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ALBERTA RADIOCARBON DATES

LIONEL E. JACKSON, Jr.
MARK PAWSON

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Listings of radiocarbon dates with regional significance to the late Quaternary geochronology and geomorphology of Alberta

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Critical Reader

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INTRODUCTION

Radiocarbon dating is the most widely applicable technique for assigning absolute ages to earth materials in the age range of zero to ca. 50 000 years before present (BP)[1,2].

More than five hundred radiocarbon dates from Alberta have been published in the scientific literature and university theses prior to 1982[3]. These dates were produced in the course of geological, archeological[4,5], and paleoclimatic investigations. Selected dates from this total are assembled and organized under twelve headings which pertain to the Quaternary history and animal life of Alberta. Not all of the paleoclimatic and archeological dates have direct geological significance, nor does published information accompanying these dates always provide adequate stratigraphic information to allow a geological interpretation of them. Consequently, the dates appearing in the accompanying tables include only those for which published information is sufficient to assign regional geological significance rather than merely site-specific value.

The authors realize that regional significance, like beauty, may dwell in the eye of the beholder. Consequently, the choice of radiocarbon dates appearing in these lists was a subjective one based upon the stratigraphic data accompanying the dates. Dates lacking any stratigraphic information or insufficient information to establish their stratigraphic context were not selected for the accompanying tables. Dates on specific phenomena, such as landslide activity, which were not of significance to regional geochronology (e.g., glaciation or deglaciation) or regional geomorphic changes (e.g., regional stream alluviation) were also not included. Inclusion or exclusion of dates was not decided on the basis of date quality, e.g., the likelihood of contamination by younger or older carbon, chronological conflicts with other dates, etc. Radiocarbon dates may initially be rejected as being unacceptable only to find later that the dates are reasonable but the stratigraphic frameworks of the dates are erroneous.

[1]The "present" is taken, by international convention, to be the calendar year 1950 AD.

[2]For a description of the principles of the conventional carbon-14 dating see Hedges (1979). For a description of currently experimental methodology see Bennett (1979).

[3]Unpublished dates are included by permission of the person responsible for them.

[4]A radiocarbon date list for archeological sites is available from the Alberta Provincial Museum, Edmonton, Alberta.

[5]The radiocarbon dates were numbered in order of our compilation and evaluation, and these numbers were used as site designators in the tables and figures. These site numbers have no significance beyond their usefulness in preparing this compilation. The order of dates in each table is by geographic location starting from the southeast corner of Alberta and progressing northwest and/or north.

INTRODUCTION

La datation au carbone radioactif est la technique la plus universelle pour attribuer des âges absolus aux matières que renferme la planète et dont les origines varient de zéro à environ 50 000 années BP (abbréviation de Before Present, soit avant le présent)[1,2].

Plus de 500 dates établies de cette manière en Alberta ont été publiées dans des documents scientifiques et des thèses universitaires avant 1982[3]. Ces dates ont été attribuées au cours d'études géologiques, archéologiques[4,5] et paléoclimatiques. Certaines d'entre elles ont été retenues et sont réunies et classées sous 12 rubriques ayant trait à l'histoire et à la vie animale en Alberta pendant le Quaternaire. Les dates paléoclimatiques et archéologiques n'ont pas toutes une importance géologique directe, pas plus que l'information publiée également offerte ne donne de renseignements stratigraphiques suffisants pour en permettre l'interprétation géologique. Par conséquent, les dates qui figurent dans les tableaux qui les accompagnent ne comprennent que celles pour lesquelles il existe suffisamment de données publiées pour pouvoir leur attribuer une importance géologique régionale plutôt qu'une valeur propre à l'emplacement.

Les auteurs se rendent compte que l'importance régionale, tout comme la beauté, est une valeur subjective. Il ne faudra donc pas s'étonner qu'ils aient procédé à un choix subjectif des dates qui paraissent dans les listes, selon les données stratigraphiques qui les accompagnaient. Les dates auxquelles viennent s'ajouter que très peu de données stratigraphiques ou de données insuffisantes pour en définir le contexte stratigraphique n'ont pas été retenues dans les tableaux. Les dates attribuées à des phénomènes particuliers comme des glissements de terrain, sans valeur pour la géochronologie régionale (p. ex., glaciation ou déglaciation) ou les transformations géomorphologiques régionales (p. ex., sédimentation fluviatile régionale) ont également été omises. Cette décision d'inclure ou d'exclure des dates ne s'est pas faite selon la valeur qualitative de la date (notamment, la probabilité de contamination par du carbone plus jeune ou plus vieux, des conflits chronologiques avec d'autres dates, etc.). Les dates établies au carbone radioactif peuvent parfois, au premier abord, sembler inacceptables pour ensuite s'avérer raisonnables, mais assorties d'un contexte stratigraphique erroné.

[1]*De par une convention internationale, le "présent" est l'année 1950 du calendrier actuel.*

[2]*Pour en savoir davantage sur les principes de la datation classique au carbone 14, consulter Hedges (1979). Pour une description des méthodes actuellement à l'essai, voir Bennett (1979).*

[3]*Certaines dates inédites sont incluses avec le consentement de l'intéressé.*

[4]*On peut se procurer une liste des dates établies au moyen du radiocarbone et utilisées lors de fouilles archéologiques auprès du Alberta Provincial Museum, à Edmonton (Alberta).*

[5]*Les dates établies au radiocarbone ont été numérotées au fur et à mesure de leur compilation et de leur évaluation, et ces numéros ont été repris dans les tableaux et les figures pour indiquer les emplacements. Ces numéros n'ont d'autre utilité qu'aux fins de la présente compilation. Les dates sont classées dans les tableaux selon le lieu, partant de l'extrémité sud-est vers le nord-ouest et le nord de l'Alberta.*

Two types of comments are presented with the dates in the accompanying tables. The "comments" column consists of the authors' interpretations of the significance of the date based upon the reported sample stratigraphy for each sample. The footnotes consist of technical data and other information provided in the sample reference. We have also added commentaries on the relationships of dates to other related dates; these latter commentaries in the footnotes are followed by L.J. (the senior author's initials) in order to avoid confusion as to what was provided by the original reference and what are our comments based upon a number of related dates.

The location co-ordinates presented in the tables are approximate beyond the minute range. While assembling this list we occasionally found published co-ordinates that wildly disagreed with accompanying published descriptions of the collection site locations. In such cases we changed the original co-ordinates to fit with the description.

Radiocarbon years are not synonymous with calendar years. The radiocarbon content of the atmosphere has varied significantly in the past (Fig. 1). Those wishing to correct radiocarbon ages to calendar years are referred to calibration charts and tables of Stuiver and Suess (1966), Olsson (1970), Suess (1970), Damon et al., (1972, 1974), Michael and Ralph (1974), Stuiver (1978), and Klein et al., (1982).

On trouvera, dans les tableaux, deux types de remarque se référant aux dates. La colonne des "remarques" comprend les interprétations de l'importance de la date faites par les auteurs selon la stratigraphie signalée pour chaque échantillon. Les notes en bas de page fournissent des données techniques et d'autres renseignements figurant dans la source. On a, en outre, ajouté des commentaires sur les rapports entre ces dates et d'autres dates connexes; les commentaires en bas de page sont suivis des initiales L.J. (auteur principal), qui permettent de les distinguer du contenu de la source originelle et des remarques émises par les auteurs à partir de quelques dates connexes.

Les coordonnées géographiques fournies dans les tableaux sont précises à la minute près. En dressant la liste, les auteurs ont à l'occasion découvert des coordonnées, dans les sources, qui dérogeaient considérablement des descriptions qui les accompagnaient de l'endroit où le prélèvement avait eu lieu. Lorsque de tels cas ce présentaient, il a fallu modifier les coordonnées originelles de façon à les faire correspondre au lieu décrit.

Les dates établies au radiocarbone ne coincident pas avec les années civiles. La teneur en carbone 14 de l'atmosphère, dans le passé, a considérablement varié (fig. 1). Ceux qui désirent convertir l'âge absolu en années civiles sont priés de se référer aux tableaux et tables de datation de Stuiver et Suess (1966), d'Olsson (1970), de Suess (1970), de Damon et coll. (1972, 1974), de Michael et Ralph (1974), de Stuiver (1978) et de Klein et coll. (1982).

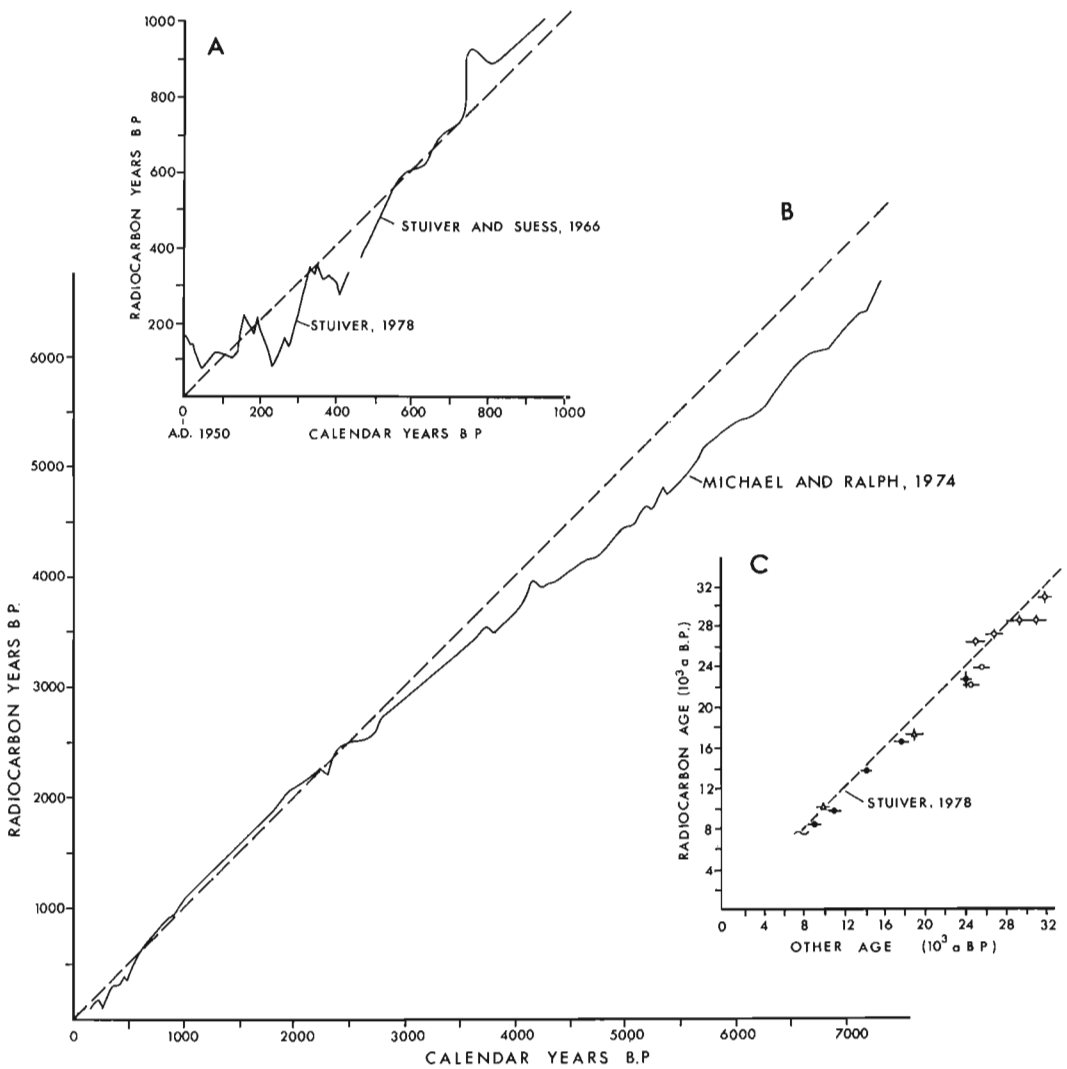

Figure 1.

Relationships between radiocarbon age and age obtained through other geochronological methods

Discussion of tables

The radiocarbon dates listed in the twelve tables are as follows:

Table 1 – Supratill dates beyond the range of radiocarbon dating. This table includes dates on samples taken from nontill sediments which are not overlain by glacial till. These dates place a minimum age on the last incursion of glacial ice into the area of sampling.

Table 2 – Subtill dates beyond the range of radiocarbon dating. These dates were determined on samples obtained from sediments underlying one or more tills. They place a minimum age on the subtill sediments and a maximum age on the overlying tills.

Table 3 – Finite subtill radiocarbon dates. This table contains finite dates obtained from samples under one or more tills; however, these dates assign a maximum age to the deposition of the overlying till by glacial ice and directly date the sediments from which the dated sample was obtained.

Table 4 – Intratill and supratill radiocarbon dates in the range of 20 000 to 50 000 BP. The supratill dates indicate a minimum time for the start of ice-free conditions following the deposition of the till. The one intratill date provides a maximum age for the deposition of the till.

Table 5 – Supratill radiocarbon dates in the range of 12 000 to 20 000 BP. These dates indicate a minimum time for the start of ice-free conditions.

Table 6 – Supratill radiocarbon dates in the range of 8500 to 12 000 BP. Apart from their younger ages these dates have the same significance as those in Table 5. They place absolute minimum limits on the disappearance of glacial ice.

Table 7 – Radiocarbon dates associated with proglacial lakes. These dates were determined on samples obtained from glacial lake sediments or sediments which immediately overlie the glacial lake sediments.

Table 8 – Radiocarbon dates indicating postglacial rates of stream alluviation and/or erosion.

Table 9 – Dates related to tephras[6]. These dates were determined on samples which closely overlie, underlie or are present within tephras. They provide minimum, maximum or direct[7] ages respectively for these tephras.

Table 10 – Dates related to paleosols. These dates provide minimum or maximum ages for buried soils. Dates determined directly on soil materials should be regarded as representing a mean age for the organic constituents of the soil at the time the soil was buried.

[6]Three tephras have been dated in Alberta: St. Helens Y, Mazama, and Bridge River. The Glacier Peak, which is also present, is undated in Alberta and consequently, no references to it appear in Table 9. Two dates have been reported for it in the United States: 12 000 ±310 BP (WSU-155) from Washington State (Fryxell, 1965) and 12 750 ±350 BP (W1644) from Montana (Ives et al., 1967, p. 517).

[7]Direct ages refer to situations where datable materials are incorporated within the tephra, e.g., an animal killed and butchered by hunters during a volcanic ash fall, so that its bones are buried within the tephra. Dates on these bones are direct dates on the tephra.

Explication des tableaux

Les dates établies au radiocarbone sont ventilées en 12 tableaux comme suit:

Tableau 1 *– Tills supraglaciaires impossibles à dater au carbone radioactif. Le préent tableau comprend la dataton d'échantillons prélevés dans les dépôts autres que le till et, d'ailleurs, non recouverts par des tills glaciaires. Les dates établies fixent un âge minimum pour la dernière avancée glaciaire dans la région d'échantillonnage.*

Tableau 2 *– Tills sous-glaciaires impossibles à dater au carbone radioactif. Les dates ont été fixées d'après des échantillons de sédiments prélevés sous un ou plusieurs des tills. Elles attribuent un âge minimal aux sédiments sous-glaciaires et un âge maximal aux dépôts de till qui les recouvrent.*

Tableau 3 *– Datation absolue au carbone radioactif de tills sous-glaciaires. Le présent tableau établit les dates absolues selon des échantillons prélevés sous un ou plusieurs tills; les dates attribuent toutefois un âge maximum à la mise en place du till glaciaire susjacent et datent directement les sédiments d'où proviennent les échantillons.*

Tableau 4 *– Les tills intra et supraglaciaires datés au carbone radioactif varient en âge, entre 20 000 et 50 000 ans BP. Les dates attribuées aux dépôts supraglaciaires indiquent une limite de temps minimale au début de la déglaciation, après la mise en place du till. L'unique date attribuée aux dépôts intraglaciaires donne un âge maximum à la mise en place du till.*

Tableau 5 *– Les tills supraglaciaires datés au carbone radioactif varient en âge, entre 12 000 et 20 000 ans BP. Elles donnent une limite de temps minimale au début de la déglaciation.*

Tableau 6 *– Les tills supraglaciaires datés au carbone radioactif varient en âge, entre 8 500 et 12 000 ans BP. Sauf le fait qu'elles s'avèrent plus récentes, ces dates ont la même importance que celles du tableau 5. Elles imposent des limites maximales absolues à la disparition des glaces.*

Tableau 7 *– Dates établies au carbone radioactif, associées aux lacs proglaciaires. Elles ont été calculées au moyen d'échantillons prélevés des sédiments de lacs glaciaires ou de sédiments immédiatement susjacents.*

Tableau 8 *– Dates établies au carbone radioactif qui révèlent les rythmes d'alluvionnement et d'érosion par les cours d'eau après la glaciation.*

Tableau 9 *– Dates associées à des projections volcaniques[6] attribuées à des échantillons recueillis à la surface, en dessous ou à l'intérieur des téphras. Elles donnent l'âge minimum, maximum ou direct[7], respectivement, des téphras.*

Tableau 10 *– Dates attribuées à des paléosols. Elles attribuent des âges minimum ou maximum aux sols enfouis. Les dates établies directement à partir de matériaux du sol doivent être considérées comme donnant l'âge moyen d'éléments organiques du sol au moment de son enfouissement.*

[6]*Trois téphras ont été datés en Alberta: St. Helens Y, Mazama et Bridge Rier. Le Glacier Peak, également présent, n'a pas été daté en Alberta; c'est pourquoi il ne figure pas au tableau 9. Deux dates sont signalées à son sujet, aux Etats-Unis: l'Etat de Washington (Fryxell, 1965) rapporte 12 000 ± 310 BP (WSU-155) et le Montana (Ives et coll., 1967, p. 517), 12 750 ± 350 BP (W 1644).*

[7]*Les âges directs se rapportent à des matériaux datables intégrés aux téphras, par exemple un animal tué et dépecé par des chasseurs durant une pluie de cendres volcaniques, de sorte que les os sont enfouis dans le téphra. Par conséquent, les dates attribuées à ces ossements donnent directement l'âge du téphra.*

Table 11 – Dates on past mammalian fauna.

Table 12 – Radiocarbon dates from nearby areas of British Columbia, Saskatchewan, and Montana that have significant implications for Late Pleistocene and Holocene events in Alberta. This table gives radiocarbon dates from the immediately adjacent areas of adjoining provinces and the state of Montana which have the potential to clarify, corroborate, contradict, or simply augment the radiocarbon geochronology of Alberta.

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Any errors of fact or interpretation are entirely the responsibility of the authors.

