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RADIOCARBON DATES OF LATE QUATERNARY MEGAFAUNA AND BOTANICAL REMAINS FROM CENTRAL ALBERTA, CANADA

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INTRODUCTION

The chronologic record of late Quaternary biota from central Alberta has broad implications for understanding the archaeological, geological, paleontological, and paleoenvironmental record of western North America. Radiocarbon dates on remains of Pleistocene megafauna were previously used as proxies for the advance and retreat of ice sheets across Alberta (e.g. Young et al. 1994; Dyke 2005), and are important for understanding landscape changes that likely influenced the timing of human dispersal into North America (Burns 1996). ^{14}C records of Holocene age continue to refine our understanding of landscape change leading up to modern environmental conditions (Beaudoin 2003). Here, we report 15 ^{14}C dates from new and previously recorded sites in central Alberta, and one from just across the border within Saskatchewan (Figure 1).

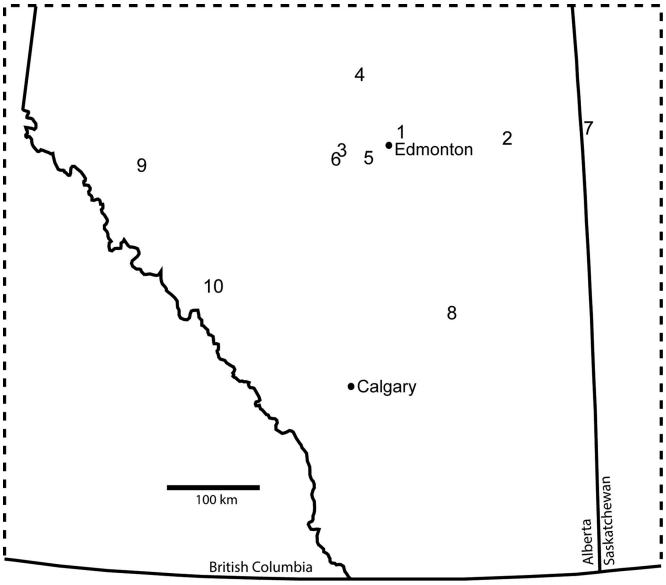

Figure 1 Geographic location of sites discussed in this paper. Numbers correspond to order of appearance in text: 1. Inland Aggregates Pit 48; 2. Vermillion River Bison; 3. Henkel Farm; 4. Pembina River Bison; 5. Juniper Pit; 6. Dahm Pit; 7. Benson Site; 8. Hampton's Dugout; 9. Solomon Creek; 10. "Brian's Creek."

Newly reported sites are discussed individually in the following ^{14}C date list. These localities often consist of isolated finds, may not be the subject of further research, and generally contain insufficient material to justify independent reporting. However, by providing georeferenced chronological "pinning points," these data do contribute to our overall understanding of the ecology and distribution of late Quaternary fauna and flora of central Alberta.

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Many of the specimens reported here were recovered from fluvial gravels and sands, emphasizing the importance of those depositional contexts for the preservation of significant late Quaternary paleontological resources in western Canada. The recovery history of many of these specimens further highlights the role of industry and the public in finding fossils and ensuring their preservation in museum collections.

Precise locality coordinates are not included here, but those data are available upon request. A map showing the general geographic location of records discussed here is presented in Figure 1. Finite dates were calibrated using OxCal v 4.2.3 (Bronk Ramsey 2009, 2013) and the latest IntCal13 data set (Reimer et al. 2013). Calibrated values are included in the Comment section where appropriate. Unless otherwise stated, values are at the 95.4% confidence interval. Laboratory number is followed by a unique number assigned to each submitted sample by the Quaternary Palaeontology Program or the Quaternary Environments Program, Royal Alberta Museum. Some dates have been referenced in abstracts or in published sources with limited visibility, as indicated.

