


Confirming a Cultural Association at the La Prele Mammoth Site (48CO1401), Converse County, Wyoming

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Archaeologists have long subjected Clovis megafauna kill/scavenge sites to the highest level of scrutiny. In 1987, a Columbian mammoth (*Mammuthus columbi*) was found in spatial association with a small artifact assemblage in Converse County, Wyoming. However, due to the small tool assemblage, limited nature of the excavations, and questions about the security of the association between the artifacts and mammoth remains, the site was never included in summaries of human-killed/scavenged megafauna in North America. Here we present the results of four field seasons of new excavations at the La Prele Mammoth site that confirm the presence of an associated cultural occupation based on geologic context, artifact attributes, spatial distributions, protein residue analysis, and lithic microwear analysis. This new work identified a more extensive cultural occupation including the presence of multiple discrete artifact clusters in close proximity to the mammoth bone bed. This study confirms the presence of a second Clovis mammoth kill/scavenge site in Wyoming and shows the value in revisiting proposed terminal Pleistocene kill/scavenge sites.

Keywords: Mammoth, Clovis, Paleoindian, Late Pleistocene, North America

Los arqueólogos han sometido durante mucho tiempo a los sitios de caza y destazamiento de megafauna de Clovis al más alto nivel de escrutinio. En 1987, se encontró un mamut colombino (*Mammuthus columbi*) en asociación espacial con un pequeño conjunto de artefactos en el condado de Converse, Wyoming. Sin embargo, debido al pequeño conjunto de herramientas, la naturaleza limitada de las excavaciones y a las preguntas sobre la seguridad de la asociación entre los artefactos y los restos de mamuts, el sitio nunca se incluyó en los resúmenes de los sitios de caza y destazamiento de megafauna de Norteamérica. Aquí presentamos los resultados de cuatro temporadas de campo de nuevas excavaciones en el sitio La Prele Mammoth que confirman la presencia de una ocupación cultural asociada y basada en el contexto geológico, atributos de artefactos, distribuciones espaciales, análisis de residuos de proteínas y análisis microscópico de huellas de uso lítico. Este nuevo trabajo identificó una ocupación cultural más extensa que incluye la presencia de múltiples grupos de artefactos discretos en una proximidad espacial cercana a la cama de huesos de mamut. Este estudio confirma la presencia del segundo sitio de caza y destazamiento de mamuts de Clovis en Wyoming y muestra el valor de retornar a sitios de caza y destazamiento propuestos del Pleistoceno Terminal.

Palabras clave: mamut, Clovis, Paleoindio, Pleistoceno, Norteamérica

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In the early twentieth century, Aleš Hrdlička and others established three requirements necessary to prove a Pleistocene-aged human presence in the New World: (1) artifacts or remains that were clearly human, (2) artifacts in indisputable context (direct association), (3) control over chronology (undisturbed stratigraphy; Adovasio and Page 2009:99; Haynes 1969; Meltzer 2015a). These stringent, yet reasonable, requirements were met in 1927 when prominent scientists A. V. Kidder and Frank H. H. Roberts confirmed the association of artifacts with extinct bison remains in Folsom, New Mexico. Soon after, archaeologists discovered what would later be classified as Clovis points associated with mammoth bones at the Dent site in Colorado (Figgins 1933). Starting with these discoveries of fluted points and extinct fauna, the hallmark of the Clovis culture has become the hunting of now-extinct Pleistocene fauna (Kornfeld 2007; Meltzer 2015a). While many archaeologists question the view of Clovis as big-game specialists (Cannon and Meltzer 2004, 2008), there is universal acceptance in the field that Clovis hunters did, at least occasionally, hunt megafauna (Haynes and Hutson 2013; Kornfeld 2007; Surovell and Waguespack 2009). Understanding the number and nature of Pleistocene megafauna kills/scavenge sites is therefore vital to understanding North America's earliest widespread inhabitants.