Tableau 11 – *Dates attribuées à la faune mammifère du passé.*

Tableau 12 – *Datation au carbone radioactif de régions avoisinantes, en Colombie-Britannique, en Saskatchewan et dans le Montana qui ont eu une influence marquée sur les événements du Pléistocène récent et de l'Holocène, en Alberta. Ce tableau énumère les dates obtenues au carbone radioactif de régions immédiatement attenantes à des provinces adjacentes et à l'Etat du Montana, susceptibles de préciser, de corroborer, de contredire ou tout simplement d'accroître les données géochronologiques sur l'Alberta.*

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Les auteurs assument l'entière responsabilité des erreurs de fait ou d'interprétation qui auraient pu se glisser dans le texte.

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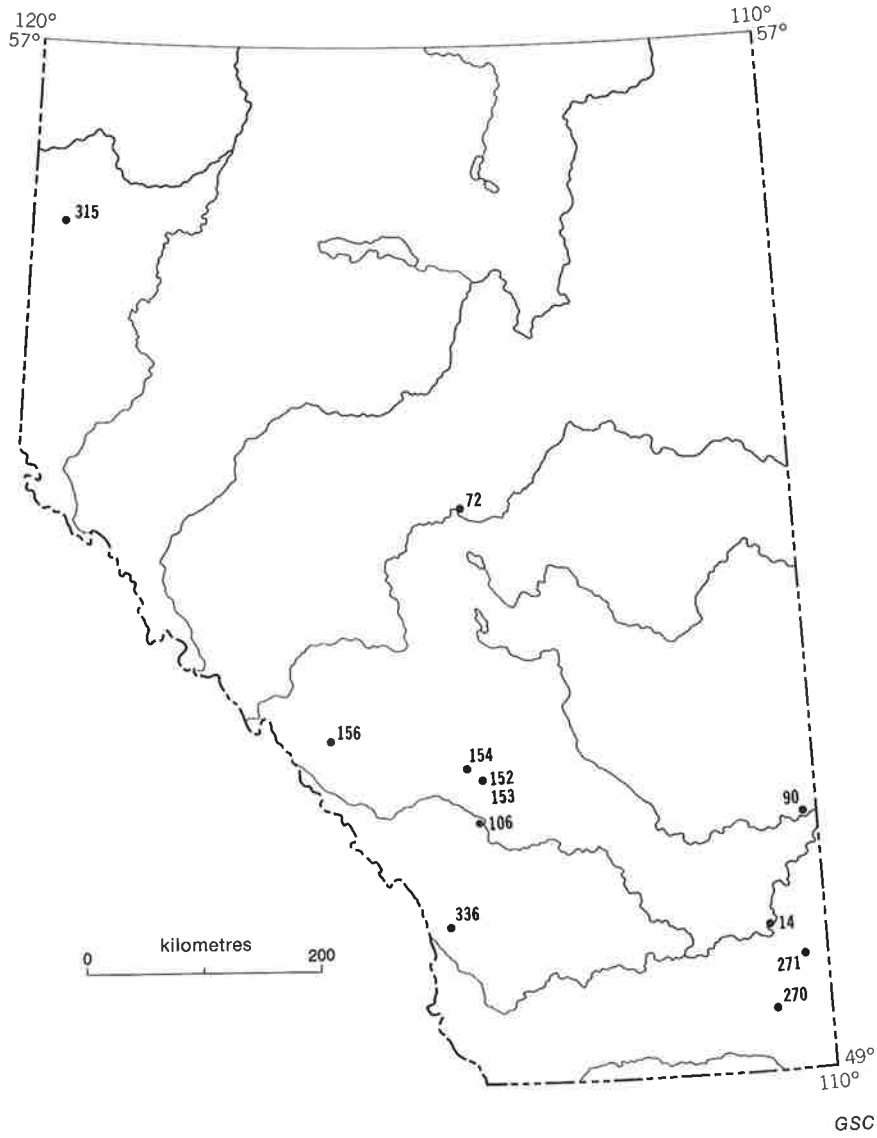

Figure 2. *Locations of dates listed in Tables 1 and 4*

Table 1. Supra-till dates beyond the range of radiocarbon dating

Site No. (cf. Fig. 2)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
14	GSC-780[e]	>30 000	Medicine Hat	50°07'45" 110°38'40"	1	25 (p. 219)	CSC	wood	Dates extensive mammal fauna.
152	S-204[f,g]	>35 000	Sharp Hills	51°21'00" 114°00'00"	3	44 (p. 365)	JGN	peat	Minimum date for Foothills Erratic Train.
156	S-213[g,h]	>33 000	Red Deer River	51°38'00" 115°50'00"	5	44 (p. 366)	JGN	charcoal	Minimum age for last glaciation in area.
315	WAT-361[i,j]	>30 000	Boone Lake	55°34'51" 119°25'43"	2	59 (p. 1872)	JMW	organic clay	Indicates ice free conditions during Late Wisconsinan.

[a] GSC, Geological Survey of Canada; S, University of Saskatchewan; WAT, University of Waterloo.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in reference list.

[d] CSC, C.S. Churcher; JGN, J.G. Nelson; JMW, J.M. White.

[e] no NaOH leach pretreatment; mixed with dead gas; one 3-day count; may be contaminated by modern rootlets.

[f] date greater than expected, compare with S-205. L.J.

[g] obtained from glaciofluvial gravels.

[h] date greater than expected.

[i] ^{13}C corrected $\delta^{13}C‰$ -26.6; possible error due to contamination by dead carbon.

[j] latitude and longitude calculated from site description.

Table 4. Intra and supra-till radiocarbon dates in the range of 20,000 to 50,000 years B.P.

Site No. (cf. Fig. 2)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
270	I-2607[e]	20 600 ± 410	Manyberries	49°28'10" 110°34'37"	2	4 (p. 121)	MJB	organic detritus and charcoal	Indicates area was not glaciated during Late Wisconsinan.
271	I-1878[e]	34 900 $\pm^{1000}_{800}$	Irvine	49°55'00" 110°16'15"	2	4 (p. 121)	MJB	charcoal	Indicates area was not glaciated during Late Wisconsinan.
336	GAK-5438[f]	23 100 ± 860	Plateau Mountain	50°11'00" 114°31'00"	7	11 (p. 1508)	JAB	bone collagen	Indicates ice did not reach level of January Cave during Late Wisconsinan.
90	GSC-1387[g]	20 400 ± 320	Empress	50°57'50" 110°00'50"	1	28 (p. 16)	WFS, CSC, AMS	bone fragments	Possible minimum date for ice-free interval during Late Wisconsinan.
106	GSC-2409[h]	49 400 ± 1000	Midnapore	50°54'40" 114°03'40"	3	30 (p. 7)	MR	wood	Maximum date for last advance of Laurentide Ice Sheet into area.
153	S-205[i]	33 500 ± 2000	Sharp Hills	51°21'00" 114°00'00"	3	44 (p. 365)	JGN	peat	Minimum age for Foothills Erratics Train and Late Wisconsinan glaciation.
154	S-206	26 700 ± 1400	Carstairs	51°20'00" 114°10'00"	3	44 (p. 365)	JGN	peat	Minimum age for Foothills Erratics Train and Late Wisconsinan glaciation.
72	GSC-1129[j]	21 700 ± 840	Duffield	53°24'00" 114°18'00"	1	36 (p. 288)	SP	humic acid[k]	Indicates area was not glaciated during Late Wisconsinan.

[a] GSC, Geological Survey of Canada; S, University of Saskatchewan; I, Teledyne Isotopes; GAK, Gakushuin Natural Radiocarbon.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in reference list.

[d] MJB, M.J. Bik; JAB, J.A. Burns; CSC, C.S. Churcher; JGN, J.G. Nelson; SP, S. Pawluk; MR, M. Rapsey; WFS, W.F. Smith; AMS, A.MacS. Stalker.

[e] latitude and longitude calculated from site description.

[f] obtained from cave sediments which overlie bedrock. L.J.

[g] thought to be more reliable than GSC-1199 although neither allows sufficient time for post-Late Wisconsinan incision of Red Deer River; possibly the valley was cut earlier.

[h] one 5-day count.

[i] compare with S-204, which was a greater date than expected. L.J.

[j] date suspect, possible contamination by dead carbon from local lignite outcrops.

[k] extracted from buried Ah horizon; mixed with dead gas; one 3-day count.

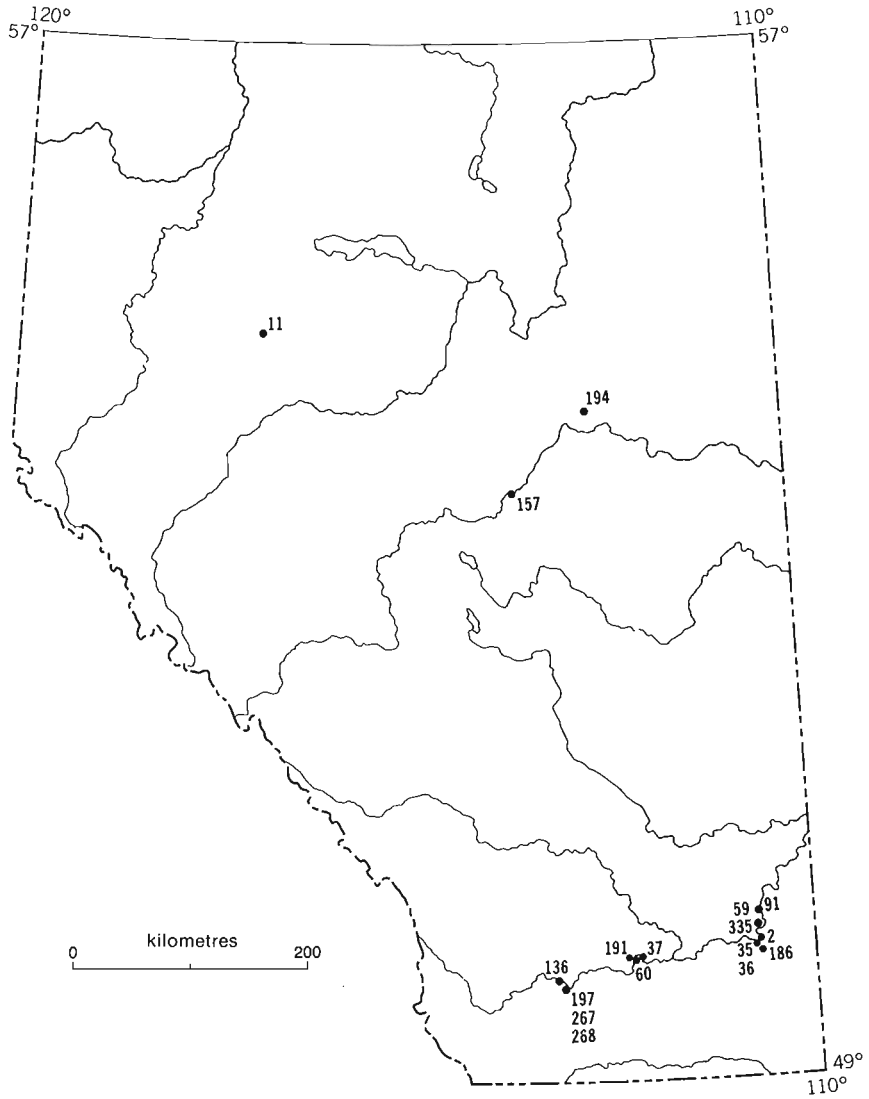

Figure 3. *Locations of dates listed in Table 2*

Table 2. Sub-till dates beyond the range of radiocarbon dating

Site No. (cf. Fig. 3)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
2	GSC-543	>46 700	Medicine Hat	50°04'00" 110°37'30"	1	33 (p. 13)	AMS	wood	Underlies 3-4 till sheets, sample possibly Sangamonian age.
35	GSC-847[e,f]	>36 000	Medicine Hat	50°02'20" 110°38'15"	1	26 (p. 66)	AMS	plant fragments[h]	Sample believed to be Yarmouthian or older.
36	GSC-876[e,g]	>36 000	Medicine Hat	50°02'10" 110°44'00"	1	26 (p. 66)	AMS	shells	Underlies 3 till sheets. Possibly Sangamonian age.
59	GSC-1044[i]	>38 000	Medicine Hat	50°07'45" 110°38'40"	1	36 (p. 288)	LMK	wood fragments	Sample from intertill silt and clay containing scattered bones.
91	GSC-1734[j]	>43 000	Medicine Hat	50°14'25" 110°39'15"	1	28 (p. 16)	AMS	wood	Sample believed to be Yarmouthian or Sangamonian age.
335	GX-210[k,l,m]	>36 600	Medicine Hat	50°04'00" 110°37'30"	1	56 (p. 68)	JAW	wood	Minimum age for Saskatchewan Gravels and Sands.
136	GSC-237[n]	>54 500	Oldman River	49°46'30" 113°01'30"	2	16 (p. 9)	AMS	wood	Sample from interglacial sediments.
37	GSC-888[e,o]	>37 000	Taber	49°55'30" 112°04'00"	1	26 (p. 67)	AMS	wood	Underlying 2 till sheets. Mid-Wisconsinan or Sangamonian age.
60	GSC-1233[p]	>49 000	Taber	49°55'45" 112°11'00"	1	36 (p. 288)	AMS	wood	Provides minimum age for "Taber child" remains (ref. 7).
191	S-65[q]	>32 000	Taber	49°56'00" 112°11'00"	2	41 (p. 75)	AMS	wood	From pebbly sand below surface till.
197	L-433-B[r]	>30 000	Lethbridge	49°45'48" 113°01'15"	2	52 (p. 22)	AMS	wood	Indicates "F" band older than Iowan Substage of Late Wisconsinan.
267	L-221-C[s]	>26 000	Lethbridge	49°46'30" 113°01'30"	2	6 (p. 157)	AMS	wood	Indicates host sediments to be pre-Late Wisconsinan.
268	L-455-A[t]	>25 000	Lethbridge	49°45'48" 113°01'15"	2	52 (p. 22)	AMS	wood	Indicates "F" band older than Iowan Substage of Late Wisconsinan.
11	GSC-501	>42 500	Goose River	54°46'00" 116°47'30"	1	33 (p. 16)	DAS	wood	Minimum age for subtill deposits.
157	S-215	>33 000	Edmonton	53°29'30" 113°35'00"	1	44 (p. 366)	LAB	wood	Sample from Saskatchewan Gravels and Sands.
194	S-92[r]	>31 000	Smoky Lake	54°07'00" 112°30'00"	1	41 (p. 76)	JK	wood	Indicates only one glacial invasion during Late Wisconsinan.

[a] GSC, Geological Survey of Canada; S, University of Saskatchewan; GX, Geochron Laboratories; L, Lamont.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] non-bracketed numbers refer to numbered citations in the reference list.

[d] LAB, L.A. Bayrock; JK, J. Kachmor; LMK, L.M. Kisko; AMS, A.MacS. Stalker; DAS, D.A. St.-Onge; JAW, J.A. Westgate.

[e] mixed with dead gas.

[f] same deposit as GSC-543 but slightly higher stratigraphically.

[g] same deposit as GSC-780.

[h] poorly preserved.

[i] one 3-day count.

[j] one 4-day count.

[k] latitude and longitude calculated from site description.

[l] rerun of sample GX-102 dated at 29 200 $^{+1800}_{-1600}$ BP; also see reference 24 (p. 14).

[m] repeat date on new sample from GX-102. GX-210 agrees with unpublished dates from the area.

[n] preliminary acid leach.

[o] considered more reliable than GSC-728, thought to be from the same horizon as "Taber child" (ref. 54)

[p] four 1-day counts. Corroborates S-65 and GSC-888.

[q] correlates with L-221C (>26 000 BP), L-433B (>30 000 BP), L-433B humic portion (>34 000 BP), L-455A (>25 000 BP), L-455A humic portion (>37 000 BP).

[r] humic portion >34 000 BP. Confirms evidence of >28 000 BP date obtained from interglacial "F" band elsewhere. Original dates and laboratory number reported in the Bulletin of the Alberta Society of Petroleum Geologists, v. 6, n. 10, 1958.

[s] see L-433B and L-455A, see also the Bulletin of the Alberta Society of Petroleum Geologists, v. 6, n. 9, p. 231, 1958 and v. 6, n. 10, p. 252, 1958.

[t] humic portion >37 000 BP. Confirms evidence of >28 000 BP date obtained from interglacial "F" band elsewhere. Original dates and laboratory number reported in the Bulletin of the Alberta Society of Petroleum Geologists, v. 6, n. 10, 1958. L-445A comes from same band as L-433B, about 45 m apart.

[u] rerun on material previously dated at 21 600 ±900 BP by Department of Physics, University of Manitoba. No lab number available. See Gravenor, C.P. and Ellwood, B. 1956: A radiocarbon date from Smokey Lake, Alberta; Research Council of Alberta, Preliminary Report 56-3, 17 p. L.J.