RESULTS

FAUNA

Camelidae

RAM P05.10.52: Western camel, *Camelops hesternus*

Beta-291716 **>43,500 BP**
QP.185

Bone collagen. Royal Alberta Museum Locality: Inland Aggregates Pit 48. A sample for accelerator mass spectrometry (AMS) ^{14}C analysis was taken from an isolated left metacarpal recovered from a gravel pit excavation located near Edmonton, Alberta. Collected in 2005 by J A Burns; submitted by C N Jass.

Comment: Remains of Quaternary megafauna from Inland Aggregates Pit 48 are discussed in some detail in the literature (e.g. Burns and Young 1994; Jass et al. 2011). Direct ^{14}C dates on *Camelops* are presently uncommon from the Quaternary record of central Alberta, and from the southern provinces of Canada in general (see Harington 2003). Other directly dated remains of *Camelops* from Alberta include a record from near Vauxhall (10,708 ± 100 BP; Burns 2010) and another from the Wally's Beach site (11,070 ± 80 BP; Kooyman et al. 2012), both located in southern Alberta.

Bovidae

RAM P12.2.1: Bison, *Bison bison*

Beta-316504 **170 ± 30 BP**
QP.190 **$\delta^{13}C$ = –19.2‰**

Bone collagen. Royal Alberta Museum Locality: Vermillion River Bison. 291–251 cal BP (17.3% probability), 229–133 cal BP (50.5% probability), 118–71 cal BP (8.0% probability), and 35 to present cal BP (19.6% probability). A sample for AMS ^{14}C analysis was taken from a complete skull of *Bison bison*. The skull was found in structureless, sandy sediments ~50 cm below the exposed, modern surface of the bank of the Vermillion River. Sediments that preserved the skull showed some evidence of leaching relative to overlying sediments. Collected and submitted in 2012 by C N Jass.

Comment: Latter portions of the age range (35 cal BP and younger) can likely be excluded from consideration given the record of extirpation of *Bison* across most of North America by the 1880s (Brink 2008). As such, the Vermillion River Bison may represent a record from one of the last generations of free-ranging *Bison* in Alberta.

RAM P10.12.2: Bison, *Bison* sp.

Beta-316503 **10,320 ± 40 BP**
QP.189 **$\delta^{13}C$ = –18.9‰**

Bone collagen. Royal Alberta Museum Locality: Henkel Farm. 12,384–11,975 cal BP. A sample for AMS ^{14}C analysis was taken from a metacarpal of *Bison*. Bones were uncovered by landowner while removing fill from a small hill situated on a landscape characterized by hummocky topography. All materials were recovered from a structureless, silty clay. Collected in 2010 by C N Jass; submitted in 2012 by C N Jass.

Comment: Other recovered elements included a metacarpal, a tibia, a radius, two cervical vertebrae, and a vertebral fragment. Initially, the bones were interpreted as being of late Holocene age, but further consideration of the context (i.e. a small hill surrounded by no uplands) suggested the possibility of an older age. The record represents an early, post-glacial maximum occurrence of *Bison* in central Alberta.

RAM P11.6.1: Bison, *Bison* sp.

Beta-330605 **4950 ± 30 BP**
QP.196 **$\delta^{13}C$ = –19.3‰**

Bone collagen. Royal Alberta Museum Locality: Pembina River Bison. 5735–5606 cal BP. A sample for AMS ^{14}C analysis was taken from a partial skull of *Bison*. A skull and several other skeletal elements of *Bison* were collected from beach sands on a point bar along the Pembina River. Collected in 2011 by C N Jass and A Esch; submitted in 2012 by C N Jass.

Comment: Bones were not in primary context and may represent reworking from intact deposits further upstream.

RAM P12.6.1: Bison, *Bison* sp.

Beta-330606 **4280 ± 30 BP**
QP.197 **$\delta^{13}C$ = –19.3‰**

Bone collagen. Royal Alberta Museum Locality: Juniper Pit. 4957–4821 cal BP. A sample for AMS ^{14}C analysis was taken from a complete skull of *Bison* recovered from a sand and gravel mining operation located west of Edmonton, Alberta. Collected in 2012 by staff of Lafarge; submitted in 2012 by C N Jass.

