Late Pleistocene horse and camel hunting at the southern margin of the ice-free corridor: Reassessing the age of Wally's Beach, Canada

Michael R. Waters[a,1], **Thomas W. Stafford Jr.**[b], **Brian Kooyman**[c], **and L. V. Hills**[c,d]

[a]Center for the Study of the First Americans, Department of Anthropology and Department of Geography, Texas A&M University, College Station, TX 77843-4352; [b]Department of Physics and Astronomy, Aarhus University, DK-8000, Aarhus C, Denmark; [c]Department of Archaeology and [d]Department of Geosciences, University of Calgary, Calgary, AB, Canada T2N 1N4

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The only certain evidence for prehistoric human hunting of horse and camel in North America occurs at the Wally's Beach site, Canada. Here, the butchered remains of seven horses and one camel are associated with 29 nondiagnostic lithic artifacts. Twenty-seven new radiocarbon ages on the bones of these animals revise the age of these kill and butchering localities to 13,300 calibrated y B.P. The tight chronological clustering of the eight kill localities at Wally's Beach indicates these animals were killed over a short period. Human hunting of horse and camel in Canada, coupled with mammoth, mastodon, sloth, and gomphothere hunting documented at other sites from 14,800–12,700 calibrated y B.P., show that 6 of the 36 genera of megafauna that went extinct by approximately 12,700 calibrated y B.P. were hunted by humans. This study shows the importance of accurate geochronology, without which significant discoveries will go unrecognized and the empirical data used to build models explaining the peopling of the Americas and Pleistocene extinctions will be in error.

Pre-Clovis | Clovis | Pleistocene | megafauna | extinction

The only known late Pleistocene horse and camel kill and butchering localities occur at the southern margin of the ice-free corridor in the rolling Prairie of southwest Alberta, Canada, at the Wally's Beach site (DhPg-8), about 180 km south of Calgary (Fig. 1). Here, seven butchered horses (*Equus conversidens*) (1) and one butchered camel (*Camelops hesternus*) (2) were found associated with nondiagnostic lithic artifacts. These sites were originally assigned to the Clovis complex based on five inaccurate radiocarbon ages and horse protein residue extracted from two unassociated fluted projectile points. Here we present 27 new radiocarbon ages that revise the age of these kill localities. These new ages show that accurate radiocarbon geochronology requires rigorous sample pretreatment and isolation of chemically pure fractions, especially to accurately date bone (*SI Text* and Figs. S1–S4). Without such care, significant archaeological discoveries will go unrecognized and be misinterpreted. The new ages for Wally's Beach also allow us to explore the role of hunting in the extinction of megafauna at the end of the Pleistocene.

The eight kill and butchering localities at Wally's Beach lay 30 m above the St. Mary River. Individual carcasses and associated artifacts were buried to a depth of 1.5–2.0 m in aeolian loess and sand that overlies Wisconsinan glacio-fluvial sediments. Each carcass was isolated and horizontally separated from other carcasses by 25–100 m over a distance of 500 m (1, 2). At each locality, some bones of each carcass were still articulated, although most were scattered and with some elements missing (Fig. 1). Multiple cutmarks made by stone tools occur on the hyoid bone of Horse B and on a cervical vertebra of the camel. The ribs of the camel display spiral fractures where they were broken away from the vertebral column. These taphonomic patterns are consistent with human disarticulation; the absence of carnivore gnaw marks and other damage to the bones suggests rapid burial of the horse and camel localities (1, 2). Twenty-nine lithic artifacts and one rounded cobble were found at the horse localities (1), with at least one lithic artifact associated with each horse. Three lithic artifacts were associated with the camel (2). These are all nondiagnostic artifacts and are mostly flakes, used flakes, and core tools (Fig. 1). Most are made of quartzite that is locally available in the glacial till, but some are made of chert.

Previously, four radiocarbon ages ranging from 10,980 ± 80 ^{14}C y B.P. (TO-7691) to 11,350 ± 80 ^{14}C y B.P. (TO-8972) were obtained from bison, horse, muskox, and caribou bones from the aeolian sediments at Wally's Beach (Table 1) (1). A single date of 11,070 ± 80 ^{14}C y B.P. (TO-13513) was obtained on the rib of the butchered camel (2). All of these dates were on gelatin and are considered inaccurate because of the chemical fraction dated (*SI Text*). None of the seven horses with butchering evidence and associated with artifacts was directly dated in the original study.