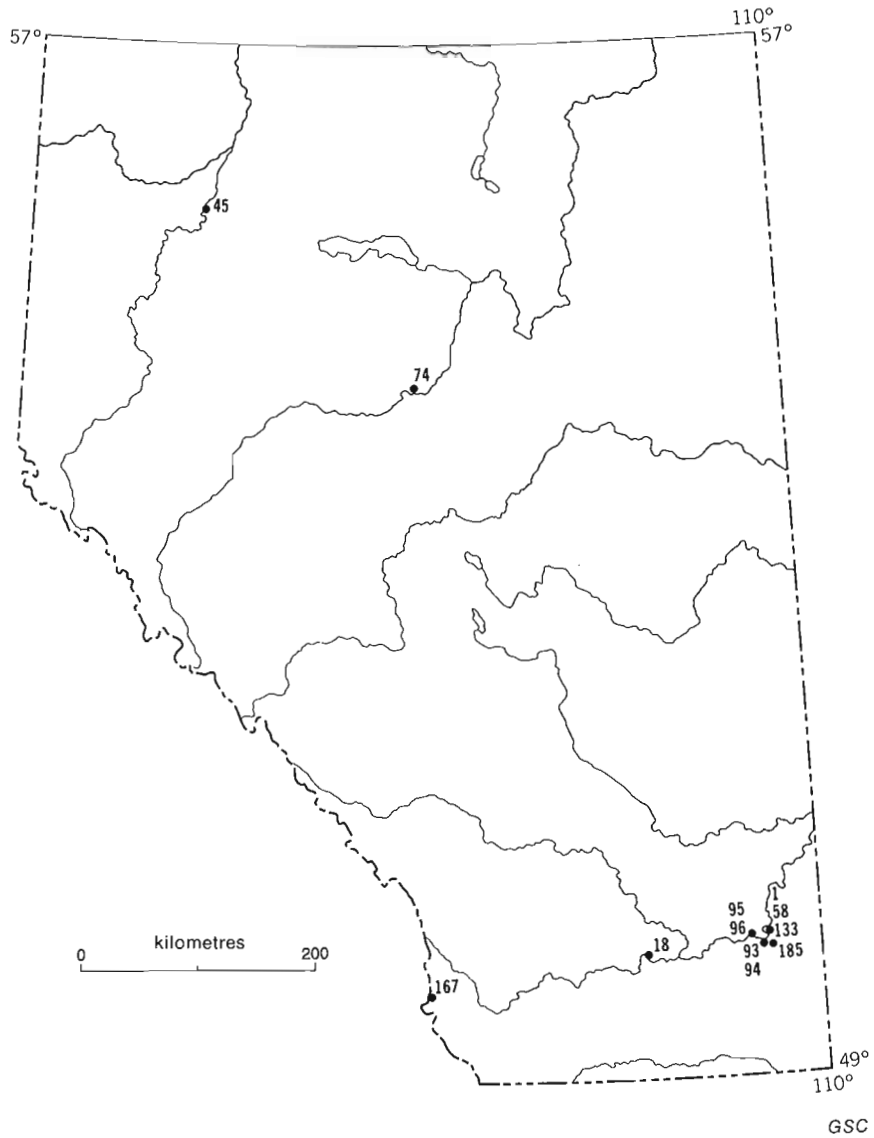

Figure 4. *Locations of dates listed in Table 3*

Table 3. Finite sub-till radiocarbon dates

Site No. (cf. Fig. 4)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
1	GSC-578[e]	28 630 ± 800	Medicine Hat	50°06'00" 110°38'00"	1	33 (p. 13)	AMS	plant fragments	Underlies pre-Late Wisconsinan till.
58	GSC-1370[f,g]	25 000 ± 800	Medicine Hat	50°06'00" 110°38'00"	1	36 (p. 288)	AMS	wood	Provides a minimum age for overlying Late Wisconsinan tills.
133	GSC-205[h]	24 490 ± 200	Medicine Hat	50°06'00" 110°38'00"	1	16 (p. 8)	AMS	plant fragments	Maximum age for overlying tills.
93	GSC-1399[i,j]	15 200 ± 250	Medicine Hat	50°01'55" 110°44'05"	1	28 (p. 17)	AMS	bone collagen	Maximum age for overlying till.
94	GSC-1399-2[j,k]	23 500 ± 330	Medicine Hat	50°01'55" 110°44'05"	1	28 (p. 17)	AMS	bone apatite	Maximum age for overlying till.
95	GSC-1442[l]	37 900 ± 1100	Redcliff	50°04'38" 110°49'10"	1	28 (p. 17)	AMS	wood and bark	Maximum age for overlying till.
96	GSC-1442-2[l]	38 700 ± 1100	Redcliff	50°04'38" 110°49'10"	1	28 (p. 17)	AMS	wood and bark	Maximum age for overlying till.
185	GX-102[m]	29 200 ± [illegible]	Twin Cliffs	50°04'00" 110°38'00"	1	24 (p. 146)	JAW	carbonized wood	Maximum age for overlying glacial drift.
18	GSC-728[n,o]	35 980 ± 1060	Taber	49°55'30" 112°04'00"	1	25 (p. 220)	AMS	wood	Maximum age for four overlying tills.
167	GAK-2336	22 700 ± 1000	Eagle Cave	49°37'00" 114°38'00"	5	23 (p. 59)	ALB	bone	Maximum age for Late Wisconsinan glaciation in Crowsnest Pass.
74	GSC-1019-2[p,q,r]	52 200 ± 1760	Fort Assiniboine	54°21'30" 114°53'00"	1	36 (p. 291)	DAS	wood	Dates widespread, stratified intertill deposit.
45	GSC-1020[s]	43 500 ± 620	Watino	55°43'00" 117°38'00"	1	26 (p. 69)	JAW	wood	Suggests area was not glaciated until Late Wisconsinan.

[a] GSC, Geological Survey of Canada; GAK, Gakushuin Natural Radiocarbon; GX, Geochron Laboratories.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers correspond to numbered citations in reference list.

[d] ALB, A.L. Bryan; AMS, A.MacS. Stalker; DAS, D.A. St-Onge; JAW, J.A. Westgate.

[e] no NaOH leach pretreatment; GSC-205, 5-6 m above this sampled horizon.

[f] consistent with and corroborates stratigraphically higher GSC-205 and stratigraphically lower GSC-578.

[g] mixed with dead gas, one 4-day count.

[h] no NaOH leach pretreatment; mixed with dead gas.

[i] $\delta^{13}C = -10.3‰$ 24-hour leach; mixed with dead gas; one 1-day count.

[j] discrepancy between GSC-1399 and GSC-1399-2 (23 500 ± 330 BP). Neither should be used until further dates are obtained.

[k] $\delta^{13}C = -10.3‰$ treated with 50% acetic acid.

[l] one 3-day count; GSC-1442-2 is a corroborating rerun of GSC-1442.

[m] considered contaminated, GX-210 yielded a date of >36 000 BP from new material from the same horizon. Agrees well with other unpublished dates from this area.

[n] mixed with dead gas.

[o] GSC-888 considered more reliable.

[p] date suspect, possible contamination by older organic material.

[q] two 1-day counts.

[r] rerun of GSC-1019 (>40 000 BP).

[s] corroborates GX-1207, I-2516. Indicates I-2616 to be anomalously young.

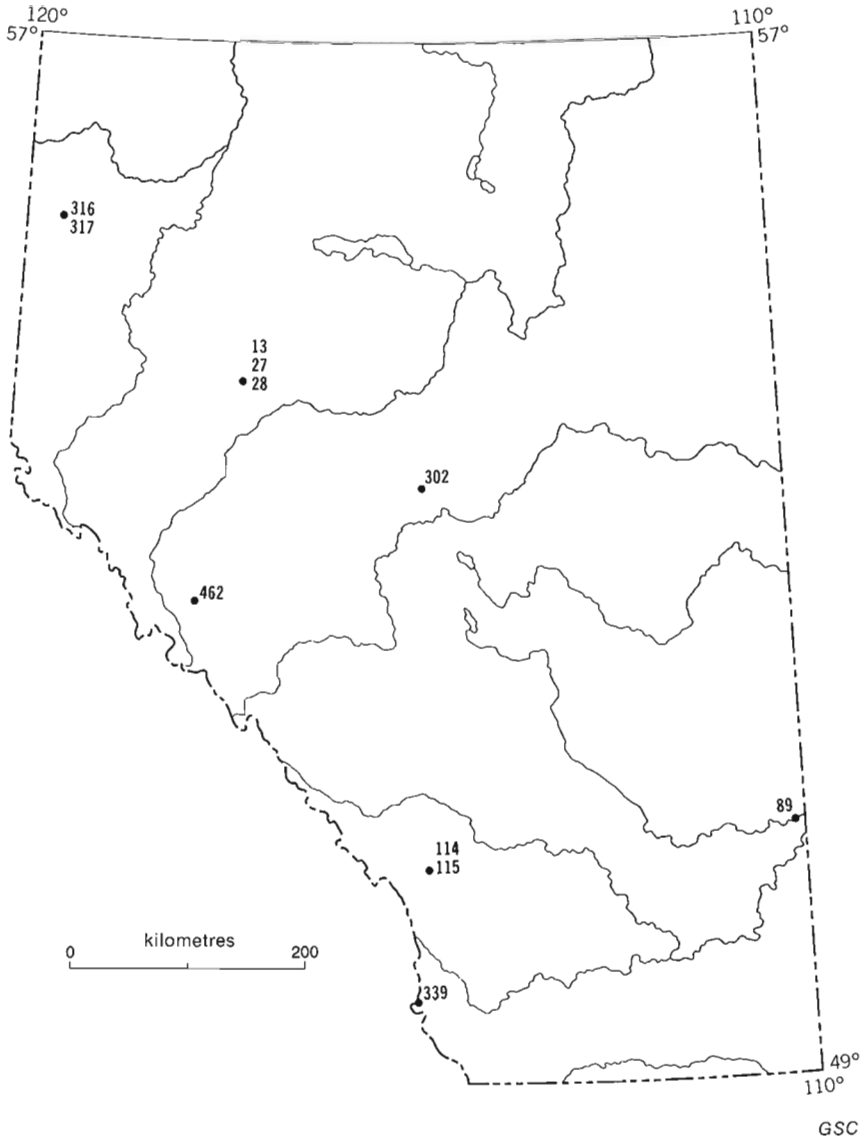

Figure 5. *Locations of dates listed in Table 5*

Table 5. Supra-till radiocarbon dates in the range of 12,000 to 20,000 years B.P.

Site No. (cf. Fig. 5)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
339	RL-362[e,f]	14 470 ± 610	Crowsnest Pass	49°40'00" 114°35'00"	5	12 (p. 98)	JCD	charcoal	Minimum date for deglaciation of area.
114	GSC-2668[g,h]	18 300 ± 380	Chalmer's Bog	50°39'30" 114°33'30"	4	31 (p. 17)	LEJ	aquatic moss[i]	Evidence for ice-free corridor in southern Foothills in Late Wisconsinan.
115	GSC-2670[i,j,k]	18 400 ± 1090	Chalmer's Bog	50°39'30" 114°33'30"	4	31 (p. 17)	LEJ	aquatic moss[i]	Evidence for ice-free corridor in southern Foothills in Late Wisconsinan.
89	GSC-1199[l,m,n]	14 200 ± 1120	Empress	50°57'50" 110°00'50"	1	28 (p. 16)	WFS	bone fragments	Minimum date for deglaciation.
462	BGS-629[o]	13 500 ± 400	Maligne Lake	52°44'00" 117°37'00"	5	22	MSK	wood fragments and organic detritus	Minimum date for deglaciation.
302	TX-2560[f,p,q]	16 180 ± 980	Wabamum Lake	53°33'14" 114°38'51"	2	20 (p. 197)	RGH	fossil pollen	Minimum date for deglaciation.
13	GSC-508[g]	12 190 ± 350	Little Smoky River	54°21'00" 117°01'00"	2	33 (p. 16)	DAS	gastropod shells	Minimum date for deglaciation.
27	GSC-694[l,r]	13 510 ± 230	Little Smoky River	54°21'00" 117°01'00"	2	25 (p. 222)	DAS	gastropod shells	Minimum date for deglaciation.
28	GSC-698[l,r]	13 580 ± 260	Little Smoky River	54°21'00" 117°01'00"	2	25 (p. 222)	DAS	gastropod shells	Minimum date for deglaciation.
316	WAT-408[f,s]	12 650 ± 320	Bonne Lake	55°34'51" 119°25'43"	2	59 (p. 1872)	JMW	organic clay	From a core indicating ice-free conditions for the last 30 000 years.
317	WAT-406[f,t]	17 570 ± 650	Bonne Lake	55°34'51" 119°25'43"	2	59 (p. 1872)	JMW	organic clay	From a core indicating ice-free conditions for the last 30 000 years.

[a] GSC, Geological Survey of Canada; TX, University of Texas; WAT, University of Waterloo; RL, Radiocarbon Ltd., BGS, Brock University.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in the reference list.

[d] CSC, C.S. Churcher; JCD, J.C. Driver; RGH, R.G. Holloway; LEJ, L.E. Jackson Jr.; MSK, M.S. Kearny WFS, W.F. Smith; AMS, A. MacS. Stalker; DAS, D.A. St-Onge; JMW, J.M. White.

[e] date is anomalously old when compared to artifacts in surrounding sediments; probably contaminated by dead carbon.

[f] latitude and longitude calculated from site description.

[g] no NaOH leach pretreatment; mixed with dead gas; one 3-day count.

[h] $\delta^{13}C = -32.6‰$.

[i] *Drepanocladus crassicostatus*.

[j] no NaOH leach pretreatment; one 4-day count.

[k] $\delta^{13}C = -32.4‰$.

[l] mixed with dead gas, one 3-day count.

[m] one hour NaOH leach pretreatment.

[n] older than expected.

[o] sample possibly contaminated by old carbon.

[p] $\delta^{13}C ‰ -27.03$; age corrected for $^{13}C/^{12}C$.

[q] date is from a series from the same core site. Significant contamination is suspected in overlying dates TX-2553, TX-2554, TX-2555, TX-2556, and TX-2557 and consequently is likely for this date as well. L.J.

[r] 1-1.5 m stratigraphically lower than GSC-508.

[s] ^{13}C corrected $\delta^{13}C ‰ -26.3$, possible error due to contamination.

[t] ^{13}C corrected $\delta^{13}C ‰ -26.7$, possible error due to contamination.

Table 6. Supra-till radiocarbon dates in the range of 8500 to 12,000 years B.P.

Site No. (cf. Fig. 6)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
134	GSC-220[e,l]	10 000 ± 130	Blood Indian Res.	49°18'30" 113°34'00"	3	16 (p. 8)	AD	humus	Minimum date for deglaciation.
138	GSC-161[f]	10 620 ± 250	Blood Indian Res.	49°32'30" 112°56'30"	3	15 (p. 4)	AMS	organic matter	Minimum date for deglaciation.
188	GSC-211	10 400 ± 200	Cowley	49°40'00" 113°59'00"	4	55 (p. 35)	AMS	shell	Minimum date for deglaciation.
97	GSC-1501[g,h]	10 600 ± 280	Kipp, North Section	49°46'30" 113°01'30"	2	28 (p. 18)	AMS	shell	Minimum date for deglaciation.
309	GX-956	9520 ± 240	Oldman Gap	49°51'05" 114°22'05"	5	37 (p. 19)	OAC	bone	Provides minimum date on landslide occurrence and deglaciation.
137	GSC-141[i]	9560 ± 170	Waldron Ranch	49°48'00" 114°07'00"	5	15 (p. 4)	AMS	charcoal	Minimum date for deglaciation.
139	GSC-3	10 500 ± 200	Taber Provincial Park	49°48'30" 112°10'30"	2	14 (p. 6)	AMS	wood	Minimum date for deglaciation.
193	S-68	11 000 ± 250	Oldman River	49°48'38" 112°10'00"	2	41 (p. 75)	LAB	wood	Minimum date for deglaciation.
269	I-1877[j]	10 550 ± 350	Foremost	49°51'05" 110°25'37"	2	3 (p. 437)	MJB	shell fragments	Minimum date for deglaciation.
57	GSC-1061	10 200 ± 240	Medicine Hat	50°08'05" 110°34'20"	1	36 (p. 288)	AMS	shell	Minimum date for deglaciation.
135	GSC-236[m]	9290 ± 260	Willow Creek	50°09'00" 113°59'00"	4	16 (p. 9)	AMS	shell	Minimum date for deglaciation.
101	GSC-2162[n]	10 600 ± 100	Longview	50°32'30" 114°27'30"	4	34 (p. 13)	LEJ	shell	Minimum date for deglaciation.
126	GSC-2965[o]	10 400 ± 110	Kananaskis valley	50°52'00" 115°10'00"	5	32 (p. 9)	GMM	wood fragments	Minimum date for deglaciation.
319	RL-757[k]	11 300 ± 290	Calgary	50°57'45" 114°01'00"	3	60 (p. 733)	MW	bone	Minimum date for deglaciation.
320	GSC-3065[k,q]	10 200 ± 280	Calgary	51°02'45" 114°04'30"	3	61 (p. 189)	MW	bone	Minimum date for deglaciation.
321	RL-905	8710 ± 230	Calgary	51°04'30" 114°12'40"	3	61 (p. 281)	MW	charcoal	Basal date for a succession of postglacial sediments.
273	I-5676[r]	9650 ± 160	Cochrane	51°10'00" 114°29'00"	3	19 (p. 49)	SAH	shell	Minimum date for deglaciation.
5	GSC-612[k]	10 760 ± 160	Cochrane	51°10'40" 114°27'10"	3	33 (p. 14)	AMS	bone	Minimum date for deglaciation.
6	GSC-613[k]	11 370 ± 170	Cochrane	51°10'40" 114°27'30"	3	33 (p. 15)	AMS	bone	Minimum date for deglaciation.
41	GSC-989[k]	11 100 ± 160	Cochrane	51°10'40" 114°27'10"	3	26 (p. 68)	AMS	bone	Minimum date for deglaciation.
276	WSU-881	11 220 ± 680	Banff National Park	51°42'30" 115°39'30"	5	19 (p. 51)	MJC	shell	Minimum date for deglaciation.
132	GSC-332	9330 ± 170	Banff National Park	51°58'00" 116°40'00"	5	17 (p. 13)	JAW	charcoal	Minimum date for deglaciation.
287	BGS-490[q]	9600 ± 300	Castleguard Meadows	52°08'06" 117°09'14"	7	40 (p. 58)	BHL	organic sediment	Suggests area was ice free by ca. 10 000 BP
110	GSC-1894[s]	9720 ± 300	Three Hills	51°41'30" 113°04'30"	2	31 (p. 16)	LVH	bone	Minimum date for deglaciation.
272	I-5126[r]	10 700 ± 150	Red Deer R. valley	51°43'00" 114°30'00"	3	19 (p. 49)	SAH	shell	Minimum date for deglaciation.
221	S-1190[p]	10 180 ± 160	Horseshoe Lake	52°21'00" 110°45'00"	1	50 (p. 52)	EIW	gyttja	Minimum date for deglaciation.
274	I-5675[q]	10 250 ± 165	Rocky Mountain House	52°28'16" 114°32'00"	3	19 (p. 49)	SAH	shell	Minimum date for deglaciation.
275	I-5677[q]	9670 ± 140	Rocky Mountain House	52°28'16" 114°32'00"	3	19 (p. 49)	SAH	bone	Minimum date for deglaciation.
140	S-140[t,u]	10 600 ± 300	N. Saskatchewan R. series	52°25'33" 114°16'38"	2	42 (p. 74)	LAB	marl	Minimum date for deglaciation.
463	BGS-627[v]	10 850 ± 300	Maligne Lake	52°44'00" 117°37'00"	5	22	MSK	wood fragments/organics	Minimum date for deglaciation.
452	GSC-3195[w]	8770 ± 80	Watchtower Basin	52°50'00" 117°50'00"	1	unpublished[oo]	BHL	wood	Minimum date for deglaciation.
448	BETA-1480	9945 ± 275	Watchtower Basin	52°50'00" 117°50'00"	1	22	MSK	peat	Suggests area was ice free by ca. 10 000 BP
124	GSC-2682[x]	8450 ± 170	Maligne valley	52°48'50" 118°40'00"	7	31 (p. 19)	MSK	peat	Minimum date for deglaciation.
286	BGS-465[q]	9660 ± 280	Tonquin Creek	52°44'35" 118°24'00"	6	40 (p. 58)	BHL	peat	Suggests area was ice free by ca. 10 000 BP
29	GSC-768	8830 ± 150	Marlboro	53°33'30" 116°43'30"	2	25 (p. 223)	MAR	marl	Minimum date for deglaciation.
295	TX-2553[q,y]	9520 ± 1430	Wabamun Lake	53°33'14" 114°42'16"	2	20 (p. 197)	RGH	fossil pollen	The significance of dates TX-2553, TX-2554, TX-2555, TX-2556
296	TX-2554[q,z]	9890 ± 2530	Wabamun Lake	53°33'14" 114°42'16"	2	20 (p. 197)	RGH	fossil pollen	and TX-2557 is questionable since all overlie the Mazama tephra
297	TX-2555[q,aa]	10 090 ± 2530	Wabamun Lake	53°33'14" 114°42'16"	2	20 (p. 197)	RGH	fossil pollen	(ca. 6700 BP; ref. 43, p. 32) and therefore are apparently
298	TX-2556[q,bb]	10 240 ± 2290	Wabamun Lake	53°33'14" 114°42'16"	2	20 (p. 197)	RGH	fossil pollen	contaminated. Dates TX-2558 and TX-2559 underlie the Mazama
299	TX-2557[q,cc]	10 300 ± 3720	Wabamun Lake	53°33'14" 114°42'16"	2	20 (p. 197)	RGH	fossil pollen	tephra but are likely to be significantly contaminated by dead
300	TX-2558[q,dd,ff]	10 400 ± 390	Wabamun Lake	53°33'14" 114°38'51"	2	20 (p. 197)	RGH	fossil pollen	carbon as well since they are from the same core and were
301	TX-2559[q,ee,ff]	11 750 ± 420	Wabamun Lake	53°33'14" 114°38'51"	2	20 (p. 197)	RGH	fossil pollen	determined from the same material.
109	GSC-2404	10 900 ± 190	Cooking Lake	53°31'00" 113°00'00"	1	31 (p. 16)	DE	shell	Minimum date for deglaciation.
77	GSC-861	10 200 ± 170	Greencourt	54°00'15" 115°04'00"	1	36 (p. 292)	DAS	shell	Minimum date for deglaciation.
73	GSC-1053[gg]	10 400 ± 200	Clear Lake	54°14'00" 114°47'30"	1	36 (p. 291)	JT, RJM	organic silty clay	Minimum date for deglaciation.
75	GSC-859[hh]	10 900 ± 160	Freeman River	54°25'00" 115°00'00"	1	36 (p. 291)	DAS	wood	Minimum date for deglaciation.
76	GSC-903[ii]	12 400 ± 600	Freeman River	54°25'00" 115°00'00"	1	36 (p. 292)	DAS	shell	Minimum date for deglaciation.
226	S-1308	9560 ± 190	Edson	53°59'00" 117°28'00"	3	50 (p. 54)	RV	tufa	Minimum date for deglaciation.
12	GSC-525[e]	8560 ± 170	Marsh Head Creek	54°10'00" 116°54'30"	3	33 (p. 16)	DAS	peat	Minimum date for deglaciation/muskeg development.
26	GSC-673[e]	8530 ± 170	Marsh Head Creek	54°13'00" 116°55'00"	2	25 (p. 222)	DAS	peat	Dates termination of ice-blockage of Little Smoky River valley.
66	GSC-1093[gg]	10 700 ± 170	Alpen Siding Lake	54°27'00" 113°00'00"	1	36 (p. 290)	JT	marly gyttja	Minimum date for deglaciation.
111	GSC-1380[h,jj]	10 200 ± 280	Athabasca	54°42'00" 113°15'30"	1	31 (p. 17)	SHR	freshwater shells	Minimum date for deglaciation.
112	GSC-1205[kk,ll]	10 200 ± 160	Athabasca	54°43'00" 113°17'00"	1	31 (p. 17)	SHR	bone	Minimum date for deglaciation.
65	GSC-1049[mm]	11 400 ± 190	Lofty Lake	54°44'00" 112°29'00"	1	36 (p. 289)	JT, RJM	gyttja	Minimum date for deglaciation.
104	GSC-1998[h,gg,nn]	10 200 ± 110	Dollar Lake	55°10'00" 117°12'00"	1	34 (p. 13)	RJM	organic sediment	Minimum date for deglaciation and start of organic accumulation.
314	WAT-362[q,oo]	10 740 ± 395	Boone Lake	55°34'51" 119°25'43"	2	59 (p. 1872)	JMW	organic mud	Indicates ice free conditions.
120	GSC-2895[pp,qq]	10 200 ± 100	Watino	55°43'00" 117°37'30"	1	31 (p. 18)	NB, CSC	bone	Minimum date for deglaciation.
121	GSC-2902[h,pp,rr]	10 200 ± 100	Watino	55°43'00" 117°37'30"	1	31 (p. 19)	NB, CSC	bone	Minimum date for deglaciation.
118	GSC-2865[gg,pp]	9880 ± 130	Peace River	56°13'40" 117°18'10"	1	31 (p. 18)	CSC, MW	bone	Minimum date for deglaciation.
105	GSC-2004[gg,mm]	11 000 ± 200	Sulpher Lake	56°43'00" 118°19'00"	2	34 (p. 13)	RJM	clay/gyttja/marl	Minimum date for deglaciation.
100	GSC-2038[h,ss]	11 300 ± 110	Mariana Lake	55°57'00" 112°01'00"	1	34 (p. 12)	RJM	gyttja	Minimum date for deglaciation.
332	GSC-3402[tt]	9910 ± 90	Athabasca River	58°15'00" 111°25'00"	1	unpublished	DGS	wood	Minimum date for deglaciation.
189	S-116	8600 ± 100	Caribou Mountains	59°00'00" 115°15'00"	1	42 (p. 74)	CPG	peat	Minimum date for deglaciation and beginning of peat accumulation.

