meyer and Liboiron 1990
249. DjPm-16, Oldman River, 9600±210, AECV-746C, Van Dyke 1994
250. Frenchman Valley, 9225±330, S-2931, Klassen 1993
251. Robsart, 9500±40, GSC-4098, McNeely and McCuaig 1991
252. Val Marie, 9880±110, TO-2212, Klassen 1993
253. Val Marie, 9910±80, TO-1711, Klassen 1993
254. Fletcher Site, 9380±110, TO-1097, Wilson et al. 1991
255. Oldman River, 11000±250, S-68, McCallum and Dyck 1960