Archaeologists have subjected Paleoindian kill/scavenge sites to intense scrutiny, especially so for sites containing proboscidean (*Mammuthus* sp., *Mammuthus americanum*, *Cuvieronius* sp.) remains (Cannon and Meltzer 2004; Frison and Todd 1986; Grayson and Meltzer 2002, 2015; Haynes 1988, 1991, 2002, 2007a; Haynes and Huckell 2007; Haynes and Krasinski 2010; Haynes and Stanford 1984; Hofman 2001; Kreutzer 1988; Meltzer and Mead 1985; Saunders and Daeschler 1994; Waguespack and Surovell 2003). The skepticism of a human presence at bone bed sites is warranted, since natural death sites can be difficult to distinguish from kill/scavenge sites (e.g., Haynes 1991, 2007b; Haynes and Klimowicz 2015; Lyman 1994; Todd 1987; Todd and Rapson 1999). This high bar for acceptance, however, potentially rejects true associations and consequently affects both interpretations of Clovis lifeways

(Cannon and Meltzer 2004, 2008; Haynes 2002; Surovell and Waguespack 2009) and the debate surrounding the cause of megafaunal extinctions in the Americas (for review, see Meltzer 2015b; Waguespack 2013). Accordingly, sites containing the remains of extinct megafauna require close attention to taphonomy and site formation to determine human involvement.

Following Hrdlička and William Henry Holmes, archaeologists ask that megafauna kill/scavenge sites meet three requirements: (1) contemporaneity of human and megafauna remains, (2) direct association between human activity and megafauna remains, and (3) evidence for use of megafauna remains (e.g., cutmarks, breakage; Grayson and Meltzer 2002, 2015; Haynes and Stanford 1984). Researchers have used these criteria to scrutinize possible megafauna kill/scavenge sites (Cannon and Meltzer 2004; Grayson 1984; Grayson and Meltzer 2002, 2015; Haynes 1988, 2002; Haynes and Stanford 1984; Surovell and Waguespack 2009).

Here we apply these criteria to a previously questioned mammoth kill site, the La Prele Mammoth site. The site's initial excavations (Walker et al. 1988) left doubt regarding the association of artifacts with the mammoth remains (Byers 2002; Grayson and Meltzer 2002). However, our four seasons of investigations show that the La Prele site meets the three criteria, resolves previous doubts about the site, and contains an undeniable association between evidence of human activity and mammoth remains.

The La Prele Mammoth Site

The La Prele Mammoth site (48CO1401) is buried in an alluvial terrace of La Prele Creek, a tributary of the North Platte River, near the town of Douglas in Converse County, Wyoming (Figures 1–2). Initially called the Hinrichs and later the Fetterman Mammoth, the site was discovered in fall 1986 by two Douglas locals, Mike Earnst and William Hinrichs. The following spring a crew led by Dr. George Frison tested the site with an approximately 3 × 4 m block. Frison and crew recovered the partial remains of a mammoth (*Mammuthus* sp.) and a small artifact assemblage that included a stone tool, a possible hammerstone, and two in situ flakes