For Figure 6 and footnotes, see pages 14 and 15 respectively

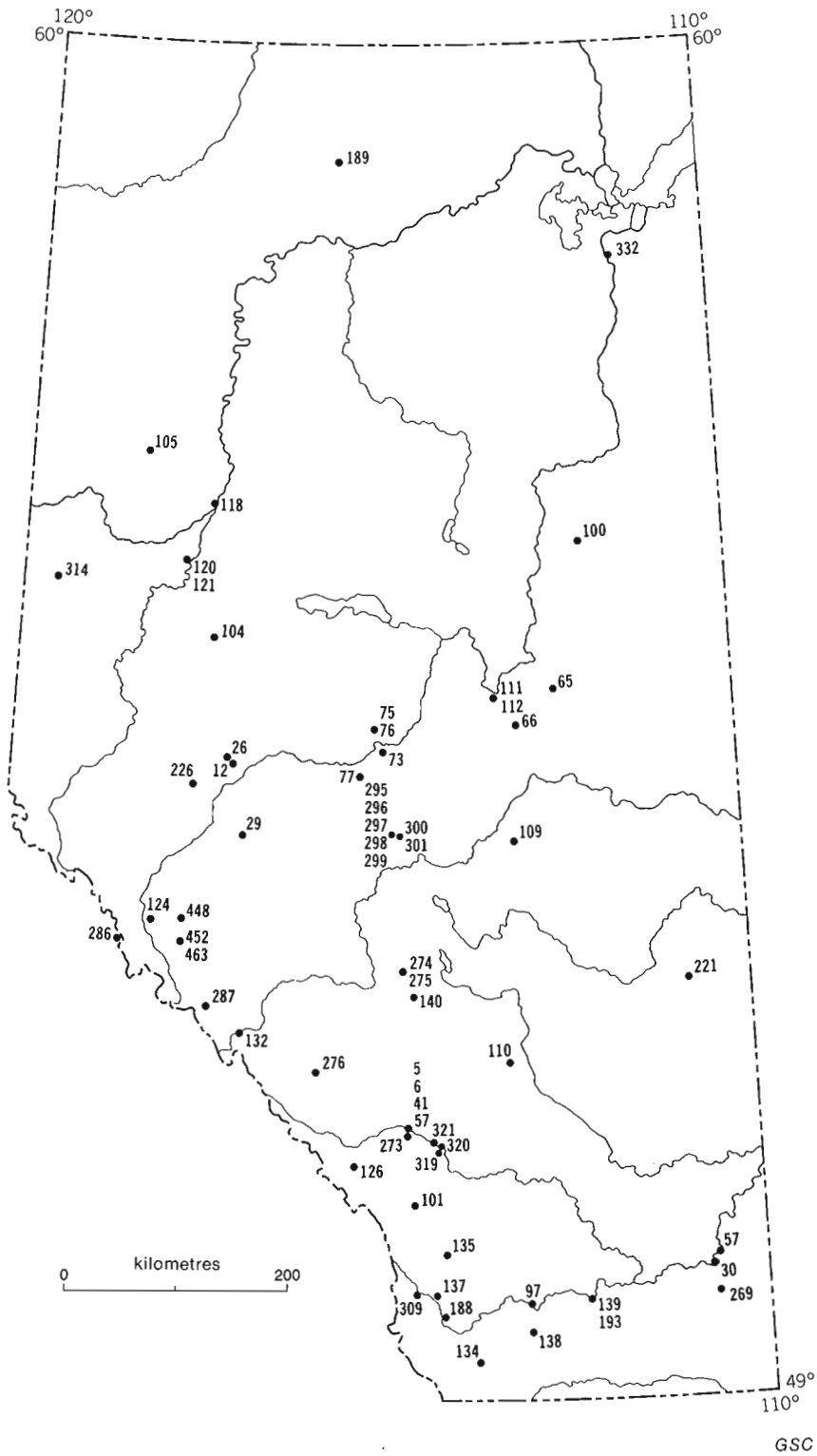

Figure 6. *Locations of dates listed in Table 6 .*

Table 6. (cont.)

[a] GSC, Geological Survey of Canada; S, University of Saskatchewan; I, Teledyne Isotopes; WSU, Washington State University; BGS, Brock University; TX, University of Texas; GX, Geochron Laboratories; WAT, University of Waterloo; RL, Radiocarbon Ltd., BETA, Beta Analytical.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in the reference list.

[d] LAB, L.A. Bayrock; MJB, M.J. Bik; NB, N. Boisvert; MJC, M.J. Chambers; OAC, O.A. Christiansen; CSC, C.S. Churcher; AD, A. Dreimanis; DE, D. Emerson; CPG, C.P. Gravenor; SAH, S.A. Harris; LVH, L.V. Hills; RGH, R.G. Holloway; LEJ, L.E. Jackson, Jr.; MSK, M.S. Kearney; BHL, B.H. Luckman; GMM, G.M. Macdonald; RJM, R.J. Mott; SHR, S.H. Richards; MAR, M.A. Roed; DGS, D.G. Smith; AMS, A. MacS. Stalker; DAS, D.A. St-Onge; JT, J. Terasmae; RV, R. Voguiell; EIW, E.I. Wallick; JAW, J.A. Westgate; MW, M. Wilson; JMW, J.M. White.

[e] no NaOH leach pretreatment.

[f] no NaOH leach pretreatment; single count.

[g] also see GSC-1332 and GSC-220 from similar stratigraphic positions and event sequences. L.J.

[h] one 3-day count.

[i] no NaOH leach pretreatment; mixed with dead gas, single long count.

[j] area may not have been glaciated during the Late Wisconsinan.

[k] dates and corroborates other dates on the Big Hill Creek Formation. L.J.

[l] correlates with GSC-161 (10 620 ± 230 BP). L.J.

[m] mixed with dead gas; outermost 5% of shell removed by acid leach.

[n] 20% HCl leach; one 2-day count.

[o] two 1-day counts.

[p] sedimentation rate of 0.1 cm per year.

[q] latitude and longitude calculated from site description.

[r] location by personal communication from the collector.

[s] HCl, NaOH leaches; mixed with dead gas; one 3-day count.

[t] alteration of ^{14}C content (greater apparent age for carbonate fraction) discrepancy with S-107 due to dead carbon in the marl.

[u] longitude does not fit site description; suspect new longitude should be = 115°00'00"W. L.J.

[v] contamination by dead carbon suspected by collector.

[w] corroborates BETA-1480. L.J.

[x] mixed with dead gas; one 4-day count.

[y] age corrected $\delta^{13}C$‰ -28.9.

[z] age corrected $\delta^{13}C$‰ -27.48.

[aa] age corrected $\delta^{13}C$‰ -27.66.

[bb] age corrected $\delta^{13}C$‰ -27.54.

[cc] age corrected $\delta^{13}C$‰ -26.22.

[dd] age corrected $\delta^{13}C$‰ -27.22.

[ee] age corrected $\delta^{13}C$‰ -27.63.

[ff] contamination by dead carbon should be suspected due to the anomalous overlying dates in the same series. L.J.

[gg] no NaOH pretreatment; mixed with dead gas.

[hh] discrepancy with GSC-903, but thought to be the lesser contaminated of the two.

[ii] possibly contaminated; mixed with dead gas; one 4-day count.

[jj] corroborated by GSC-1205 (10 200 ± 160 BP).

[kk] previously published uncorrected (10 000 ± 160 BP) by D.A. St-Onge, 1970.

[ll] overnight NaOH leach; two 1-day counts.

[mm] no NaOH leach pretreatment; one 2-day count; mixed with dead gas.

[nn] requires palynological studies to verify the date.

[oo] ^{13}C corrected $\delta^{13}C$‰ -28.0; possible error due to contamination.

[pp] GSC-2865, -2895 and -2902 corroborate one other. L.J.

[qq] $\delta^{13}C$ = -20.3‰; two 1-day counts.

[rr] $\delta^{13}C$ = -21.1‰.

[ss] $\delta^{13}C$ = -26.2‰; mixed with dead gas.

[tt] NaOH; HCl (no reaction) and distilled water pretreatment.

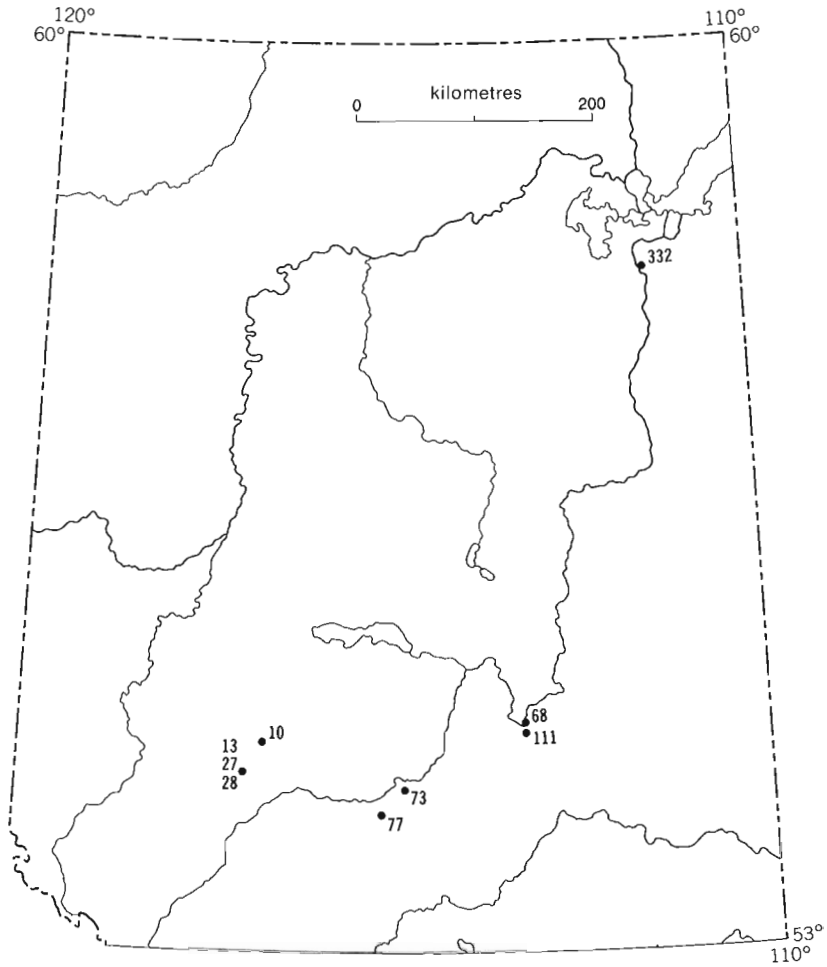

Figure 7. *Locations of dates listed in Table 7*

Table 7. Radiocarbon dates associated with the history of proglacial lakes

Site No. (cf. Fig. 7)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
77	GSC-861	10 200 ± 170	Greencourt	54°00'15" 115°04'00"	1	36 (p. 292)	DAS	shell	Dates phase of glacial Lake Edmonton.
73	GSC-1053[e]	10 400 ± 200	Clear Lake	54°14'00" 114°47'30"	1	36 (p. 291)	JT, RJM	organic silty clay	Minimum age for drainage of small proglacial lakes.
13	GSC-508[e]	12 190 ± 350	Little Smoky River	54°21'00" 117°01'00"	2	33 (p. 16)	DAS	shell	Minimum age for glacial Lake Rycroft.
27	GSC-694[f,g]	13 510 ± 230	Little Smoky River	54°21'00" 117°01'00"	2	25 (p. 222)	DAS	shell	Dates sedimentation in glacial Lake Rycroft.
28	GSC-698[f,g]	13 580 ± 260	Little Smoky River	54°21'00" 117°01'00"	2	25 (p. 222)	DAS	shell	Dates sedimentation in glacial Lake Rycroft.
10	GSC-551[e]	6590 ± 150	Atikamek Creek	54°35'00" 116°46'00"	1	33 (p. 15)	DAS	peat	Minimum age for drainage of glacial Lake Rycroft.
111	GSC-1380[h,i]	10 200 ± 280	Athabasca	54°42'00" 113°15'30"	1	31 (p. 17)	SHR	shell	Dates sedimentation in glacial Lake Athabasca; minimum date for lake drainage.
332	GSC-3402[j]	9910 ± 70	Lake Athabasca	58°15'00" 111°25'00"	1	unpublished	DGS	wood	Indicates age of major glacially dammed high stage of early Lake Athabasca.
68	GSC-1205	10 000 ± 160	Athabasca	54°43'00" 113°17'00"	1	54 (p. 184)	DAS	bone	Minimum age for drainage of proglacial lake.

[a] GSC, Geological Survey of Canada.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in reference list.

[d] RJM, R.J. Mott; SHR, S.H. Richard; DGS, D.G. Smith; DAS, D.A. St-Onge; JT, J. Terasmae.

[e] no NaOH treatment; mixed with dead gas; one 3-day count.

[f] mixed with dead gas; one 3-day count.

[g] 1-1.5 m stratigraphically lower than GSC-508.