Comment: Fossil remains are commonly uncovered by heavy equipment as part of ongoing sand and gravel mining operations in Alberta. Precise geologic data are often not available for many specimens recovered in this manner, and ^{14}C dates provide the most direct method for developing temporal context for fossils from sand and gravel operations. Institutionally, there is a strong working relationship between industry and museums in Alberta (Tanke et al. 2013).

Cervidae

RAM P12.12.1: Elk, *Cervus elaphus*

Beta-339349 **1600 ± 30 BP**
QP.201 **$\delta^{13}C$ = –19.2‰**

Antler collagen. Royal Alberta Museum Locality: Dahm Pit. 1552–1411 cal BP. A sample for AMS ^{14}C analysis was taken from a partial antler of *Cervus elaphus* recovered from a sand and gravel mining operation southwest of Duffield, Alberta, near the North Saskatchewan River. Collected in 2012 by staff of Mixcor Aggregates; submitted in 2013 by C N Jass.

Comment: As mentioned above, precise geologic provenience is often not available for specimens recovered from sand and gravel mining operations. However, exposed, sedimentary faces at this site suggest fluvial deposition (e.g. well-sorted gravel layers; wood-rich layers). ^{14}C age is consistent with wood remains recovered *in situ* from within a gravel layer (see below). Canadian Shield clasts occur in abundance and likely represent reworking of glacial till within a post-glacial, fluvial context.

RAM P97.5.1: Muskoxen, *Ovibos moschatus*

Beta-342758 **41,460 ± 570 BP**
QP.208 **δ^{13}C = –19.5‰**

Bone collagen. Royal Alberta Museum Locality: Inland Aggregates Pit 48. 45,977–43,886 cal BP. A sample for AMS ^{14}C analysis was taken from a partial skull of *Ovibos moschatus* recovered from a sand and gravel mining operation located near Edmonton, Alberta. Collected in 1998 by staff of Inland Aggregates; submitted in 2013 by C N Jass.

Comment: Description of P97.5.1 was presented in Jass et al. (2011). The age of this specimen is consistent with another published date on the species from the same region (see Harington 2003). The extinct helmeted musk-ox (*Bootherium bombifrons*) is known from the same locality (Jass et al. 2011). However, whether these taxa coexisted in central Alberta remains uncertain, as the age range for fossils collected from Pit 48 encompasses ≥50,000 yr of geologic time.

FLORA

RAM P12.12.2: Wood

Beta-339354 **1650 ± 30 BP**
QP.206 **δ^{13}C = –23.2‰**

Wood. Royal Alberta Museum Locality: Dahm Pit. 1687–1418 cal BP. A sample for AMS ^{14}C analysis was taken from a piece of wood recovered *in situ* from a sand and gravel mining operation southwest of Duffield, Alberta, near the North Saskatchewan River. The wood was collected from a sandy lens in a thick gravel layer (≥8 ft) that was overlain by a thick, structureless, sandy clay (~12 ft thick). The lower half of the exposed gravel face was characterized by iron staining. The wood-bearing sand lens occurred within iron-stained portions of the deposit. Collected in 2012 by C N Jass; submitted in 2013 by C N Jass.

Comment: Unsilicified wood remains are common in gravels of pre- and post-glacial maximum age in central Alberta.

RAM QE2004-D15: Wood, *Betula* sp.

BGS-2590 **3040 ± 50 BP**
δ^{13}C = –25.63‰

Wood. Royal Alberta Museum Locality: Benson site. 3368–3077 cal BP. The wood was collected from the south valley side of the North Saskatchewan River. The collection site is located ~4 km on the Saskatchewan side of the provincial boundary. An intact tree trunk was found buried ~22 ft (7 m) below the current upland surface, and was exposed by excavation (cleaning) of a dugout. Enclosing material was fine-grained clastic sediment. The sample for dating (conventional ^{14}C analysis) was taken from the center of a slice recovered from the buried tree. Collected in 2002 by A B Beaudoin and B Dawe; submitted in 2004 by A B Beaudoin. Taxonomic determination was done in 2004 by R D Fecteau.