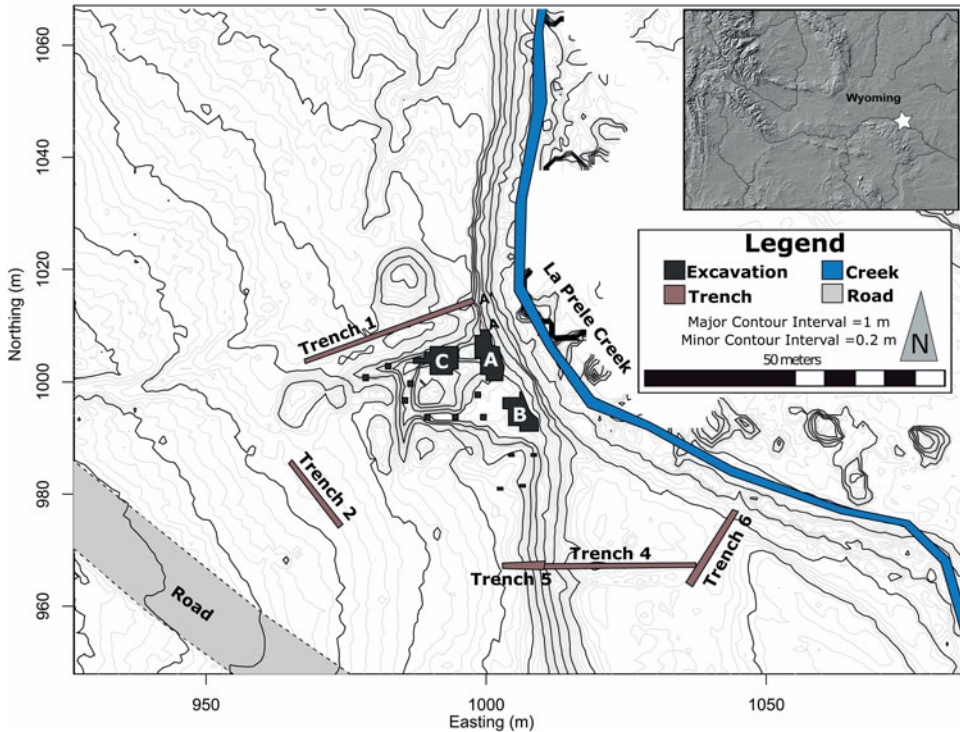


Figure 1. Local topographic map of the La Prele Mammoth site identifying geologic trenches and excavation areas. Major contours are at 1 m intervals, while minor contours are at 20 cm. Note that some of the topography in the immediate area of the excavation is due to backhoe work to expose archaeological strata, and topographic lines were not rendered in the northeast portion of the map due to heavy brush (topographic map created by Randy Haas). (Color online)

(Walker et al. 1988). The mammoth remains consisted predominantly of axial elements, the other portions having perhaps washed down the creek before the site was identified (Byers 2002:Table 1). The artifact assemblage grew when seven flakes were found in the sediments surrounding the mammoth bones in their plaster casts (Byers 2002; Walker et al. 1988).¹ The initial excavators concluded that “these flakes would have been deposited at the same stratigraphic level as the ribs, lending credence to the association of the stone biface [flake tool] and flake found during excavation and the mammoth bone” (Walker et al. 1988:159). Unfortunately, for the next 30 years the site sat untouched because of a dispute with the landowner.

In the intervening years, Byers (2002) cast doubt on the original interpretation of cultural association based on analysis of the 1987 field notes and assemblage. The lack of butchery marks and the close anatomical position of the

bones were consistent with a natural death event. Bone weathering patterns suggested that the mammoth remains were partially buried at least twice before being completely covered, leaving the door open for the subsequent deposition of unassociated artifacts (Byers 2002:432–435). Finally, slight elevation differences between the bone bed and in situ artifacts found during excavation pointed to separate depositional events for the artifacts and mammoth remains (Byers 2002:Figure 11; Walker et al. 1988). Byers hypothesized that during one of the partial burial events, artifacts from a later or nearby occupation were washed into the bone bed. This hypothesis was also consistent with the small size and quantity of the artifact assemblage. While none of these analyses is damning on its own, together they cast doubt on human involvement with the mammoth (Byers 2002).

A change in landowners allowed us to return to the site in 2014 to address the possibility of



Figure 2. Overview of the 1987 and 2015 excavations at the La Prele Mammoth site. The site has been actively eroding since its discovery, and approximately 1.5 m of Block A has been lost. (Color online)

a cultural presence there. After relocating the 1987 block, we expanded the original excavations and tested additional portions of the site. Units were excavated in 50×50 cm quadrants in 5 cm levels, and all materials recovered in situ, regardless of size, were point plotted using a total station. All sediments were wet screened with $\frac{1}{16}$ -inch mesh, and screen matrix was picked in the laboratory after initial picking in the field. Portions of the site contained calcium carbonate concretions large enough to obscure artifacts. These carbonate-rich sediments were treated with acetic acid and picked for artifacts, and gravels were weighed by size. Since an understanding of the site's formation processes was critical to addressing the previous questions, we excavated several geologic trenches that were profiled and dated using radiocarbon and optically stimulated luminescence.

Encouraged by the discovery of additional cultural materials and faunal remains, we completed four seasons of excavations at the site

(2014 to 2017). In total we have excavated just under 100 m^2 along with six geologic trenches (Figure 1). New excavations include the expansion of the 1987 bone bed (Block A), two associated artifact concentrations (Blocks B and C), and 11 test units. We have identified multiple activity areas surrounding the mammoth and recovered more than 1,700 pieces of chipped stone, 500+ bone fragments, and 1,600+ ocher pieces. Here we focus on the evidence supporting the cultural association with the mammoth remains, while future publications will present the details and interpretations of the new artifact assemblages found at the La Prele Mammoth site.