[h] one 3-day count.

[i] confirmed by GSC-1205 (10 200 ± 160 BP). L.J.

[j] unpublished date courtesy of the collector. L.J.

Table 8. Radiocarbon dates indicating post glacial rates of stream alluviation and/or erosion

Site No. (cf. Fig. 8)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
291	GX-1435[e]	8190 ± 260	Waterton Lakes	49°00'00" 114°00'00"	4	46 (p. 25)	BOR	charcoal	Indicates most deposition on alluvial fan was completed by ca. 8200 BP.
202	S-724	1200 ± 170	Belly River	49°08'00" 113°40'00"	4	49 (p. 348)	JMQ	charcoal	Minimum age for lowest terrace of Belly River.
240	S-865	1100 ± 85	Manyfingers	49°16'40" 113°33'15"	3	50 (p. 75)	JTT	bone	Minimum age for first and second terrace of Belly River.
241	S-866	1075 ± 90	Manyfingers	49°16'40" 113°33'15"	3	50 (p. 75)	JTT	bone	Minimum age for first and second terrace of Belly River.
200	S-722	1380 ± 70	Manyfingers	49°17'00" 113°33'00"	3	49 (p. 347)	PP	bone	Minimum age for lowest terrace of Belly River.
134	GSC-220[f]	10 000 ± 130	Blood Indian Res.	49°18'30" 113°34'00"	3	16 (p. 8)	AD	humus	Indicates 5.5 m of stream aggradation since 10 000 BP.
3	GSC-447[g,h]	6150 ± 140	Castle River	49°29'00" 114°03'30"	3	33 (p. 14)	AMS	bone	Sample beneath 18 m of outwash, alluvial and eolian sand.
4	GSC-490[g,h]	6100 ± 180	Castle River	49°29'00" 114°03'30"	3	33 (p. 14)	AMS	bone	Beneath 18 m of outwash, alluvial and eolian sand.
20	GSC-705[h]	6340 ± 140	Castle River	49°29'00" 114°03'30"	3	25 (p. 220)	AMS	bone	Dates period of alluviation.
21	GSC-741[i]	3380 ± 170	Castle River	49°29'00" 114°03'30"	3	25 (p. 221)	AMS	shell	Dates period of alluviation.
22	GSC-743[j]	2680 ± 140	Castle River	49°29'00" 114°03'30"	3	25 (p. 221)	AMS	charcoal	Dates period of alluviation.
39	GSC-901[j,k]	2490 ± 180	Castle River	49°29'00" 114°03'30"	3	26 (p. 67)	AMS	charcoal	From alluvium underlain by outwash, approximate date for alluviation[l].
346	RL-447	6230 ± 180	Crowsnest Pass	49°35'00" 114°22'00"	5	12 (p. 101)	BOR	bone	Minimum age for river incision below buried horizons.
347	RL-511	6230 ± 160	Crowsnest Pass	49°35'00" 114°22'00"	5	12 (p. 101)	BOR	bone	Minimum age for river incision below buried horizons.
348	RL-510	6610 ± 160	Crowsnest Pass	49°35'00" 114°22'00"	5	12 (p. 101)	BOR	bone	Minimum age for river incision below buried horizons.
97	GSC-1501	10 600 ± 280	Kipp, North Section	49°46'30" 113°01'30"	2	28 (p. 18)	AMS	shell	Indicates possible late aggradation of Oldman River.
139	GSC-3[m]	10 500 ± 200	Taber Provincial Park	49°48'30" 112°10'30"	2	14 (p. 6)	AMS	wood	Dates early postglacial alluviation of Oldman River.
193	S-68	11 000 ± 250	Oldman River	49°48'38" 112°10'00"	2	41 (p. 75)	LAB	wood	Indicates elevation of the Oldman River Bed ca. 11 000 BP.
52	GSC-753	1250 ± 130	Cypress Hills	49°31'30" 110°13'38"	3	36 (p. 286)	PDJ	buried soil	Indicates a period of nondeposition on pediment surface.
166	GAK-2334	7300 ± 130	East Battle Creek	49°39'00" 110°02'00"	4	23 (p. 58)	WJE	charcoal	Indicates 4.5 m of stream incision since 7300 BP.
53	GSC-800[n]	3950 ± 130	Cypress Hills	49°39'40" 110°04'18"	3	36 (p. 286)	PDJ	buried soil	Indicates a period of nondeposition by Battle Creek.
54	GSC-1101[o]	5100 ± 280	Cypress Hills	49°40'00" 110°18'00"	3	36 (p. 287)	RJM	marl	Minimum date for formation of Elkwater Lake.
277	I-2428[n]	3880 ± 165	Battle Creek	49°39'40" 110°04'18"	4	1 (p. 159)	PDJ	charcoal/bones	Minimum age for a fluvial terrace along Battle Creek.
280	I-2609[n]	3610 ± 100	Cypress Hills	49°39'40" 110°04'18"	4	1 (p. 159)	PDJ	humic soil material	Maximum age for overlying fan alluvium.
281	I-2608	880 ± 100	Battle Creek	49°39'40" 110°04'18"	4	1 (p. 159)	PDJ	humic soil material	Comparison with I-2428 gives minimum rate of alluviation.
84	GSC-857[r]	1670 ± 130	Gros Ventre Creek	49°53'00" 110°31'00"	2	27 (p. 24)	MJB	buried soil	Dates temporary interruption in alluviation.
85	GSC-1001[k,s]	3600 ± 140	Gros Ventre Creek	49°53'00" 110°31'00"	2	27 (p. 24)	MJB	buried soil	Dates beginning of colluvial reworking of till.
17	GSC-805[k]	11 200 ± 200	Medicine Hat	50°04'40" 110°39'20"	1	25 (p. 220)	CSC	bone	7-14 m above present river level, indicates rapid incision.
57	GSC-1061	10 200 ± 240	Medicine Hat	50°08'05" 110°34'20"	1	36 (p. 288)	AMS	shell	Dates higher level of South Saskatchewan River.
92	GSC-1735[t]	5760 ± 170	Medicine Hat	50°14'12" 110°38'35"	1	28 (p. 17)	AMS	shell	Gives date for previous incision by river.
253	S-1209	3740 ± 100	Cactus Flower	50°15'00" 110°38'00"	1	51 (p. 105)	LB	charcoal	Minimum age for establishment of present South Saskatchewan R. floodplain.
254	S-1210[u]	4220 ± 130	Cactus Flower	50°15'00" 110°38'00"	1	51 (p. 105)	LB	charcoal	Minimum age for establishment of present South Saskatchewan R. floodplain.
204	S-782	4130 ± 85	Cactus Flower	50°15'00" 110°38'00"	1	49 (p. 351)	EAS	charcoal	Dates flood events along South Saskatchewan River.
205	S-783	2130 ± 130	Cactus Flower	50°15'00" 110°38'00"	1	49 (p. 352)	EAS	charcoal	Dates flood events along South Saskatchewan River
206	S-784	3625 ± 80	Cactus Flower	50°15'00" 110°38'00"	1	49 (p. 352)	EAS	bone	Dates flood events along South Saskatchewan River.
207	S-820	3890 ± 160	Cactus Flower	50°15'00" 110°38'00"	1	49 (p. 352)	EAS	bone	Dates flood events along South Saskatchewan River.
208	S-821	3725 ± 95	Cactus Flower	50°15'00" 110°38'00"	1	49 (p. 352)	EAS	charcoal	Dates flood events along South Saskatchewan River.
209	S-822	3620 ± 95	Cactus Flower	50°15'00" 110°38'00"	1	49 (p. 352)	EAS	charcoal	Dates flood events along South Saskatchewan River.
210	S-823	3615 ± 95	Cactus Flower	50°15'00" 110°38'00"	1	49 (p. 352)	EAS	charcoal	Dates flood events along South Saskatchewan River.
318	GX-2104	8145 ± 320	Calgary	50°57'45" 114°01'00"	3	60 (p. 733)	BOR	bone	Marks period of aggradation by Bow River.
319	RL-757	11 300 ± 290	Calgary	50°57'45" 114°01'00"	3	60 (p. 733)	MW	bone	Marks period of aggradation and formation of terrace by Bow River.
71	GSC-1209[v,x]	8080 ± 150	Calgary	51°02'00" 114°05'00"	3	36 (p. 290)	NWR	bone	Indicates Bow River floodplain level ca. 8100 BP.
320	GSC-3065[e]	10 200 ± 280	Calgary	51°02'45" 114°04'30"	3	61 (p. 189)	MW	bone	Dates postglacial alluviation.
322	GX-6397-A[w,x]	8300 ± 280	Calgary	51°02'00" 114°05'00"	3	61 (p. 281)	MW	bone	Dates beginning of overbank deposition on old alluvial terrace.
323	GX-6396-A[x]	6580 ± 205	Calgary	51°02'00" 114°05'00"	3	61 (p. 281)	MW	bone	Dates overbank deposition on alluvial terrace.
324	GX-6395-A[x]	5470 ± 150	Calgary	51°02'00" 114°05'00"	3	61 (p. 281)	MW	bone	Dates overbank deposition on alluvial terrace by Bow River.
325	GX-6394-A[x]	5145 ± 170	Calgary	51°02'00" 114°05'00"	3	61 (p. 281)	MW	bone	Dates termination of overbank deposition on alluvial terrace by Bow River.
326	RL-902[e,u]	4630 ± 160	Calgary	51°03'30" 114°09'00"	3	61 (p. 388)	MW	bone	Minimum date for alluvial terrace.
327	RL-906[e]	4010 ± 150	Calgary	51°03'30" 114°09'00"	3	61 (p. 254)	MW	charcoal	Minimum date for alluvial terrace deposits.
329	RL-904[e]	1560 ± 120	Calgary	51°03'30" 114°09'30"	3	61 (p. 281)	MW	bone	Minimum date for alluvial fan formation.
86	GSC-1744[y]	2530 ± 140	Windle	50°56'30" 115°08'00"	5	39 (p. 6)	MW	bone	Indicates no downcutting of Kananaskis River in last 2500 years.
102	GSC-2219[t]	7690 ± 110	Seebe	51°02'30" 115°03'00"	4	34 (p. 13)	LEJ	charcoal	Gives rate of incision by Kananaskis River since 7600 BP.
5	GSC-612[z]	10 760 ± 160	Cochrane	51°10'40" 114°27'10"	3	33 (p. 14)	PC	bone	Dates postglacial alluviation by Bow River.
6	GSC-613[z]	11 370 ± 170	Cochrane	51°10'40" 114°27'10"	3	33 (p. 15)	GC	bone	Dates postglacial alluviation by Bow River.
40	GSC-988[aa]	5670 ± 150	Cochrane	51°10'40" 114°27'10"	3	26 (p. 68)	AMS	bone	Dates terrace strath cut by Bow River.
41	GSC-989[bb]	11 100 ± 160	Cochrane	51°10'40" 114°27'30"	3	26 (p. 68)	AMS	bone	Dates postglacial alluviation by Bow River.
98	GSC-612-2[k,q]	7220 ± 480	Cochrane	51°10'40" 114°27'10"	3	28 (p. 18)	PC	bone	Dates postglacial alluviation by Bow River.
42	GSC-894[k,p,cc]	2870 ± 140	Warden Rock	51°42'10" 115°41'30"	6	26 (p. 69)	MJC	charcoal	Dates period of aggradation by Red Deer River.
43	GSC-906[cc]	2510 ± 180	Warden Rock	51°42'10" 115°41'30"	6	26 (p. 69)	MJC	shell	Dates period of aggradation by Red Deer River
44	GSC-974[dd]	1580 ± 140	Warden Rock	51°42'10" 115°41'30"	6	26 (p. 69)	MJC	charcoal	Minimum date for initiation of 23 m of degradation by Red Deer River.
132	GSC-332	9330 ± 170	Banff National Park	51°58'00" 116°40'00"	5	17 (p. 13)	JAW	charcoal	Minimum age for incision of North Saskatchewan R. to level of dated horizon.
140	S-140[ee,hh]	10 600 ± 300	North Saskatchewan R.	52°25'33" 114°16'38"	2	42 (p. 74)	LAB	marl	Indicates rapid postglacial incision by North Saskatchewan River[ff].
141	S-107[gg,hh]	7350 ± 100	North Saskatchewan R.	52°25'33" 114°16'38"	2	42 (p. 74)	LAB	wood	Indicates rapid postglacial incision by North Saskatchewan River[ff].
142	S-106[gg,hh]	8150 ± 100	North Saskatchewan R.	52°25'33" 114°16'38"	2	42 (p. 74)	LAB	wood	Indicates rapid postglacial incision by North Saskatchewan River[ff].
211	S-804[ii]	2765 ± 90	Weed Creek	53°17'00" 113°57'00"	1	50 (p. 49)	RCS	bone	Dates higher level of Weed Creek.
237	S-874[jj]	3260 ± 320	Flach Site	53°30'00" 113°00'00"	1	50 (p. 71)	RB	charcoal	Dates terminal phase of North Saskatchewan River terrace construction.
23	GSC-767[kk]	8320 ± 140	Duffield	53°25'33" 114°16'38"	1	25 (p. 221)	LVH	wood	Indicates rapid postglacial downcutting by North Saskatchewan River.
108	GSC-1207[v,ll]	6040 ± 140	Pakan	54°02'00" 112°20'00"	1	31 (p. 16)	SHR	bone	From alluvial terrace; dates former high floodplain of North Saskatchewan R.
70	GSC-1195	2700 ± 140	Bellis	54°03'00" 112°13'00"	1	54 (p. 184)	DAS	bone	Dates North Saskatchewan River level 12 m above present.
107	GSC-1195-2[v,mm]	2800 ± 140	Bellis	54°03'00" 112°14'00"	1	31 (p. 16)	SHR	bone	Dates postglacial alluvial terrace.
112	GSC-1205[v,nn]	10 200 ± 160	Athabasca	54°43'00" 113°17'00"	1	31 (p. 17)	SHR	bone	Dates initial period of postglacial sedimentation in Athabasca floodplain.
439	BIRM-714[e]	4490 ± 140	Smoky	53°56'29" 119°02'10"	4	5	JWB	bone	Dates North Saskatchewan River level 20 m above present.
125	GSC-2802[oo]	4540 ± 230	Grande Prairie	55°05'00" 118°43'20"	1	31 (p. 19)	CSC	charcoal	Minimum date for underlying terrace; Maximum age for overlying alluvium.
120	GSC-2895[pp,qq]	10 200 ± 100	Watino	55°43'00" 117°37'30"	1	31 (p. 18)	NB	bone	Dates period of postglacial alluviation.
121	GSC-2902[pp,rr]	10 200 ± 100	Watino	53°43'00" 117°37'30"	1	31 (p. 19)	NB	bone	Dates period of postglacial alluviation.
118	GSC-2865[n,pp]	9880 ± 130	Peace River	56°13'40" 117°18'10"	1	31 (p. 18)	CSC	bone	Dates period of postglacial alluviation.
68	GSC-1205	10 000 ± 160	Athabasca	54°43'00" 113°17'00"	1	54 (p. 184)	DAS	bone	Dates elevation of Athabasca River ca. 10 000 BP.

For Figure 8 and footnotes, see pages 18 and 19 respectively

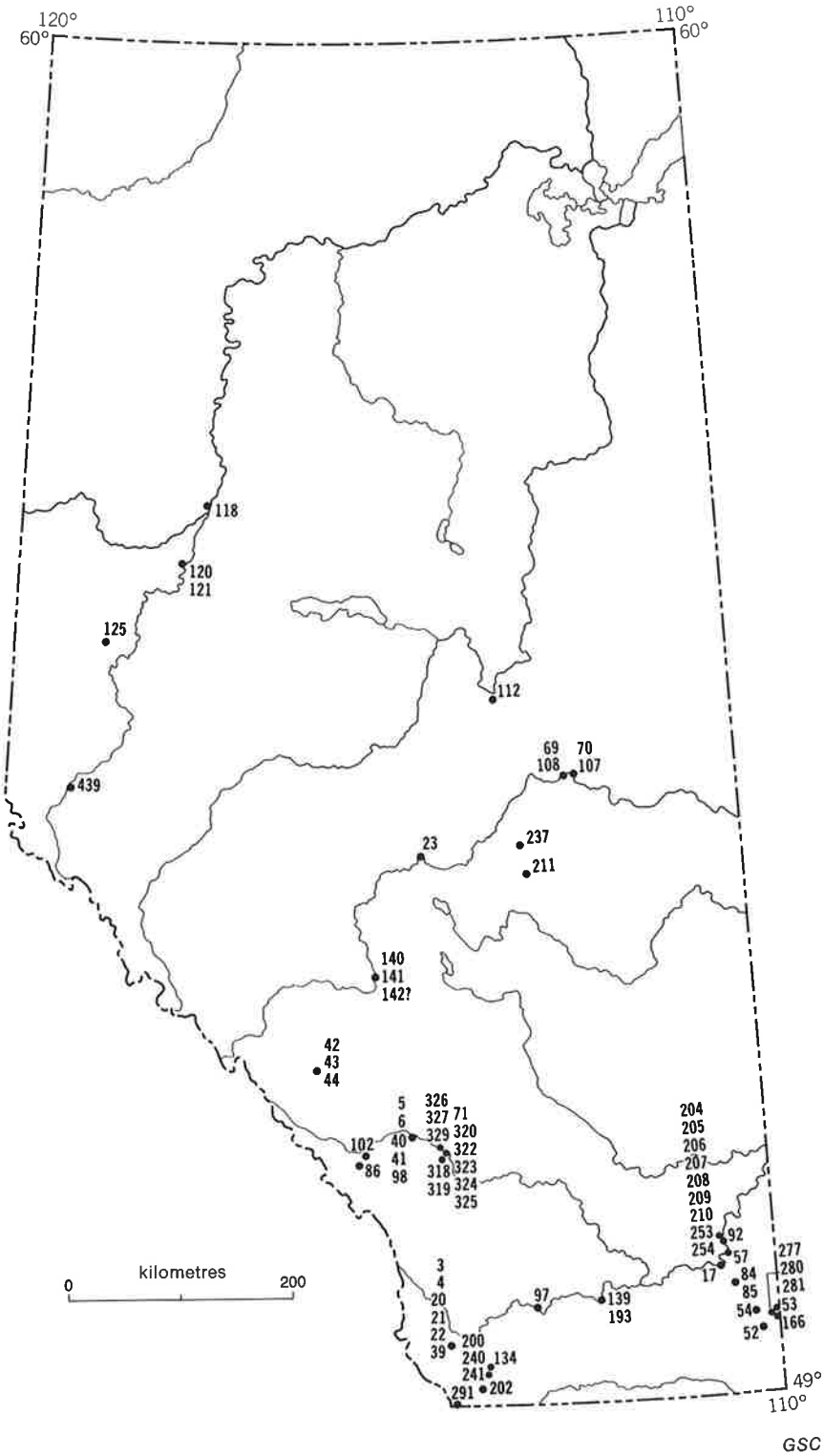

Figure 8. *Locations of dates listed in Table 8*

Table 8. (cont.)