Comment: Birch trees are common on north-facing river valley slopes in central Alberta (see Beaudoin and Pyszczyk 1998). The wood was well preserved, suggesting rapid burial. Rings on the outer

margin of the slice are ~2 mm in width, so the central section used for ^{14}C dating (~46 mm radius) probably represents at least about 20–25 yr of growth. Given the setting, the tree was probably buried by slumping. Landslides and slumping are common along the North Saskatchewan Valley, especially on north-facing slopes. Late Holocene slope movements associated with the onset of cooler and moister Neoglacial conditions have been identified at other localities in the Canadian plains (e.g. Sauchyn 1990).

RAM ASA-D91-53: Wood, *Populus* sp.

AECV-1396C **10,200 ± 130 BP**
$\delta^{13}C$ = –25.8‰

Wood. Royal Alberta Museum Locality: Hampton's Dugout. 12,400–11,350 cal BP. Conventional ^{14}C date. The wood was recovered from about 4.5 m below the ground level during dugout excavation in an area identified as likely a former lake bed. The wood (tree) was lying horizontally in the sediment when it was found and had an estimated diameter of ~15 cm. The specimen was wet and "soggy" when found. Collected in 1988 by landowner; submitted in 1991 by A B Beaudoin. Taxonomic determination was done in 1991 by A S Gottesfeld.

Comment: Poplar (aspen) is abundant in the vegetation of central Alberta at present, although trees and woodland are not prevalent in the Drumheller area where this specimen was found. This date is one of a suite of "snapshot" records that document early Holocene vegetation in central Alberta. Current deglacial chronology suggests that this area was ice free and vegetated before 12,000 BP (see maps in Dyke 2005). Further to the east, contemporary wood remains in similar sedimentary contexts are often of white spruce (*Picea glauca*), documenting an early coniferous forest phase (e.g. Yansa 2006). This specimen lends credence to the view that the coniferous forest was of limited extent close to the ice front and did not extend into central and southern Alberta. This date was mentioned in an abstract by Beaudoin (1992).

RAM ASA-D88-11: Wood, *Picea* sp.

AECV-621C **4340 ± 100 BP**
$\delta^{13}C$ = –23.5‰

Wood. *Picea* sp. Royal Alberta Museum Locality: Solomon Creek. 5298–4630 cal BP. Confidence interval 95.3%. Conventional ^{14}C date. The wood was recovered from a cutbank and had been exposed after recent flooding (summer 1987) scoured out the bank. The upper part of the section consisted of alluvial sands and fine gravel, with some cross-bedding, capped by fine-grained silty material, probably eolian in origin. The sample was taken from a log, several meters long and ~31 cm in diameter, protruding from the cutbank at ~4.5 m depth. This was one of two large logs exposed in the section. Both were oriented roughly the same direction, and were associated with other woody debris. Tree rings suggest the tree was more than 150 yr old. Collected in 1988 by A B Beaudoin and M Wright; submitted in 1988 by A B Beaudoin. Taxonomic determination was done in 1991 by D Grosser (Universität München).

Comment: This discovery is quite unusual because the logs are so well preserved, implying that they must have been buried rapidly, perhaps by sediment laid down by Solomon Creek in a severe flood event such as the one that re-exposed the logs in 1987. Included in raw date list by Beaudoin (1991).

RAM ASA-D88-12: Wood, *Picea* sp.

AECV-622C **4330 ± 100 BP**
$\delta^{13}C$ = –26.0‰

Wood. *Picea* sp. Royal Alberta Museum Locality: Solomon Creek. 5290–4626 cal BP. Convention-

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al ^{14}C date. Wood at same locality as ASA-D88-11, and was on the downstream side of the section. The sample was taken from a log, several meters long and ~45 cm in diameter, protruding from the cutbank at ~4.5 m depth. Tree rings suggest the tree was more than 180 yr old. Collected in 1988 by A B Beaudoin and M Wright; submitted in 1988 by A B Beaudoin. Taxonomic determination was done in 1991 by D Grosser (Universität München).