Geologic and Chronological Setting

The La Prele Mammoth is buried within a 7 m alluvial terrace of the La Prele Creek (Figure 2). Terrace sediments span circa 20,000–45,000 cal BP and include alluvial, colluvial, and eolian deposits with intermittent episodes of soil

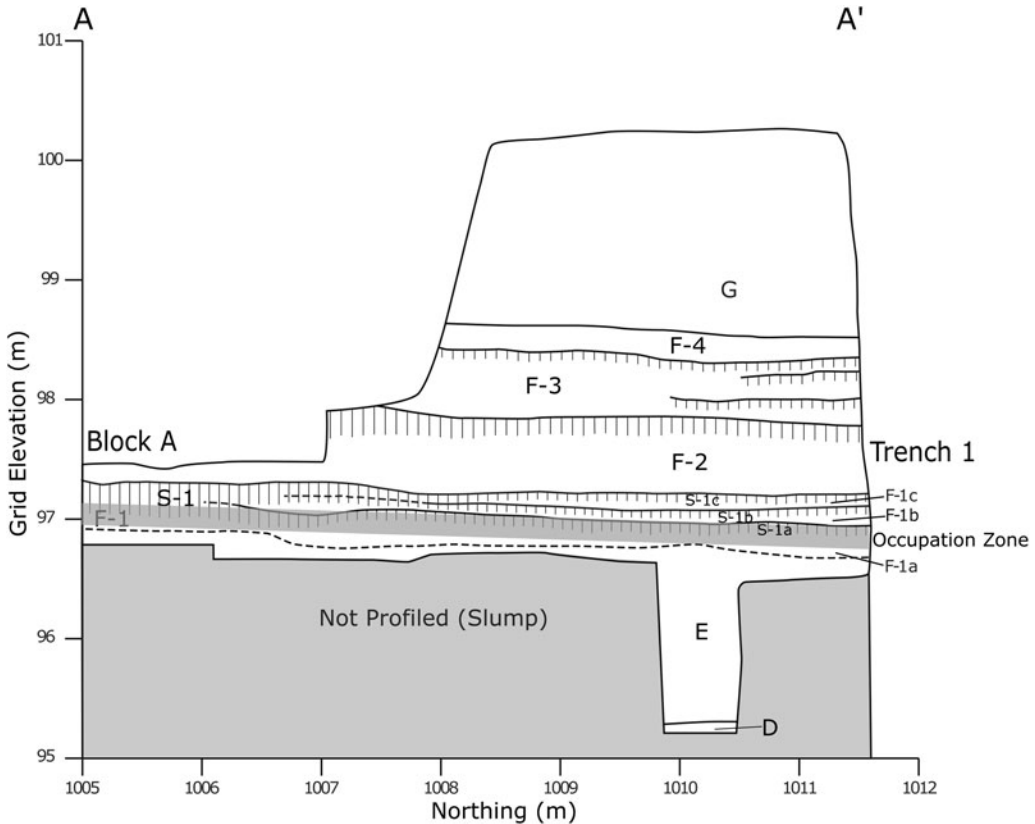


Figure 3. Profile of cleaned terrace face between Block A and Trench 1 in 2015. The archaeological deposits sit at the base of S-1, which welds into a single soil in the center of this profile just north of Block A. Strata descriptions can be found in Supplemental Text 1.

formation (Supplemental Text 1; Supplemental Tables 1–2). The only known archaeological deposits at the locality are in the same stratigraphic horizon as the mammoth, at the lower margin of a buried A-horizon (S-1) within the overbank sediments in which it formed (F-1; Figure 3). Based on texture, sorting, and bedding, we determined that the sediments underlying (F-1) and immediately overlying (F-2) are low-energy overbank flood deposits, not colluvial as previously hypothesized (Albanese 2000; Byers 2002). While the S-1 paleosol presents as a pedogenic unit within the excavated portion of the site, it is likely the product of three A-horizons that weld just north of Block A (Figure 3). This is consistent with the mammoth being buried in three stages as hypothesized by Byers (2002) based on bone weathering patterns.

Site dating has been complicated by the presence of young contaminants. Originally, Byers (2002:421) reported two early Holocene dates on the mammoth bone, 8890 ± 60 BP (CAMS-74661) and 9060 ± 50 BP (CAMS-72350; Table 1). While the close range of the dates allowed for some confidence, Byers acknowledged that these dates were young for a mammoth site and could have been affected by contamination. Since 2014, an additional 10 dates from two different portions of the site directly or indirectly date the occupation (Table 1), two of which were recently published by Devìese and colleagues (2018). Dated materials include four bone fragments (two mammoth, two large mammal), two calcined bone samples, two pieces of charcoal, and two samples of soil organic matter. The distribution of the dates confirms the presence of contaminants, as the six

Table 1. Summary of Radiocarbon Dates That Directly or Indirectly Date the Occupation.