Results

We obtained 27 new radiocarbon dates on XAD-purified collagen and other chemical fractions extracted from bones from all seven butchered horses, the butchered camel, and a nearby, unbutchered muskox (*Bootherium bombifrons*) (Table 2 and *SI Text*). These ages are derived from XAD-purified amino acids from bone collagen and are free of younger and older organic contaminants, thereby enabling accurate dating of the bone (3, 4) (*SI Text*). Eight XAD-collagen dates for the horses associated with artifacts range from 11,410 ± 30 ^{14}C y B.P. (UCIAMS-127349) to

Significance

Archaeological discoveries at Wally's Beach, Canada, provide the only direct evidence of horse and camel hunting in the Americas at the end of the last Ice Age. Here, seven horses and one camel were attacked and butchered near a river crossing by prehistoric hunters. New radiocarbon dates revise the age of these kill and butchering localities to 13,300 y ago. Other North American kill and butchering sites show that prehistoric hunters preyed on 6 of the 36 genera of large mammals, called megafauna, for at least 2,000 y before these animals became extinct, around 12,700 y ago. Accurate dating is necessary to build meaningful chronologies for the Ice Age peopling of the Americas and to understand megafauna extinctions.

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[1]To whom correspondence should be addressed. Email: mwaters@tamu.edu.

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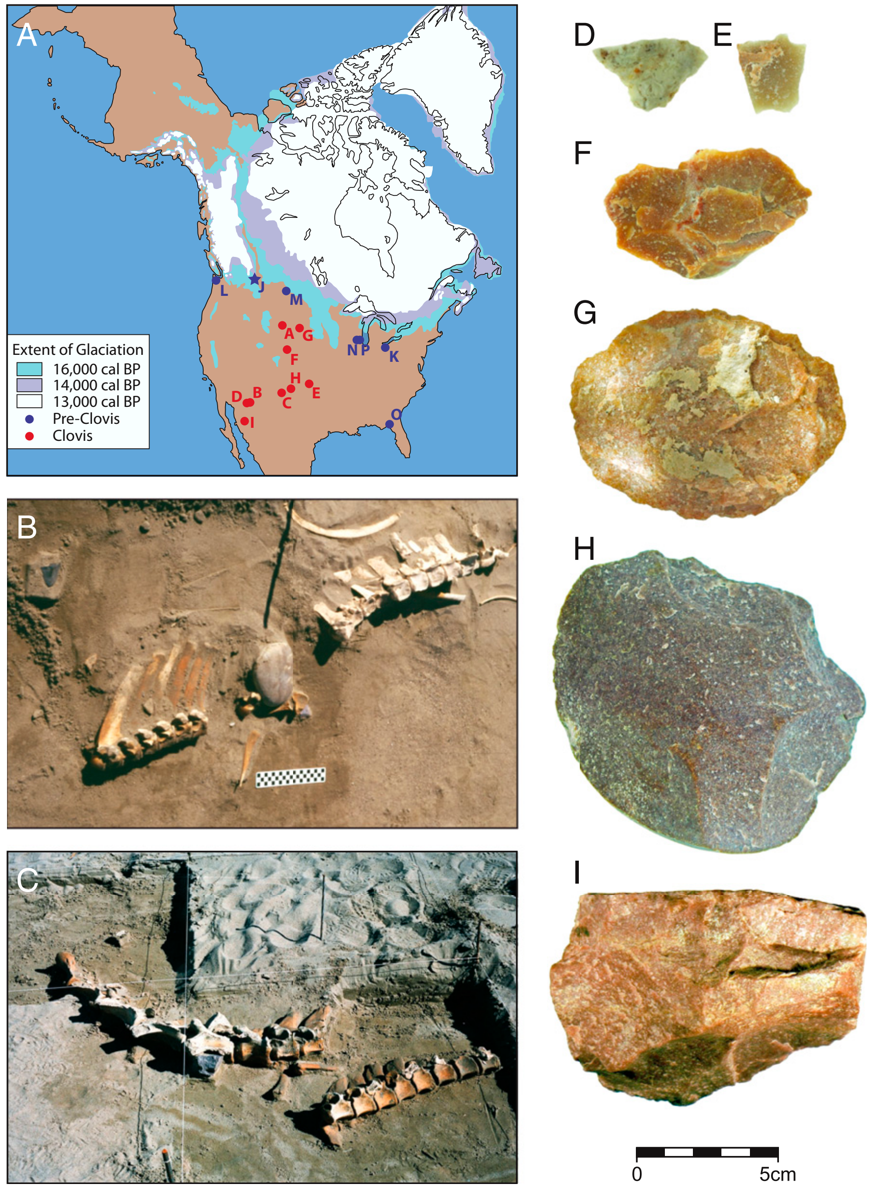