Comment: This discovery is quite unusual because the logs are so well preserved, implying that they must have been buried rapidly, perhaps by sediment laid down by Solomon Creek in a severe flood event such as the one that re-exposed the logs in 1987. Included in raw date list by Beaudoin (1991).

RAM ASA-D92-13: Wood, *Alnus* sp.

AECV-1614C **4380 ± 90 BP**

$\delta^{13}C$ = –25.3‰

Twig. *Alnus* sp. Royal Alberta Museum Locality: Solomon Creek. 5295–6830 cal BP. Conventional ^{14}C date. Twig was recovered from same locality and section as ASA-D88-11. Twig was part of the debris that had accumulated in association with the large logs. Collected 1988 by A B Beaudoin and M Wright; submitted in 1992 by A B Beaudoin. Taxonomic determination was done in 1992 by A S Gottesfeld.

Comment: This discovery is quite unusual because the logs are so well preserved. This implies that they must have been buried rapidly, perhaps by sediment laid down by Solomon Creek in a severe flood event such as the one that re-exposed the logs in 1987.

RAM ASA-D92-34: Wood, *Picea* sp.

AECV-1679C **4200 ± 80 BP**

$\delta^{13}C$ = –21.9‰

Wood. *Picea* sp. Royal Alberta Museum Locality: Solomon Creek. 4958–4449 cal BP. Conventional ^{14}C date. Wood was recovered from same locality as ASA-D88-11. This sample was collected some years later when the bank had slumped. Diameter of sampled log ~30 cm, probably same log as ASA-D88-11. Collected in 1991 by P Murphy (University of Alberta); submitted in 1992 by A B Beaudoin. Taxonomic identification was done in 1996 by J Gonzalez (Forintek Canada Corp.).

Comment: Logs were still well preserved and intact after 4 yr of exposure. Samples were retrieved for display purposes.

RAM ASA-D92-35: Wood, *Picea* sp.

AECV-1680C **4070 ± 90 BP**

$\delta^{13}C$ = –21.9‰

Wood. *Picea* sp. Royal Alberta Museum Locality: Solomon Creek. 4839–4299 cal BP. Confidence interval 95.3%. Conventional ^{14}C date. Wood was recovered from the same locality as ASA-D88-11. This sample was collected some years later when the bank had slumped. Diameter of sampled log ~36 cm, probably same log as ASA-D88-12. Collected in 1991 by P Murphy (University of Alberta); submitted in 1992 by A B Beaudoin. Taxonomic identification was done in 1996 by J Gonzalez (Forintek Canada Corp.).

Comment: Logs were still well preserved and intact after 4 yr of exposure. Samples were retrieved for display purposes.

RAM ASA-D87-49: Charcoal

AECV-463C **6720 ± 150 BP**
$\delta^{13}C$ = –20.9‰

Wood charcoal. Royal Alberta Museum Locality: "Brian's Creek." 7922–7325 cal BP. Conventional ^{14}C date. Charcoal recovered at ~4.25 m depth in back-hoe test in alluvial fan along the north side of the North Saskatchewan River. Matrix is buff silt. Site is on unnamed creek east of Timber Creek and west of Whirlpool Point. Collected in 1987 by B M Ronaghan under ASA Permit 87-37. Submitted in 1988 by A B Beaudoin.

Comment: Back-hoe test for cultural material was taken about 75 to 100 m south and east from stream cut on fan that was measured in 1987 (Ronaghan and Beaudoin 1987). Section contained two tephras. Based on stratigraphic position and occurrence in similar sections upstream on the North Saskatchewan River (Westgate and Dreimanis 1967); these were assumed to be Bridge River and Mazama tephra. ^{14}C date was obtained from a level lower than the lower tephra in the exposed section. The date supports the attribution of this tephra as Mazama, and also confirms that this fan is likely paraglacial in origin, similar to fans in adjacent areas of Jasper National Park (see Beaudoin and King 1994). This record was also included in raw date list by Beaudoin (1988).

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