2σ Calibrated Age (BP)	1σ ¹⁴ C Age (BP)	δ ¹³ C (‰)	Lab No.	Area	Collection Year	Material	Fraction	Source
Direct Dates								
10,196–9769	8890 ± 60		CAMS-74661	Block A	1987	Mammoth bone	Gelatin	Byers 2002:421
10,300–10,157	9060 ± 50		CAMS-72350	Block A	1987	Mammoth bone	KOH-extracted collagen	Byers 2002:421
12,721–12,532	10,654 ± 58	-17.9	AA108894	Block B	2016	Large-mammal bone	Ultrafiltered collagen	This report
12,738–12,658	10,760 ± 30		UCIAMS-40174	Block A	1987	Mammoth bone	Gelatin	Devièse et al. 2018:Table 8
12,762–12,597	10,776 ± 59	-16.4	AA108895	Block B	2016	Large-mammal bone	Ultrafiltered collagen	This report
12,922–12,716	10,965 ± 30		UCIAMS-206764	Block A	1987	Mammoth bone	XAD hydrolysate ^a	Devièse et al. 2018:Table 8
13,074–12,779	11,066 ± 61	-20.3	AA108893	Cutbank	1986	Mammoth bone	Ultrafiltered collagen ^a	This report
13,290–12,765	11,190 ± 130	-23.0	AA107104	Block B	2015	Calcined bone	Apatite carbonate ^{a,b}	This report
13,041–12,757	11,035 ± 50	-22.7	OxA-X-2736-14	Block A	1987	Mammoth bone	Hydroxyproline ^a	Devièse et al. 2018:Table 10
17,330–16,640	13,997 ± 90	-19.7	AA109297	Block B	2016	Calcined bone ^c	Apatite carbonate ^b	This report
Indirect Dates								
12,982–12,720	10,969 ± 52	-25.1	AA105498	Block A	2014	Charcoal ^d	Humins	This report
12,803–12,696	10,873 ± 35	-26.0	AA107604	Block B	2015	Charcoal ^d	Humins	This report
12,413–12,061	10,382 ± 40	-25.4	AA105496	Block B	2014	Soil organic matter	Humins	This report
12,245–11,982	10,323 ± 39	-25.5	D-AMS 004329	Cutbank	2013	Soil organic matter	Humins	This report

Note: Dates were calibrated using OxCal with the IntCal 13 calibration curve (Reimer et al. 2013). All radiocarbon dates from the site can be found in Supplemental Table 1.

^aDates considered most reliable by the authors.

^bAccuracy established by Chatters et al. 2017.

^cAnomalous date.

^dIndicates the age of the stratigraphic unit, as charcoal fragments cannot be directly associated with the occupation.

dates on mammoth bone produced the youngest as well as some of the oldest dates on the site. We also have one date on calcined bone, $13,997 \pm 90$ BP (AA109297), that is anomalously old, for which we do not have a good explanation of its age.

Because contamination of bone collagen almost always produces radiocarbon dates that are too young, we argue that the oldest mammoth bone collagen dates and a calcined bone date from Block B are closest to representing the true age of the site. These four oldest direct dates produce a statistically homogeneous subset determined by pairwise *t*-tests (Long and Rippeteau 1974) after calibration. Those include two dates first reported herein on ultrafiltered collagen from a recovered mammoth rib ($11,066 \pm 61$ BP, AA108893) and a calcined bone date from Block B ($11,190 \pm 130$ BP, AA107104) from a hearth-centered activity area (Mackie et al. 2020). We also include two dates published by Devièse and others (2018), one hydroxyproline date on collagen from a mammoth vertebra from the 1987 excavation ($11,035 \pm 50$ BP, OxA-X-2736-14), and a sample of XAD-purified protein hydrolysate from the same vertebra ($10,965 \pm 30$, UCIAMS-206764). After calibration and averaging by the Long and Rippeteau (1974) method, our best estimate for the age of the site is $12,846 \pm 29$ cal BP, placing the La Prele Mammoth site within the Clovis time period as defined by Waters and Stafford (2007). Further confirmation of this age estimate comes from two soil organic matter dates on the S-1 paleosol dating the soil formation to a few hundred years after the mammoth's death (Table 1). The discovery of a nearly complete fluted projectile point in the same stratigraphic level as the mammoth approximately 20 m to the southeast of the bone bed confirms the cultural affiliation as Clovis.