Fig. 1. (*A*) Map showing the location of Wally's Beach (j) and other sites: a, Colby, WY; b, Murray Springs, AZ; c, Blackwater Draw, NM; d, Lehner, AZ; e, Domebo, OK; f, Dent, CO; g, Lange-Ferguson, SD; h, Lubbock Lake, TX; i, El Fin del Mundo, Mexico; k, Firelands, OH; l, Manis, WA; m, Lindsay, MT; n, Schaefer, WI; o, Page-Ladson, FL; p, Hebior, WI. (*B*) Butchered horse carcass with large stone and artifacts (Horse B). (*C*) Butchered camel carcass with artifacts. (*D*) Biface fragment associated with Horse 1. (*E*) Edge-modified flake tool associated with Horse C. (*F*) Edge-modified flake tool associated with Horse B. (*G*) Large biface associated with Horse 2. (*H*) Large unifacial chopper associated with Horse 2. (*I*) Core tool associated with camel.

11,470 ± 35 ^{14}C y B.P. (UCIAMS-127348). All ages overlap at 1 SD and are averaged to 11,450 ± 10 ^{14}C yBP or 13270–13,310 calibrated (cal) y B.P. The camel yielded two XAD-collagen ages that overlap by 1 SD and average 11,440 ± 25 ^{14}C y B.P. or 13,255–13,315 cal y B.P. The radiocarbon and calibrated ages for the camel overlap with the ages for the horses at 1 SD. An average of all horse and camel XAD-collagen ages (n = 10) is 11,445 ± 10 ^{14}C y B.P. or 13,270–13,310 cal y B.P. (Tables S1–S3). The earlier

Table 1. Previous radiocarbon ages from Wally's Beach site, Canada

Specimen	^{14}C y B.P. (±1 SD)	Laboratory number	Chemical fraction dated	Comments
Bison	11,130 ± 90	TO-7693	Gelatin*	No catalog number
Horse	11,330 ± 70	TO-7696	Gelatin	Cat. no. 3293.1
Muskox	10,980 ± 80	TO-7691	Gelatin	Cat. no. 3293.1
Caribou	11,350 ± 80	TO-8972	Gelatin	Cat. no. 2610.1
Camel	11,070 ± 80	TO-13513	Gelatin	Cat. no. 3610.1

*The gelatin fraction is the centrifuged solution resulting from hot water extraction of alkali-extracted, decalcified bone collagen (29).