[a] GSC, Geological Survey of Canada; S, University of Saskatchewan; GAK, Gakushuin Natural Radiocarbon; L, Lamont; GX, Geochron Laboratories; RL, Radiocarbon Ltd.; BIRM, University of Birmingham.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in reference list.

[d] LAB, L.A. Bayrock; MJB, M.J. Bik; LB, L. Bitz; NB, N. Boisvert; RB, R. Bonichsen; JWB, J.W. Brink; MJC, M.J. Chambers; PC, P. Chamney; CSC, C.S. Churcher; GC, G. Clarke; AD, A. Dreimanis; WJE, W.J. Elliot; LVH, L.V. Hills; LEJ, L.E. Jackson Jr.; PDJ, P.D. Jungerius; RJM, R.J. Mott; PP, P. Perry; JMQ, J.M. Quigg; BOR, B.O. Reeves; SHR, S.H. Richard; NWR, N.W. Rutter; RCS, R.C. Shelford; EAS, E.A. Simmonds; AMS, A. MacS. Stalker; DAS, D.A. St-Onge; JTT, J.T. Thompson; JAW, J.A. Westgate; MW, M. Wilson.

[e] latitude and longitude approximated from site description.

[f] no NaOH leach pretreatment.

[g] organic fractions of GSC-447 and GSC-490 show good agreement, carbonate fractions do not. L.J.

[h] GSC-447, GSC-490, and GSC-705 date the same gravel unit. L.J.

[i] date may be several hundred years too old, as GSC-743 is stratigraphically lower than GSC-741.

[j] close agreement with GSC-743 from same bed; suggests GSC-741 several hundred years too old. L.J.

[k] mixed with dead gas.

[l] alluvium from upvalley Cordilleran glacial advances.

[m] compare with S-68 (11 000 ± 250 BP). L.J.

[n] GSC-800, I-2428, and I-2609 corroborate one other. L.J.

[o] no NaOH leach; mixed with dead gas.

[p] corroborates shell date GSC-906. L.J.

[q] 24-hour leach pretreatment; mixed with dead gas; two 1-day counts.

[r] comparison with GSC-1001 gives time frame for accumulation of basal terrace deposits. L.J.

[s] $\delta^{13}C = -24.3°/_{oo}$, humus concentrated by pyrophosphate addition and ultrasound stirring. Comparison with GSC-857 gives time frame for accumulation of basal terrace deposits. L.J.

[t] mixed with dead gas; one 3-day count.

[u] date fits well with local stratigraphy. L.J.

[v] 24-hour NaOH leach pretreatment.

[w] GSC-1819, RL-905, and GX-6397-A, corroborate one another. L.J.

[x] GSC-1209, GX-6397-A, GX-6396-A, GX-6395-A, and GX-6394-A from the same series. L.J.

[y] 5-minute NaOH leach; two 1-day counts.

[z] GSC-612 and GSC-613 show good agreement.

[aa] some uncertainty as to the stratigraphic position of dated bone and/or possible contamination of the sample with younger carbon; see GSC-612, GSC-613, and GSC-989. L.J.

[bb] good agreement with GSC-613.

[cc] GSC-894 and GSC-906 from the same horizon. L.J.

[dd] no NaOH leach pretreatment; one 3-day count.

[ee] discrepancy with S-107 due to dead carbon in marl.

[ff] compare S-107, S-106, and S-140 for corroboration of rapid incision. L.J.

[gg] greater apparent age of carbonate fraction S-140 (10 600 ± 300 BP).

[hh] longitude does not fit site description; suspect new longitude should be 115°00'00"W. L.J.

[ii] younger date than other dates on terrrace for North Saskatchewan River. L.J.

[jj] date younger than expected.

[kk] confirms earlier date on wood at base of marl S-106.

[ll] corrected date by $^{13}C/^{12}C$ determination 5900 ± 140 BP.

[mm] a second determination on the same material as GSC-1195. These dates are stratigraphically consistent with two other terrace dates, GSC-1205 (10 200 ± 600 BP) and GSC-1207 (6040 ± 140 BP), that relate to a phase when North Saskatchewan River floodplain was 20 m higher. L.J.

[nn] previously published as the uncorrected date of 10 000 ± 160 BP by D.A. St-Onge, 1970. L.J.

[oo] no NaOH leach pretreatment; mixed with dead gas; two 1-day counts.

[pp] GSC-2865, GSC-2895, and GSC-2902 correlate well with each other. L.J.

[qq] $\delta^{13}C = -20.3°/_{oo}$, two 1-day counts.

[rr] $\delta^{13}C = -21.1°/_{oo}$.

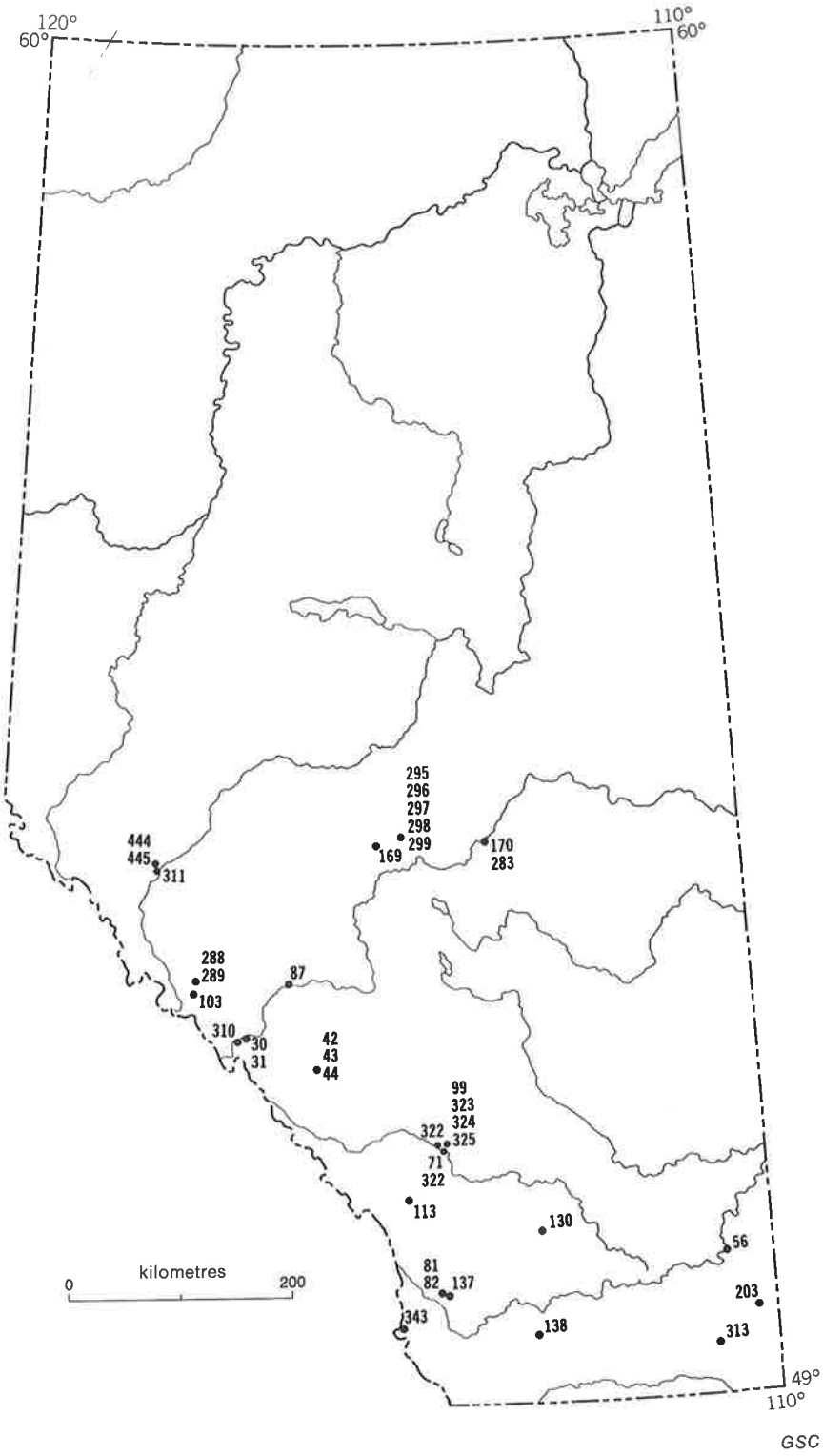

Figure 9. *Locations of dates listed in Table 9*

Table 9. Radiocarbon dates related to tephras

Site No. (cf. Fig. 9)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N	Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
343	RL-508[e]	6340 ± 160	Crowsnest Pass	49°40'00"	114°35'00"	5	12 (p. 100)	JC	bone	Minimum age for underlying Mazama tephra.
346	RL-447	6230 ± 180	Crowsnest Pass	49°35'00"	114°22'00"	5	12 (p. 101)	BOR	bone	Closely dates Mazama tephra.
347	RL-511	6230 ± 160	Crowsnest Pass	49°35'00"	114°22'00"	5	12 (p. 101)	BOR	bone	Closely dates Mazama tephra.
348	RL-510[n]	6610 ± 160	Crowsnest Pass	49°35'00"	114°22'00"	5	12 (p. 101)	BOR	bone	Closely dates Mazama tephra.
138	GSC-161[f,g]	10 620 ± 250	Blood Indian Res.	49°32'30"	112°56'30"	3	15 (p. 4)	AMS	organic matter	Maximum age for overlying tephra.
81	GSC-1255[h,i,k]	6060 ± 140	The Gap	49°51'05"	114°22'05"	5	37 (p. 18)	OAC	charcoal	Minimum age for deposition of underlying Mazama tephra.
82	GSC-1298[j,k]	6720 ± 170	The Gap	49°51'05"	114°22'05"	5	37 (p. 19)	OAC	charcoal	Maximum age for deposition of overlying Mazama tephra.
137	GSC-141[g,l]	9560 ± 170	Waldron Ranch	49°48'00"	114°07'00"	5	15 (p. 4)	AMS	charcoal	Maximum age for overlying tephra.
203	S-731	7245 ± 255	Stampede Site	49°40'00"	110°15'00"	4	49 (p. 349)	EG, DC	charred bone/charcoal	Maximum age for Mazama tephra.
56	GSC-1341	8120 ± 170	Medicine Hat	50°08'05"	110°34'20"	1	36 (p. 288)	AMS	gastropod shells	Provides maximum age for overlying Mazama tephra.
130	GSC-369[o]	5430 ± 320	Lomond	50°19'30"	112°53'30"	2	17 (p. 13)	AMS	gastropod shells	Minimum age for Mazama tephra.
113	GSC-285[j,p]	8220 ± 80	Chalmers Bog	50°39'30"	114°33'30"	4	31 (p. 17)	LEJ	peat	Maximum age for Mazama tephra.
71	GSC-1209[q,r,s]	8080 ± 150	Calgary	51°02'00"	114°05'00"	3	36 (p. 290)	NWR	bone	Maximum age for overlying Mazama tephra.
99	GSC-1819[e,r,s,t]	8400 ± 150	Calgary	51°04'30"	114°12'40"	3	29 (p. 9)	BG	carbonized twig	Maximum age for overlying Mazama tephra.
321	RL-905[r]	8710 ± 230	Calgary	51°04'30"	114°12'40"	3	61 (p. 321)	MW	charcoal	Maximum age for overlying Mazama tephra.
322	GX-6397-A[r,s]	8300 ± 280	Calgary	51°02'00"	114°05'00"	3	61 (p. 281)	MW	bone	Maximum age for overlying Mazama tephra.
323	GX-6396-A[s]	6580 ± 205	Calgary	51°02'00"	114°05'00"	3	61 (p. 281)	MW	bone	Minimum age for underlying Mazama tephra.
324	GX-6395-A[s]	5470 ± 150	Calgary	51°02'00"	114°05'00"	3	61 (p. 281)	MW	bone	Minimum age for underlying Mazama tephra.
325	GX-6394-A[s]	5145 ± 170	Calgary	51°02'00"	114°05'00"	3	61 (p. 281)	MW	bone	Minimum age for underlying Mazama tephra.
42	GSC-894[v]	2870 ± 140	Warden Rock	51°42'50"	115°41'30"	6	26 (p. 69)	MJC	charcoal	Minimum age for underlying unidentified tephra.
43	GSC-906[v,w]	2510 ± 180	Warden Rock	51°42'50"	115°41'30"	6	26 (p. 69)	MJC	gastropod shells	Minimum age for underlying unidentified tephra.
30	GSC-577[j,x]	2120 ± 150	Banff National Park	51°58'00"	116°43'00"	4	25 (p. 223)	AD	charcoal	Minimum age for Bridge River tephra.
31	GSC-531[j,x]	2670 ± 170	Banff National Park	51°58'00"	116°43'00"	4	25 (p. 223)	AD	charcoal	Maximum age for Bridge River tephra.
310	S-581[x]	2550 ± 80	Banff National Park	51°58'00"	116°43'00"	4	58 (p. 879)	not recorded	charcoal	Minimum age for Bridge River tephra.
87	GSC-1944[m,y]	8030 ± 200	Nordegg	52°24'00"	116°09'00"	3	39 (p. 6)	BOR	charcoal	Maximum age for Mazama tephra.
103	GSC-2459[t,z]	6170 ± 100	Columbia Icefield	52°12'30"	117°09'00"	7	34 (p. 13)	AJB	charcoal	Minimum age for underlying Mazama tephra.
288	BGS-451	6920 ± 100	Sunwapta Pass	52°13'00"	117°12'00"	6	40 (p. 61)	BHL	peat	Maximum age for overlying Mazama tephra.
289	BGS-450	7770 ± 110	Sunwapta Pass	52°13'00"	117°12'00"	6	40 (p. 61)	BHL	peat	Maximum age for Mazama tephra.
444	I-5518[e,aa]	3865 ± 100	Pocahontas Site	53°15'00"	117°52'00"	3	13 (p. 57)	JD	charcoal	Minimum age for St. Helens Y tephra.
445	I-5517[e]	2570 ± 95	Brule Lake	53°20'11"	117°49'42"	3	13 (p. 57)	JD	charcoal	Minimum age for St. Helens Y tephra.
311	I-6061[e,bb]	4250 ± 140	Brule Lake	53°20'11"	117°49'42"	3	13 (p. 57)	JD	charcoal	Overlies St. Helens Y tephra; apparently contaminated by dead carbon.
169	WIS-343	3550 ± 65	Entwhistle	53°35'30"	114°54'20"	2	2 (p. 343)	HN, JAW	peat	Maximum age for St. Helens Y tephra.
170	I-2778	6290 ± 250	Edmonton	53°30'00"	113°33'00"	1	9 (p. 62)	JAW	charcoal	Minimum age for underlying Mazama tephra.
283	I-2612	6330 ± 200	Edmonton	53°30'00"	113°33'00"	1	57 (p. 149)	JAW	charcoal	Minimum age for underlying Mazama tephra.
67	GSC-1132[cc]	4920 ± 330	Edmonton	53°32'00"	113°27'00"	1	36 (p. 290)	SP	humic acid[dd]	Provides minimum age for Mazama tephra.
312	I-6643	4430 ± 105	West-central Alberta	not recorded		-	58 (p. 879)	not recorded	peat/charcoal	Maximum age for deposition of St. Helens Y tephra.
295	TX-2553[e,ee]	9520 ± 1430	Wabamun Lake	53°33'14"	114°42'16"	2	20 (p. 197)	RGH	fossil pollen	Samples TX-2553 through TX-2557 range from 4.5 to 0.5 m above
296	TX-2554[e,ff]	9890 ± 2530	Wabamun Lake	53°33'14"	114°42'16"	2	20 (p. 197)	RGH	fossil pollen	Mazama tephra and are apparently contaminated by dead carbon.
297	TX-2555[e,gg]	10 090 ± 2530	Wabamun Lake	53°33'14"	114°42'16"	2	20 (p. 197)	RGH	fossil pollen	Samples TX-2558 and TX-2559 lie below the Mazama tephra, but
298	TX-2556[e,hh]	10 240 ± 2290	Wabamun Lake	53°33'14"	114°42'16"	2	20 (p. 197)	RGH	fossil pollen	these dates are suspect due to the contamination of the
299	TX-2557[e,ii]	10 300 ± 3720	Wabamun Lake	53°33'14"	114°42'16"	2	20 (p. 197)	RGH	fossil pollen	overlying dates from the same core.
300	TX-2558[e,jj]	10 400 ± 390	Wabamun Lake	53°33'14"	114°42'16"	2	20 (p. 197)	RGH	fossil pollen	
301	TX-2559[e,kk]	11 750 ± 420	Wabamun Lake	53°33'14"	114°42'16"	2	20 (p. 197)	RGH	fossil pollen	

[a] GSC, Geological Survey of Canada; I, Teledyne Isotopes; WIS, University of Wisconsin; S, University of Saskatchewan; BGS, Brock University; GX, Geochron Laboratories; RL, Radiocarbon Ltd.; TX, University of Texas.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in reference list.

[d] AJB, A.J. Bowyer; JC, J. Calder; DC, D. Cardinal; MJC, M.J. Chambers; OAC, O.A. Christensen; AD, A. Dreimanis; JD, J. Dumanski; BG, B. Gadd; EG, E. Gryba; RGH, R.G. Holloway; LEJ, L.E. Jackson Jr.; BHL, B.H. Luckman; HN, H. Nichols; SP, S. Pawluk; BOR, B.O. Reeves; NWR, N.W. Rutter; AMS, A. MacS. Stalker; JAW, J.A. Westgate; MW, M. Wilson.

[e] latitude and longitude estimated from site description.

[f] no NaOH leach pretreatment; single count.

[g] GSC-141 and GSC-161 likely date the same tephra.

[h] cold NaOH leach pretreatment.

[i] age corrected $\delta^{13}C$ -23.6‰.

[j] no NaOH leach pretreatment; one 3-day count.

[k] GSC-1255, GSC-1298, and GSC-1158 (see Table 10) from a series of archeological living floors.

[l] no NaOH leach pretreatment; mixed with dead gas; single long count.

[m] sample overlies Mazama tephra.

[n] sample partly collected from within tephra.

[o] mixed with dead gas.

[p] $\delta^{13}C$ -28.8‰.

[q] 24-hour NaOH leach pretreatment.

[r] GSC-1209, GSC-1819, RL-905, and GX-6397-A corroborate one another.