Testing Cultural Association

There are a few patterns we expect to see at the La Prele Mammoth site if the cultural activities and mammoth remains are associated. First, there should be a mechanism to account for the vertical movement of materials on-site that would explain the elevation differences between the

1987 lithic artifacts and the bone bed. Second, there should be little to no evidence of horizontal disturbance, as this would make the redeposition of artifacts from a secondary source unlikely. Third, if the cultural materials and mammoth bone are associated, they must have been deposited at the same time and would have been subjected to the same postdepositional processes. Finally, there should be some direct evidence of interaction between the cultural materials and the mammoth remains. If these four lines of evidence are present, we can reasonably conclude that there is an association between the cultural component and the mammoth bone at the site. In order to test these four lines of evidence we look at three components of the site: (1) geologic context, (2) provenience of bone and artifacts, and (3) evidence of direct association.

Geologic Context

The single strongest piece of evidence for questioning a cultural association with the mammoth remains is the elevation difference between the four in situ artifacts and the mammoth bone (Byers 2002). Byers noted that this discrepancy could be accounted for by "several geomorphological processes whose signatures are not readily identifiable . . . including bioturbation, frost heaving, and soil compaction" (2002:437). During the last four field seasons we have gained a better understanding of the geologic context and setting of the La Prele Mammoth site through excavations and geologic trenching. The exposure of a larger stratigraphic profile has allowed for a more detailed reconstruction of the Pleistocene surface. This greater understanding of the geologic context of the artifact-bearing deposits is useful for evaluating the first two lines of evidence: the presence or means for vertical and horizontal disturbances on-site.

Bioturbation. Back plots of in situ artifacts from Block A and Block B show that artifacts are stratigraphically associated with the mammoth remains (Figure 4). In all portions of the site the archaeological material is only associated with upper stratum F-1 and the S-1 paleosol. Although bioturbation had not been previously noted on-site, it is extensive, with visible