Table 2. AMS ^{14}C ages, stable isotope values, and analytical data

Specimen	Chemical fraction	δ^{15}N ‰ (AIR)	δ^{13}C ‰ (VPDB)	%N	%C	C/N (atomic %)	^{14}C yBP (± 1 σ)	AMS Lab no.	Cal y B.P. (± 1 σ)*
Camelops hesternus									
Camel, Cat. no. 3610.1 (rib, partial)									
	KOH collagen	2.0	−19.2	14.8	41.5	3.03	11,425 ± 35	UCIAMS-116390	
	Gelatin (KOH-Collagen)	1.9	−19.1	14.1	39.1	3.00	11,420 ± 30	UCIAMS-116383	
	XAD-gelatin						11,465 ± 40	UCIAMS-116400	13,270–13,365
	XAD-gelatin						11,425 ± 30	UCIAMS-127347	13,230–13,305
Equus conversidens									
Horse 1, Cat. no. 3594 (left rib)									
	KOH collagen								
	Gelatin (KOH-collagen)	0.4	−20.7	14.9	41.5	3.01	11,475 ± 30	UCIAMS-127359	
	XAD-gelatin						11,470 ± 35	UCIAMS-127348	13,275–13,360
Horese 2, Cat. no. 2988.1 (left tibia)									
	KOH collagen						11,310 ± 30	UCIAMS-127360	
	Gelatin (KOH-collagen)	2.0	−20.4	14.9	41.5	3.02	11,385 ± 30	UCIAMS-127361	
	XAD-gelatin						11,410 ± 30	UCIAMS-127349	13,215–13,290
Horse 3, Cat. no. 944 (left radius)									
	KOH collageb								
	Gelatin (KOH-collagebn)	1.5	−20.6	14.9	41.5	3.01	11,415 ± 30	UCIAMS-127362	
	XAD-gelatin						11,460 ± 30	UCIAMS-127350	13,265–13,340
Horse A, Cat. No. 315 (right rib)									
	KOH collagen						13,540 ± 40†	UCIAMS-127363	
	Gelatin (KOH-collagen)	0.6	−20.7	14.9	41.5	3.06	11,495 ± 30	UCIAMS-127364	
	XAD-gelatin						11,440 ± 30	UCIAMS-127351	13,250–13,320
Horse B, Cat. no. 164 (right rib)									
	KOH collagen								
	Gelatin (KOH-collagen)	0.6	−20.6	14.9	41.5	3.02	11,435 ± 30	UCIAMS-127365	
	XAD-gelatin						11,475 ± 30	UCIAMS-127352	13,280–13,360
Horse B, Cat. no. 159 (left ulna)									
	KOH collagen								
	Gelatin (KOH-collagen)	1.0	−20.4	14.9	41.5	3.00	11,490 ± 30	UCIAMS-127370	
	XAD-gelain						11,465 ± 30	UCIAMS-127355	13,270–13,350
Horse C, Cat. no. 683 (left femur)									
	KOH collagen						11,415 ± 30	UCIAMS-127366	
	Gelatin (KOH-collagen)	1.6	−20.4	14.9	41.5	3.01	11,435 ± 30	UCIAMS-127367	
	XAD-gelatin						11,440 ± 30	UCIAMS-127353	13,250–13,320
Horse D, Cat. no. 77.1 (left humerus)									
	KOH collagen						11,190 ± 30	UCIAMS-127368	
	Gelatin (KOH-collagen)	0.1	−20.4	14.9	41.5	3.02	11,355 ± 30	UCIAMS-127369	
	XAD-gelatin						11,430 ± 30	UCIAMS-127354	13,235–13,310
Bootherium bombifrons									
Muskox, Cat. no. 3293.1 (left rib)									
	KOH collagen						11,170 ± 30	UCIAMS-127371	
	Gelatin (KOH-collagen)	1.0	−19.3	14.9	41.5	3.01	11,255 ± 30	UCIAMS-127372	
	XAD-gelatin						11,320 ± 30	UCIAMS-127373	13,120–13,200

*Calibration radiocarbon ages used Calib 7.0 (28).
†This specimen was coated with Butvar 98 (two coats) dissolved in ethanol. KOH fraction contaminated by Butvar.

dates on gelatin underestimated the ages of these localities by 100–400 radiocarbon y (*SI Text*). Similarly, the initial gelatin radiocarbon age of 10,980 ± 80 ^{14}C y B.P. (TO-7691) for the muskox has been revised to 11,320 ± 30 ^{14}C y B.P. (UCIAMS-127373) or 13,120–13,200 cal y B.P. and shows that the unbutchered muskox remains are not temporally equivalent to the butchered horse and camel remains.