[s] GSC-1209, GX-6397-A, GX-6396-A, GX-6395-A, and GX-6394-A from the same series.

[t] two 1-day counts.

[u] from the same series as GSC-1209.

[v] GSC-906 and GSC-894 from the same horizon.

[w] 5% of outer shell leached; mixed with dead gas; one 3-day count.

[x] GSC-577, GSC-531, and S-581 from the same section.

[y] three 1-day counts.

[z] no NaOH leach pretreatment, mixed with dead gas.

[aa] HCl treatment.

[bb] HCl and NaOH treatment.

[cc] possible contamination by living rootlets.

[dd] extracted from paleosol.

[ee] age corrected $\delta^{13}C$‰ -28.19

[ff] age corrected $\delta^{13}C$‰ -27.48

[gg] age corrected $\delta^{13}C$‰ -27.66

[hh] age corrected $\delta^{13}C$‰ -27.54

[ii] age corrected $\delta^{13}C$‰ -26.22

[jj] age corrected $\delta^{13}C$‰ -27.22

[kk] age corrected $\delta^{13}C$‰ -27.63

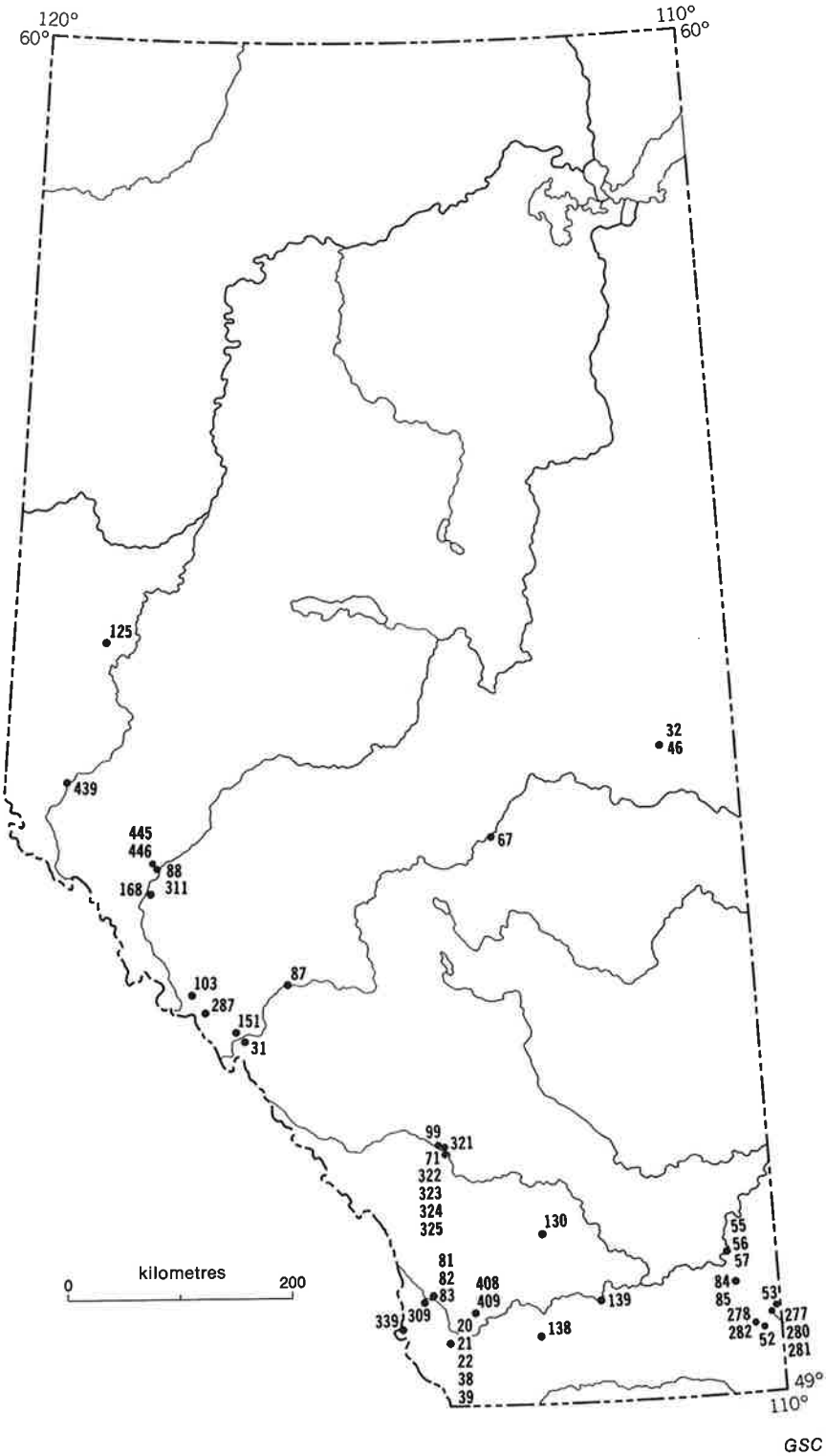

Figure 10. *Locations of dates listed in Table 10*

Table 10. Radiocarbon dates related to Paleosols

Site No. (cf. Fig. 10)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)		Sample Elevation Grouping[b]	Reference[c]	Collectors[d]	Material	Comments
20	GSC-705[e]	6340 ± 140	Castle River	49°29'00"	114°03'30"	3	25 (p. 220)	AMS	bison bone	Maximum age for overlying paleosol.
21	GSC-741[e,f]	3380 ± 170	Castle River	49°29'00"	114°03'30"	3	25 (p. 221)	AMS	gastropod shells	Between two paleosols; gives min./max. ages for lower/overlying soils.
22	GSC-743[e,f]	2680 ± 140	Castle River	49°29'00"	114°03'30"	3	25 (p. 221)	AMS	charcoal	Between two paleosols; gives min./max. ages for lower/overlying soils.
38	GSC-898[e,g,h]	1790 ± 140	Castle River	49°29'00"	114°03'30"	3	26 (p. 67)	AMS	gastropod shells	From topmost paleosol; dates paleosol and minimum age for dune formation.
39	GSC-901[e,g,jj]	2490 ± 180	Castle River	49°29'00"	114°03'30"	3	26 (p. 67)	AMS	charcoal	3.65 m above paleosol; minimum age for paleosol.
339	RL-362[i,j]	14 470 ± 610	Crowsnest Pass	49°40'00"	114°35'00"	5	12 (p. 98)	JCD	bone	Directly dates a paleosol.
346	RL-447	6230 ± 180	Crowsnest Pass	49°35'00"	114°22'00"	5	14 (p. 101)	BOR	bone	Maximum age for paleosol.
347	RL-511	6230 ± 160	Crowsnest Pass	49°35'00"	114°22'00"	5	14 (p. 101)	BOR	bone	Maximum age for paleosol.
348	RL-510	6610 ± 160	Crowsnest Pass	49°35'00"	114°22'00"	5	14 (p. 101)	BOR	bone	Maximum age for paleosol.
309	GX-956	9520 ± 240	Oldman Gap	49°51'05"	114°22'05"	5	37 (p. 19)	OAC	charred bone	Directly dates buried soil.
81	GSC-1255[k]	6060 ± 140	The Gap	49°51'05"	114°22'05"	5	37 (p. 18)	OAC	charcoal	Directly dates buried Ah horizon.
82	GSC-1298[g]	6720 ± 170	The Gap	49°51'05"	114°22'05"	5	37 (p. 19)	OAC	charcoal	Minimum age for buried Ah horizon[n].
83	GSC-1158[m,o,p]	8000 ± 150	The Gap	49°51'05"	114°22'05"	5	37 (p. 19)	OAC	charcoal	Minimum age for paleosol.
138	GSC-161[q,r]	10 620 ± 250	Blood Indian Res.	49°32'30"	112°56'30"	3	15 (p. 4)	AMS	organic matter	Minimum age for paleosol.
139	GSC-3	10 500 ± 200	Taber Provincial Park	49°48'30"	112°10'30"	2	14 (p. 6)	AMS	willow wood	Directly dates paleosol.
130	GSC-369[s]	5430 ± 320	Lomond	50°19'30"	112°53'30"	2	17 (p. 13)	AMS	gastropod shells	Maximum date for overlying soil horizon.
52	GSC-753[t,u]	1250 ± 130	Cypress Hills	49°31'30"	110°13'38"	3	36 (p. 286)	PDJ	buried soil	Paleosol identified as a black chernozem.
282	I-2610	520 ± 95	Cypress Hills	49°33'12"	110°13'04"	4	1 (p. 159)	PDJ	humic material	Minimum age for paleosol.
278	I-2429	4320 ± 110	Cypress Hills	49°33'00"	110°14'00"	4	1 (p. 159)	PDJ	charcoal	Minimum age for paleosol.
277	I-2428	3880 ± 165	Battle Creek	49°39'40"	110°04'18"	4	1 (p. 159)	PDJ	charcoal/bones	Minimum age for paleosol.
280	I-2609	3610 ± 100	Cypress Hills	49°39'40"	110°04'18"	4	1 (p. 159)	PDJ	humic soil material	Dates paleosol.
281	I-2608	880 ± 100	Cypress Hills	49°39'40"	110°04'18"	4	1 (p. 159)	PDJ	humic soil material	Minimum age for humic soil horizon.
53	GSC-800[v]	3950 ± 130	Cypress Hills	49°39'40"	110°04'18"	3	36 (p. 286)	PDJ	buried soil	Directly dates a buried black chernozem.
84	GSC-857	1670 ± 130	Gros Ventre Creek	49°53'00"	110°31'00"	2	27 (p. 24)	MJB	humic material	Directly dates paleosol.
85	GSC-1001[w,x]	3600 ± 140	Gros Ventre Creek	49°53'00"	110°31'00"	2	27 (p. 24)	MJB	humic material	Directly dates paleosol.
55	GSC-1302[y]	1110 ± 140	Medicine Hat	50°08'05"	110°34'20"	1	36 (p. 287)	LOL	charcoal	Maximum age for highest of four buried soils.
56	GSC-1341	8120 ± 170	Medicine Hat	50°08'05"	110°34'20"	1	36 (p. 288)	AMS	gastropod shells	Dates sediments between second and third lowest of four buried soils.
57	GSC-1061	10 200 ± 240	Medicine Hat	50°08'05"	110°34'20"	1	36 (p. 288)	AMS	gastropod shells	Dates sediments between till and lowest of four buried soils.
71	GSC-1209[z,aa]	8080 ± 150	Calgary	51°02'00"	114°05'00"	3	36 (p. 290)	NWR	bison bone	Minimum age for underlying paleosol.
322	GX-6397-A[z,aa]	8300 ± 280	Calgary	51°02'00"	114°05'00"	3	61 (p. 281)	MW	bone	Approximately dates the burial of paleosol.
323	GX-6396-A[aa]	6580 ± 205	Calgary	51°02'00"	114°05'00"	3	61 (p. 281)	MW	bone	Minimum age for underlying paleosol.
324	GX-6385-A[aa]	5470 ± 150	Calgary	51°02'00"	114°05'00"	3	61 (p. 281)	MW	bone	Minimum age for underlying paleosol.
325	GX-6394-A[aa]	5145 ± 170	Calgary	51°02'00"	114°05'00"	3	61 (p. 281)	MW	bone	Minimum age for underlying paleosol.
321	RL-905[z]	8710 ± 230	Calgary	51°04'30"	114°12'40"	3	61 (p. 281)	MW	charcoal	Minimum age for paleosol.
99	GSC-1819[z,bb]	8400 ± 150	Calgary	51°04'30"	114°12'40"	3	29 (p. 9)	BG	carbonized twig	Directly dates paleosol.
31	GSC-531[cc,dd]	2670 ± 170	Banff National Park	51°58'00"	116°43'00"	4	25 (p. 223)	AD	charcoal	Minimum age for underlying tephra and paleosol.
132	GSC-332[dd]	9330 ± 170	Banff National Park	51°58'00"	116°43'00"	4	17 (p. 13)	JAW	charcoal	Minimum age for overlying paleosol.
151	S-191	6020 ± 90	Banff Natl. Park	51°59'00"	116°47'00"	4	43 (p. 233)	AD	forest litter/charcoal	Dates post-Wisconsinan paleosol.
287	BGS-490[j]	9600 ± 300	Castleguard Meadows	52°08'06"	117°09'14"	7	40 (p. 58)	BHL	organic soil horizon	Directly dates buried soil.
103	GSC-2459[l]	6170 ± 100	Columbia Icefields	52°12'30"	117°09'00"	7	34 (p. 13)	AJB	charcoal	Directly dates paleosol; also minimum age for underlying paleosols.
87	GSC-1944[ee]	8030 ± 200	North Saskatchewan R.	52°24'00"	116°09'00"	3	39 (p. 6)	BOR	charcoal	Date for pedogenesis and indicates rapid rate of loess deposition.
168	I-3672	2730 ± 100	Hinton	53°11'00"	117°57'00"	3	10 (p. 102)	JD	charcoal	Dates a possible paleosol in floodplain-derived loess.
88	GSC-1730[l]	2870 ± 180	Brule Lake	53°20'00"	117°45'00"	2	39 (p. 6)	JE	charcoal	Dates incipient soil development and hiatus in dune activity.
311	I-6061[i,ff,gg]	4250 ± 140	Brule Lake	53°20'11"	117°49'42"	3	13 (p. 57)	JD	charcoal	Minimum age for paleosol.
445	I-5517[i,gg]	2570 ± 95	Brule Lake	53°20'11"	117°49'42"	3	13 (p. 57)	JD	charcoal	Minimum date for underlying paleosol.
446	I-6062[i,gg]	7250 ± 120	Brule Lake	53°20'11"	117°49'42"	3	13 (p. 57)	JD	charcoal fragments	Minimum age for paleosol; maximum age for overlying loess.
67	GSC-1132[hh]	4920 ± 300	Edmonton	53°32'00"	113°27'00"	1	36 (p. 290)	SP	humic acid[p]	Buried soil overlies Mazama tephra.
32	GSC-660[v]	4200 ± 140	Moose Lake	54°15'00"	111°00'00"	1	38 (p. 28)	WM	charcoal	Minimum age for underlying paleosol.
46	GSC-1068[ll]	4710 ± 150	Moose Lake	54°15'00"	111°00'00"	3	35 (p. 476)	WM	humic acid[ii]	Directly dates paleosol and hiatus in dune activity.
439	BIRM-714[i]	4490 ± 140	Smoky River	53°56'24"	119°02'10"	3	5	JWB	bone	Minimum age for paleosol.
125	GSC-2802[l]	4540 ± 230	Grande Prairie	55°05'00"	118°43'20"	1	31 (p. 19)	CSC, AMS	charcoal	Dates paleosol; maximum age for overlying firebands.

[a] GSC, Geological Survey of Canada; S, University of Saskatchewan; I, Teledyne Isotopes; BGS, Brock University; GX, Geochron Laboratories; RL, Radiocarbon Ltd.; BIRM, University of Birmingham.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in reference list.

[d] MJB, M. J. Bik; AJB, A.J. Bowyer; JWB, J.W. Brink; OAC, O.A. Christensen; CSC, C.S. Churcher; AD, A. Dreimanis; JCD, J.C. Driver; JD, J. Dumanski; JE, J. Elliot; BG, B. Gadd; PDJ, P.D. Jungerius; LOL, L.O. Lindoe; BHL, B.H. Luckman; WM, W. Moore; SP, S. Pawluk; BOR, B.O.K. Reeves; NWR, N.W. Rutter; AMS, A.MacS. Stalker; JAW, J.A. Westgate; MW, M. Wilson.

[e] GSC-705, GSC-741, GSC-743, GSC-898, and GSC-901 obtained from a succession of three paleosols capped by eolian sand.

[f] GSC-743 is stratigraphically lower than GSC-741. GSC-901 supports GSC-743. L.J.

[g] mixed with dead gas; one 3-day count.

[h] date may be several hundred years too old; small sample (11.6 g).

[i] latitude and longitude calculated from site description.

[j] date is anomalously old when compared to artifacts present in surrounding sediments; probably contaminated by dead carbon.

[k] cold NaOH leach pretreatment. $\delta^{13}C = -23.6‰$.

[l] no NaOH leach pretreatment; mixed with dead gas; two 1-day counts.

[m] age corrected $\delta^{13}C = -24.6‰$.

[n] comparison with GSC-1255 gives a time frame for pedogenesis.

[o] cold NaOH leach pretreatment.

[p] considered a better determination than charred bison bone from same site GX-956.

[q] no NaOH leach pretreatment; single count.

[r] corroborates shell date GSC-141 from the same horizon.

[s] sample taken from top of Mazama tephra base of pond sediments.

[t] pretreatment with $Na_2P_2O_7 \cdot 2H_2O$; no NaOH leach.

[u] soil not as well developed as unit dated by GSC-800.

[v] no NaOH leach.

[w] 20-40 cm stratigraphically lower than GSC-857. Comparison with GSC-1001 gives a time frame for pedogenesis.

[x] mixed with dead gas; $\delta^{13}C = -24.3‰$.

[y] sample pretreatment with cold NaOH leach. $\delta^{13}C = -23.4‰$.

[z] GSC-1209, GSC-1819, RL-905, and GX-6397-A corroborate one another.

[aa] GSC-1209, GX-6397-A, GX-6396-A, GX-6395-A, GX-6394-A from the same series.

[bb] cold NaOH pretreatment; two 1-day counts.

[cc] GSC-332 provides a more accurate date for paleosol.

[dd] GSC-531 and GSC-332 from the same exposure.

[ee] sample from a hearth in buried Ah horizon.

[ff] HCl and NaOH treatment.

[gg] I-5517, I-6062, and I-6061 date the same sequence of paleosols.

[hh] possibly contaminated by rootlets.

[ii] extracted from paleosol.

[jj] from same bed as GSC-741 and GSC-743. Close agreement with GSC-743, suggests GSC-741 several hundred years too old.

[kk] no NaOH pretreatment; mixed with dead gas; $\delta^{13}C = -20.4‰$.

[ll] NaOH pretreatment; mixed with dead gas; HCl neutralized; $\delta^{13}C = -20.4‰$.