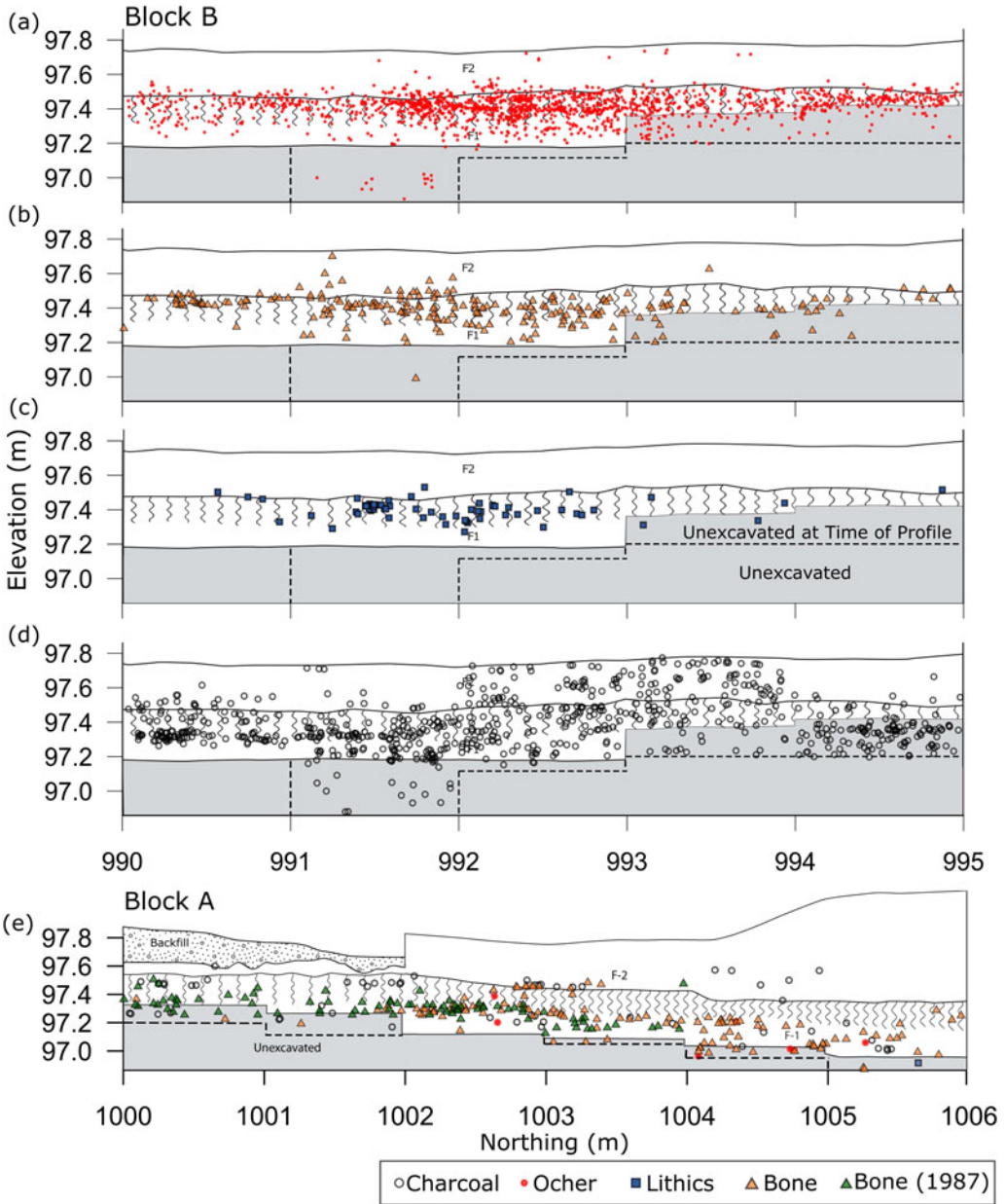


Figure 4. West wall profiles of excavation Blocks A and B with artifact back plots overlain. Deepest extent of excavation within the excavation block east of each profile is indicated by the dashed line. (Color online)

mottling of the F-1 sediment and S-1 paleosol across the site (Figure 5). Artifact back plots from several site areas show the effects of bioturbation. In Block B, small numbers of artifacts appear as deep as 55 cm beneath the postulated occupation surface, but most materials are spread throughout a 35 cm zone. Based on the relatively

small size of the majority of krotovinas (<3 cm), most of the bioturbation appears to be the result of insect and small rodent activity (Figure 5). Given this extreme bioturbation, it is unsurprising that a small number of the artifacts from 1987 were found at slightly higher elevations than the bone bed.

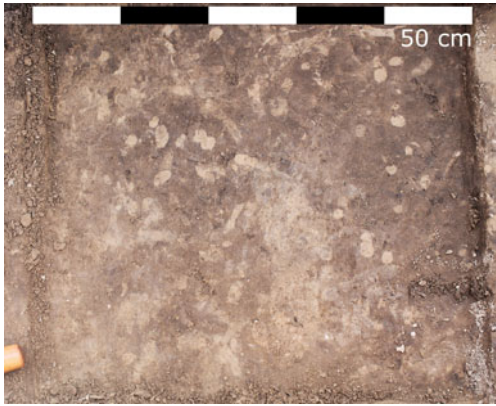


Figure 5. Typical extent of bioturbation with intermixing of the F-1 and S-1 strata. (Color online)

Reconstruction of the Pleistocene Surface. Byers (2002:427) suggested that the artifacts could have been deposited by slope-related processes. This hypothesis was based on the modern ground surface west of the site, which has a gradual slope extending from the site to a nearby strath terrace of the North Platte (Figure 1). However, our larger exposures of the paleosurface show that the Pleistocene surface had relatively little slope. The F-1/F-2 contact drops only approximately 15 cm over 16 m from south to north (N990 to N1006; Figure 4), and from west to east the site drops 20 cm over 21 m (Supplemental Text 1; Supplemental Figure 1). Thus, slopes average just under a centimeter of elevation change per meter. Redeposition of artifacts by slope-related processes is not possible under these circumstances (Fanning and Holdaway 2001; Poesen et al. 1998).

Based on taphonomic analysis of bone weathering stages, Byers (2002) concluded that the mammoth was likely buried by multiple small flood events. While the S-1 paleosol in the excavation blocks is welded into a single cumelic A-horizon, the S-1 soil separates into three thin A-horizons (Soils 1a to 1c) north of Block A (Figure 3; Supplemental Text 1). Byers (2002) attributes the artifacts' position higher than the bone as possible evidence for their deposition following one of these small flood events. We propose that the artifacts were shifted through bioturbation, as the lack of slope on the Pleistocene surfaces makes artifact redeposition over

long distances unlikely. While we agree that the mammoth was buried in three small flood events, we do not think that those events were responsible for the association between the cultural materials and the mammoth remains.

Assemblage Composition and Spatial Patterns

The presence of bioturbation offers a plausible mechanism for vertical separation between artifacts and the bone bed, but it does not indicate contemporaneity of the human occupation and mammoth remains. The radiocarbon ages from the occupation show that both cultural materials (e.g., calcined bone) and mammoth remains have overlapping ages (Table 1). However, due to an unidentified source of contamination that is younger than the sample, the consistency between dates is by no means conclusive. Instead, we look for indications of contemporaneity using artifact distributions and assemblage attributes. We use three different tests: (1) vertical movement of different materials, (2) identification of artifact clusters, and (3) comparison of lithic attributes between blocks.