The new accurate and precise AMS ages suggest contemporaneous hunting of camel and horse at around 13,300 cal y B.P. (Table 2 and Table S3) at the Wally's Beach site. The large number of kill and butchering localities in a small area that tightly overlap in time indicates intensive utilization of the site by late Pleistocene hunters and likely represents multiple hunting events over a short period, perhaps a year, a season, or even a single hunting event that lasted a few days. Trackways with foot impressions of mammoth, horse, camel, bison, and other animals (1, 5, 6) near the kill sites indicate that this was a well-traveled game trail. No formal hunting weapons were found at these kill localities and the tools left behind—bifaces, choppers, expedient tools, and flakes—were likely used to butcher the animals. These nondiagnostic artifacts date three centuries before the oldest firm date for Clovis of 12,915–13,085 cal y B.P. (4, 7). It is suggested that the Clovis complex may date back to approximately 13,315–13,475 cal y B.P. at the Aubrey site in Texas (8), and 13,325–13,440 cal y B.P. at El Fin del Mundo, Mexico (9). If true, then the Wally's Beach kill sites would be contemporaneous with Clovis. However, these earlier ages are based on two radiocarbon ages on charcoal at Aubrey and a single radiocarbon age on a small fragment of dispersed charcoal at El Fin del Mundo. Until these ages are replicated, we remain skeptical of these early dates (7). That said, protein residue extracted from two fluted projectile points found out of context within a 1.5-km radius from the kill sites tested positive for horse protein using the cross-over immunoelectrophoresis method (10). Because these projectile points are out of context and distant from the horse and camel kill sites, it is unknown if they have any association chronologically with the horse and camel kills.

Discussion

Besides horse and camel hunting at Wally's Beach, the archaeological record of dated megafauna kill and butchering sites with associated artifacts shows that humans hunted three genera of proboscideans in North America: mammoth (*Mammuthus*), mastodon (*Mammut*), and gomphothere (*Cuvieronius*). Proboscidean hunting began by at least 14,800 cal y B.P. and continued until this group went extinct around 12,700 cal y B.P. (Fig. 2), as documented by stone and osseous artifacts associated with accurately dated mammoth and mastodon bones at four sites predating Clovis [Schaefer, WI (11, 12), Hebior, WI (11, 13), Manis, WA (14), Page-Ladson, FL (15)] and seven Clovis kill and butchering localities [Colby, WY; Murray Springs, AZ; Blackwater Draw, NM; Lehner, AZ; Domebo, Ozk; Dent, CO; Lange Ferguson, ND (4, 7, 16)]. Clovis artifacts are associated with other mammoth and mastodon kill and butchering sites, but these are not dated (16, 17). Two dated sites provide evidence of pre-Clovis and Clovis human–mammoth interaction where stone artifacts were absent. At the Lindsay site in Montana, the remains of a single mammoth dating to 12,300 ± 25 ^{14}C y B.P. (14,125–14,270 cal y B.P.) exhibit cutmarks and bone breakage patterns that indicate human utilization of the mammoth (7, 18, 19). Similarly, at the Clovis-age Lubbock Lake site in Texas, taphonomic patterns and cutmarks also indicated human activity at the site at 11,100 ± 60 ^{14}C y B.P. (12,095–13,060 cal y B.P.) (20). At El Fin del Mundo, Mexico, Gomphothere remains appear to be associated with 21 lithic flakes and 4 Clovis projectile points (9). A single piece of dispersed charcoal from the surface yielding the artifacts and animal remains dates to 11,550 ± 60 ^{14}C y B.P. (AA-100181A) (13,325–13,440 cal y B.P.); however, direct dating of the skeleton is needed to confirm this age estimate. In addition to Proboscidean fauna, a femur from a ground sloth (*Megalonyx jeffersonii*) dated to 11,740 ± 35 ^{14}C y B.P. (UCIAMS-38250) or 13,485–13,575 cal y B.P. at the Firelands site in Ohio, exhibits multiple cutmarks that indicate human interaction with the sloth despite the absence of stone tools (21). Combined, this evidence indicates that humans hunted at least six genera of megafauna for 2,000 y before their extinction by around 12,700 cal y B.P.