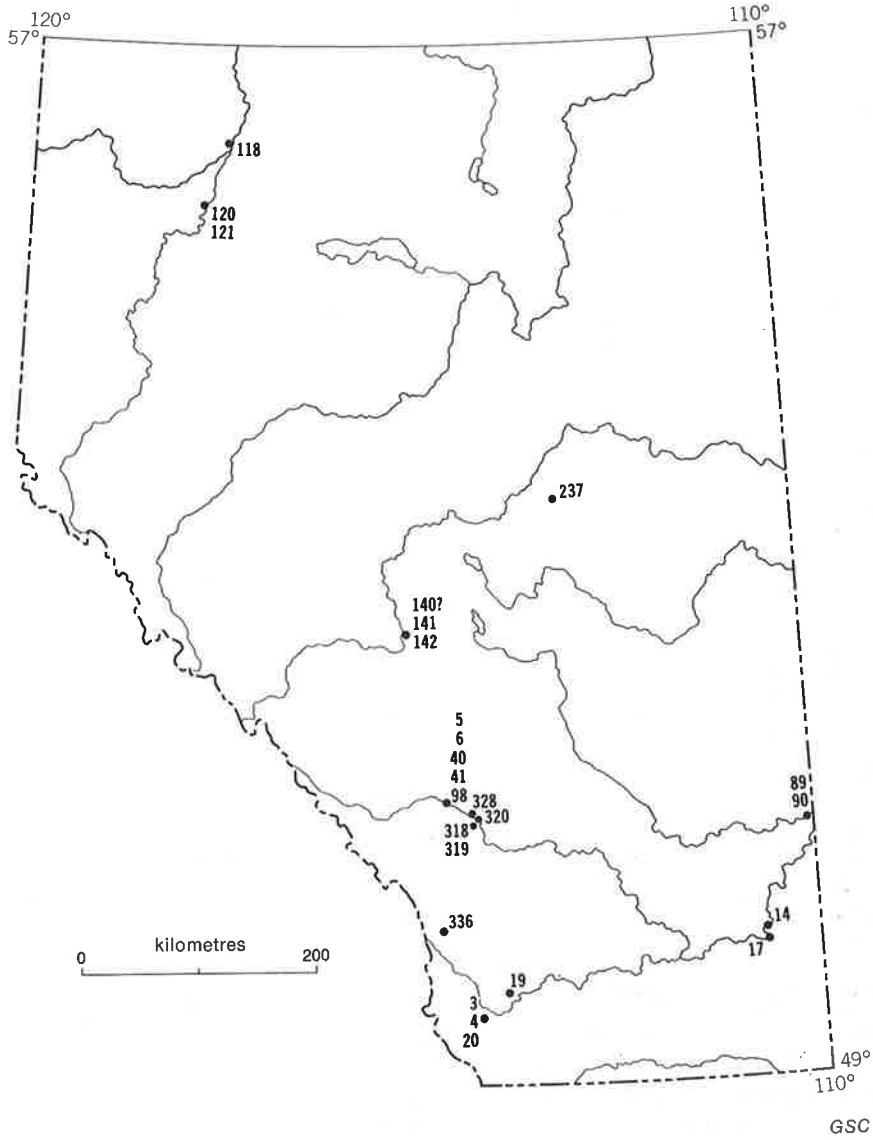

Figure 11. *Locations of dates listed in Table 11*

Table 11. Radiocarbon dates on past mammalian fauna

Site No. (cf. Fig. 11)	Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collectors[d]	Material	Comments
3	GSC-447[e,f]	6150 ± 140	Castle River	49°29'00" 114°03'30"	3	33 (p. 14)	AMS	bone[g]	*Bison*, species not identified.
4	GSC-490[e,f]	6100 ± 180	Castle River	49°29'00" 114°03'30"	3	33 (p. 14)	AMS	bone[h]	*Bison*, species not identified.
20	GSC-705[f]	6340 ± 140	Castle River	49°29'00" 114°03'30"	3	25 (p. 220)	AMS	bone	*Bison*, species not identified.
17	GSC-805[e]	11 200 ± 200	Medicine Hat	50°04'50" 110°39'20"	1	25 (p. 220)	CSC	bone[i]	Dates rich late Pleistocene faunal assemblage.
14	GSC-780	>30 000	Medicine Hat	50°07'45" 110°38'40"	1	25 (p. 219)	CSC, LMK	wood	1 m below surface amongst mammal fauna; minimum date mammal fauna.
336	GAK-5438	23 100 ± 860	Plateau Mountain	50°11'00" 114°31'00"	7	11 (p. 1508)	JAB	collagen	Basal date for succession of small mammal fauna.
318	GX-2104	8145 ± 320	Calgary	50°57'45" 114°01'00"	3	60 (p. 733)	BR	bone	Dates *Camelops* cf. *hesternus*.
319	RL-757	11 300 ± 290	Calgary	50°57'45" 114°01'00"	3	60 (p. 733)	MW	bone[j]	Dates *Camelops* cf. *hesternus*.
320	GSC-3065[k]	10 200 ± 280	Calgary	51°02'45" 114°04'30"	3	61 (p. 187)	MW	bone	*Bison*, species not identified.
328	RL-1058[k,l]	4000 ± 130	Calgary	51°05'00" 114°05'00"	3	61 (p. 281)	MW	mammoth tusk	Minimum age for mammoth tusk.
5	GSC-612[m]	10 760 ± 160	Cochrane	51°10'40" 114°27'10"	3	33 (p. 14)	PC, CSC, AMS	bone	Dates *Bison bison*, *Equus conversidens*, *Ovis Canadensis*, and *Cervis canadensis*.
6	GSC-613[m]	11 370 ± 170	Cochrane	51°10'40" 114°27'30"	3	33 (p. 15)	GC, AMS	bone	Dates *Bison bison*, *Equus conversidens*, *Ovis canadensis*, and *Cervis canadensis*.
40	GSC-988[n]	5670 ± 150	Cochrane	51°10'40" 114°27'30"	3	26 (p. 68)	AMS	bone	Dates *Bison bison*, *Equus conversidens*, *Ovis canadensis*, and *Cervis canadensis*.
41	GSC-989[o]	11 100 ± 160	Cochrane	51°10'40" 114°27'30"	3	26 (p. 68)	AMS	bone	Dates *Bison bison*, *Equus conversidens*, *Ovis canadensis*, and *Cervis canadensis*.
98	GSC-612-2[p,q]	7220 ± 480	Cochrane	51°10'40" 114°27'10"	3	28 (p. 18)	PC, CSC, AMS	collagen	Dates *Bison occidentalis*, *Equus conversidens*, *Ovis canadensis*, and *Cervis canadensis*.
89	GSC-1199[r]	14 200 ± 1120	Empress	50°57'50" 110°00'50"	1	28 (p. 16)	WFS, CSC, AMS	bone fragments	Dates mostly mammoth bones[s].
90	GSC-1387	20 400 ± 320	Empress	50°57'50" 110°00'50"	1	28 (p. 16)	WFS, CSC, AMS	bone fragments	Dates mostly mammoth bones[s].
140	S-140[t,u]	10 600 ± 300	North Saskatchewan R.	52°25'33" 114°16'38"	2	42 (p. 74)	LAB	marl	One of the last occurrences of *Bison occidentalis*.
141	S-107[u,v]	7350 ± 100	North Saskatchewan R.	52°25'33" 114°16'38"	2	42 (p. 74)	LAB	wood	One of the last occurrences of *Bison occidentalis*.
142	S-106[u,v]	8150 ± 100	North Saskatchewan R.	52°25'33" 114°16'38"	2	42 (p. 74)	LAB	wood	One of the last occurrences of *Bison occidentalis*.
237	S-874	3260 ± 320	Flach Site	53°30'00" 113°00'00"	1	50 (p. 71)	RB	charcoal	One of the youngest dated *Bison occidentalis* on northwest plains.
120	GSC-2895[w,x]	10 200 ± 100	Watino	55°43'00" 117°37'30"	1	31 (p. 18)	NB, CSC	bone[y]	Dates *Bison cf. priscus*. Other macrofauna scarce[z].
121	GSC-2902[w,aa]	10 200 ± 100	Watino	55°43'00" 117°37'30"	1	31 (p. 18)	NB, CSC	bone[bb]	Dates *Bison cf. priscus*. Other macrofauna scarce[z].
118	GSC-2865[w,cc]	9880 ± 130	Peace River	56°13'40" 117°18'10"	1	31 (p. 18)	CSC, MW	bone[dd]	Dates *Bison cf. priscus*.
19	GSC-803[e]	5410 ± 300	Fort Macleod	49°42'40" 113°38'45"	3	25 (p. 220)	BR	bone	Earliest date for northern plains buffalo.

[a] GSC, Geological Survey of Canada; S, University of Saskatchewan; GX, Geochron Laboratories; RL, Radiocarbon Ltd.; GAK, Gakushuin Laboratories.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in reference list.

[d] LAB, L.A. Bayrock; NB, N. Boisvert; RB, R. Bonichsen; JAB, J.A. Burns; PC, P. Chamney; CSC, C.S. Churcher; GC, G. Clarke; LMK, L.M. Kisko; BR, B. Reeves; WFS, W.F. Smith; AMS, A.MacS. Stalker; MW, M. Wilson.

[e] mixed with dead gas; one 3-day count.

[f] GSC-447, GSC-490, and GSC-705 date the same gravel unit.

[g] jaw.

[h] tooth.

[i] bison and horse bone.

[j] humerus.

[k] latitude and longitude calculated from site description.

[l] date rejected, contaminated by preservative. L.J.

[m] GSC-612 and GSC-613 corroborate each other.

[n] anomalously young, see GSC-612, GSC-613, GSC-989. Suspected contamination by younger bones.

[o] good agreement with GSC-613.

[p] 24-hour. NaOH leach; mixed with dead gas; two 1-day counts.

[q] older dates of Cochrane series should be favoured for age of chief bone bed in the terraces, GSC-612, GSC-613, and GSC-989.

[r] one-hour NaOH leach, mixed with dead gas, one 3-day count.

[s] *Mammuthus primigenius*, *Mammuthus imperator*, *Equus conversidens*, *Equus cf. niobrarensis*, *Camelops cf. hesternus*, *Rangifer sp?*, *Bison cf. occidentalis*. Such well developed fauna so close to time of Classical Wisconsinan glaciation seems improbable; may have lived during a prolonged interval between two advances of the Classical Wisconsinan glaciation.

[t] discrepancy with S-107 due to dead carbon in the marl. L.J.

[u] longitude does not fit site description, suspect new longitude should be 115°00'00"W. L.J.

[v] sample 0.3 m below S-140. L.J.

[w] GSC-2865, GSC-2895, and GSC-2902 corroborate one other. L.J.

[x] two 1-day counts; $\delta^{13}C = -20.3‰$.

[y] cervical vertebra.

[z] possible that other macro fauna are locally extinct.

[aa] $\delta^{13}C = -21.1‰$; one 3-day count.

[bb] *Bison* tibia.

[cc] no NaOH leach pretreatment; mixed with dead gas; two 1-day counts.

[dd] two tibias.

Table 12. Radiocarbon dates from nearby areas of British Columbia, Saskatchewan, and Montana that have significant implications for late Pleistocene and Holocene events in Alberta

Laboratory Dating No.[a]	Date (years BP)	Locality	Location (Lat. °N Long. °W)	Sample Elevation Grouping[b]	Reference[c]	Collector[d]	Material	Comments
British Columbia								
GSC-1457	10 000 ± 140	Oldman Creek	51°28'54" 117°13'24"	2	29 (p. 10)	RJF	peat	Minimum date for recession of ice from the Rockies.
GSC-173[e]	21 500 ± 300	Boat Encampment	52°16'00" 118°23'00"	5	16 (p. 9)	HWN	woody plant detritus	Maximum date for Fraser glaciation ice advance from the Rockies.
GSC-1258[f,g]	21 700 ± 240	Canoe River valley	52°11'40" 118°27'23"	1	36 (p. 294)	RAA	wood	Maximum date for Fraser glaciation ice advance from the Rockies.
I-2244	7670 ± 170	Peace River	56°00'00" 122°10'00"	1	8 (p. 263)	LTJ	elephant tusk	Indicates longevity of elephants in Canadian Rocky Mountain ice fringes.
I-2259	>40 000	Peace River	56°00'00" 122°00'00"	1	8 (p. 264)	DDC	charcoal	Minimum date for local disappearance of glacial Lake Peace.
GSC-2275[h,i]	12 200 ± 160	Upper Elk valley	50°09'30" 114°57'20"	4	29 (p. 9)	JEH	organic material	Minimum date for deglaciation near the Great Divide.
GSC-2142[j,k]	11 900 ± 100	Upper Elk valley	50°09'30" 114°57'20"	4	29 (p. 9)	JEH	organic material	Minimum date for deglaciation near the Great Divide.
GX-5598	10 125 ± 285	Upper Elk valley	50°21'05" 114°54'18"	5	18 (p. 1635)	AF, GO	wood	Minimum date for deglaciation near the Great Divide.
GX-5599[l]	13 430 ± 450	Upper Elk valley	50°21'05" 114°54'18"	5	18 (p. 1635)	AF, GO	shells	Minimum date for deglaciation near the Great Divide.
Saskatchewan								
S-460	10 060 ± 160	Empress	50°51'30" 109°58'00"	1	49 (p. 330)	PPD	A horizon	Dates paleosol; minimum date for deglaciation.
S-461	9500 ± 150	Prelate	50°45'00" 109°24'00"	1	49 (p. 330)	PPD	carbonaceous material	Minimum age for paleosol.
S-176	20 000 ± 850	Leader	50°58'00" 109°27'47"	1	43 (p. 231)	EAC	organic residue	Dates paleosol formed before last major glacial advance.
S-228	21 000 ± 800	Marsden	52°53'00" 109°54'00"	1	44 (p. 366)	DLD	carbonaceous silt	Dates weathering interval prior to last glaciation.
S-228-A[m]	18 000 ± 450	Marsden	52°53'00" 109°54'00"	1	44 (p. 366)	DLD	carbonaceous silt	Dates weathering interval prior to last glaciation.
S-228-B[n]	19 200 ± 400	Marsden	52°53'00" 109°54'00"	1	44 (p. 366)	DLD	carbonaceous silt	Dates weathering interval prior to last glaciation.
S-300-A[o]	14 670 ± 240	Evesham	52°29'00" 109°57'00"	1	44 (p. 374)	EAC	carbonate	Minimum date for deglaciation.
S-300-B[o,p]	15 850 ± 235	Evesham	52°29'00" 109°57'00"	1	44 (p. 374)	EAC	carbonaceous silt	Minimum date for deglaciation.
S-401-A[o]	12 725 ± 135	Evesham	52°29'00" 109°57'00"	1	44 (p. 374)	EAC	carbonate	Minimum date for deglaciation.
S-401-B[q]	18 000 ± 275	Evesham	52°29'00" 109°57'00"	1	44 (p. 375)	EAC	carbonaceous silt	Maximum date for start of last glaciation.
Montana								
A - 1998[r]	42 170 ± 2140	Hall Coulee	48°58'21" 113°15'00"	3	21 (p. 112)	ETK	charcoal	Supports conclusions that Late Wisconsinan Laurentide ice extended
A - 1997[r]	>38 000	Hall Coulee	48°58'21" 113°15'00"	3	21 (p. 112)	ETK	charcoal	no farther southwest than Lethbridge.

[a] GSC, Geological Survey of Canada, I, Teledyne Isotopes; GX, Geochron Laboratories; S, University of Saskatchewan; A, University of Arizona.

[b] 1: 500-750 m; 2: 750-1000 m; 3: 1000-1250 m; 4: 1250-1500 m; 5: 1500-1750 m; 6: 1750-2000 m; 7: 2000-2250 m; 8: 2250-2500 m; 9: 2500-2750 m; 10: 2750-3000 m; 11: 3000-3250 m.

[c] nonbracketed numbers refer to numbered citations in reference list.

[d] RAA, R.A. Achard; DDC, D.D. Campbell; EAC, E.A. Christiansen; PPD, P.P. David; DLD, D.L. Delorne; AF, A. Ferguson; RJF, R.J. Fulton; JEH, J.E. Harrison; LTJ, L.T. Jory; ETK, E.T. Karlstrom; HWN, H.W. Nasmith; GO, G. Osborn;

[e] correlates with deposits in sample GSC-194 (20 230 ± 270 BP).

[f] compare with GSC-173 (21 500 ± 300 BP).

[g] one 3-day count.

[h] no NaOH leach pretreatment; based on two 1-day counts.

[i] GSC-2275, GX-5598, and GX-5599 corroborate one other.

[j] no NaOH leach pretreatment; based on one 3-day count.

[k] GSC-2275 and GSC-2142 from the same horizon.

[l] may be anomalously old due to the incorporation of dead carbon; sample underlies GX-5598; outer carbonate removed from those samples; however, the true date could be younger. Date is ^{13}C corrected.

[m] S-228-A is a carbonate fraction from same sample as S-228-B.

[n] S-228-A and S-228-B are organic fractions from different locations.

[o] dates considered acceptable by collector.

[p] organic fraction.

[q] date considered unacceptable by collector.

[r] latitude and longitude estimated from site description.

ADDENDUM

Table 1

Site: 45 Date and Laboratory Number: >38 000 (GX-1207)

Locality: Watino

Collector: JAW Material: Wood

Comments: from 6 m of fossiliferous fine grained sediments overlain by 24 m of glaciolacustrine sediments; indicates ice free conditions during the mid Wisconsinan

Reference: 26, p. 69

Table 4

Site: 45 Date and Laboratory Number: 35 500 $\pm \begin{matrix} 2300 \\ 1800 \end{matrix}$ (I-2516)

Locality: Watino

Collector: JAW Material: Wood

Comments: from 6 m of fossiliferous fine grained sediments overlain by 24 m of glaciolacustrine sediments; indicates ice free conditions during the mid Wisconsinan; corroborates GSC-1020, GX-1207, I-2615, I-4878

Reference: 26, p. 69

Site: 45 Date and Laboratory Number: 35 500 $\pm \begin{matrix} 3300 \\ 2300 \end{matrix}$ (I-2615)

Locality: Watino

Collector: JAW Material: Wood

Comments: as above; corroborates GSC-1020, GX-1207, I-2516, I-4878 and shows I-2616 to be too young

Reference: 26, p. 69

Site: 45 Date and Laboratory Number: 27 400 ± 850 (I-4878)

Locality: Watino

Collector: JAW Material: Wood or peat

Comments: as above; corroborates GSC-1020, GX-1207, I-2516, I-2615

Reference: Westgate, J.A., Fritz, P., Mathews, J.V. Jr., Kalas, L. Delorme, L.D., Green, R., and Aario, R. 1972

1972: Geochronology and palaeoecology of mid-Wisconsin sediments in west-central Alberta, Canada. Abstracts, twenty-fourth International Geological Congress, Montreal, p. 380.

Site: 45 Date and Laboratory Number: 34 900 $\pm \begin{matrix} 3000 \\ 2000 \end{matrix}$ (I-2616)

Locality: Watino

Collector: JAW Material: Wood

Comments: Date is disputed by GSC-1020, GX-1207, I-2516, I-2615

Reference: 26, p. 69

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