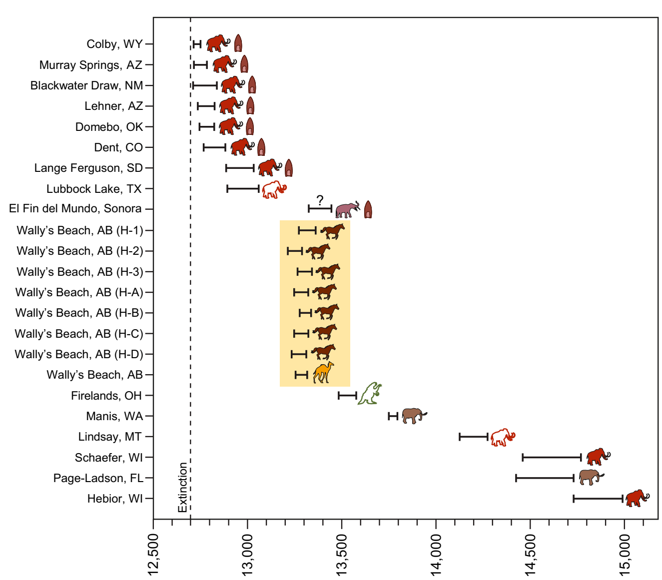

Fig. 2. Calibrated ages for horse and camel kill sites at Wally's Beach and other megafauna kill and butchering sites in North America. Solid animal shapes indicate artifacts are present at the corresponding site. Sites where Clovis points were found are indicated by the fluted-point symbol. Unfilled animal shapes indicate that no artifacts are present at the corresponding site, but kill and butchering is indicated by taphonomic evidence.

Although this empirical record is small, some tentative patterns are emerging. First, only solitary animals appear to have been hunted from approximately 15,000–13,300 cal y B.P. Multiple animal kills at a single locality occurred after that time. As shown here, eight animals were killed at Wally's Beach in a single event or as events that occurred over a short period around 13,300 cal y B.P. Similarly, at many of the later Clovis sites, multiple mammoths were killed during a single event or at the same locality over time. For example, at the Lehner site in the San Pedro Valley, AZ, 13 mammoths associated with Clovis projectile points were dated to 10,950 ± 40 ^{14}C y B.P. (12,735–12,825 cal y B.P.) (22). Furthermore, along a 30-km reach of the San Pedro Valley are five more Clovis kill sites with seven mammoth carcasses (22). Dense kill site areas such as these may represent hunters taking advantage of the aggregation of megafauna around waterholes as climate and environments rapidly changed at the very end of the Pleistocene (23). These animals may have been easy to find by following game trails that connected refugia (23).

The second pattern concerns the geographic distribution of the known kill sites. The oldest documented kill and butchering sites are concentrated along the edges of the continent, especially along the late Pleistocene ice margin (Fig. 1). This may reflect sample bias or may indicate that initial colonization of the continent first took place along the ice margin, a familiar environment to the first American migrants. In contrast, Clovis period megafauna hunting seems to have been primarily confined to the interior plains and deserts (Fig. 1), perhaps reflecting the last refugia of proboscideans.

Although climate and habitat change at the end of the Pleistocene likely played the most significant role in the decline of megafauna (24), hunting by humans was also surely a factor in the demise and extinction of some animals (25); hunting of dwindling megafauna populations would have negatively impacted these animals by increasing mortality rates and reducing recruitment rates (26, 27). The impact of hunting on megafaunal populations from approximately 15,000–13,000 cal y B.P. is unclear because the human population in North America was likely small at that time. The only hunting weapon dating to this time period at a butchering site is the tip of an osseous projectile point embedded in the rib of a mastodon at the Manis site in Washington (14). These early people likely also used stone projectile points, but these have not been found yet at an early kill and butchering site. The invention and deployment of the lanceolate, fluted projectile point—the hallmark of Clovis—by at least 13,000 cal y B.P. and its use until approximately 12,700 cal y B.P. along with the continued use of osseous weapons improved hunting success and likely helped drive the remaining megafauna to extinction.

Finally, to enhance our understanding of the early time horizon before fluted point technology became common and to better understand the extent and impact of human hunting on the megafauna requires a shift in our "search image." We must realize that kill sites of this age will likely have very few artifacts in total. These few artifacts may be nondiagnostic and nonlithic; we should not necessarily expect to find a diagnostic artifact form. In some cases, artifacts may even be absent, so identifying human involvement with the death of an animal may have to be demonstrated by taphonomic criteria. Most importantly, accurate and precise dating is fundamental to interpreting these important sites and building a solid empirical foundation to explain the peopling of the Americas and megafauna extinctions.

Materials and Methods

Samples for radiocarbon dating were pretreated and processed by T.W.S. using the methods given in refs. 3 and 4 and *SI Text*. Targets were made and ^{14}C measurements were determined at the W. M. Keck Carbon Cycle Accelerator Mass Spectrometry Laboratory under the supervision of J. Southon. Calibrated radiocarbon ages (cal B.P.) are given as 1-σ probability calendar year ages using Calib 7.0 available at calib.qub.ac.uk/calib/ (28).

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