Vertical Distribution Analysis. The first test for contemporaneity between cultural and faunal remains examines the vertical dispersal of materials by bioturbation. If the cultural materials and mammoth are associated, they would have been deposited at the same time and been subjected to the same postdepositional processes. Therefore, we should expect similar bone and artifact vertical distributions by bioturbation. For this analysis, point-plotted cultural artifacts (lithics and ocher) are compared with point-plotted bone. Unfortunately, the exact elevation of the mammoth bone bed excavated in 1987 could not be reconstructed with sufficient confidence (within 3 cm) to be included in this analysis.² Only those bones recovered from recent excavations are included, including several larger pieces of mammoth bone (partial rib, tarsal, unidentified large fragments) and many small bone fragments. Although the majority of the new bone assemblage is too small for species identification, many pieces are likely mammoth, so it is used here to represent the mammoth provenience. The slope on the La Prele site is gradual enough that it is unlikely to redeposit artifacts, but it is large enough that raw artifact elevations

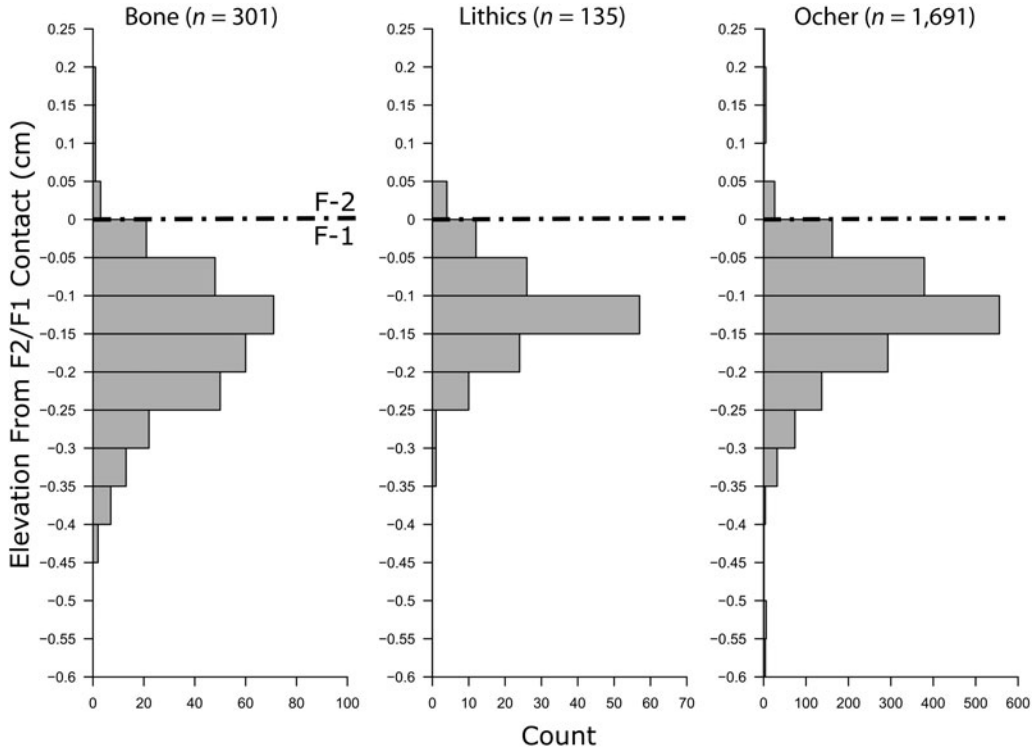


Figure 6. Dispersal of artifacts relative to the F-2/F-1 contact. The dashed line indicates the strata contact at elevation zero.

cannot be directly compared within or between excavation blocks. Instead, all mapped bone and artifact elevations can be standardized to the F-2/F-1 contact, since it is a consistent litho-stratigraphic contact that mirrors the topography of the paleosurface. We digitized the F-2/F-1 contact elevation on 17 stratigraphic profiles across the site and subtracted each artifact's elevation from the closest mapped F-2/F-1 contact elevation. The mapped stratigraphic contacts lie within approximately 5 m of each point-plotted artifact/bone/ocher (Figure 6).

The distributions of all three material classes are remarkably similar, with modes at 10–15 cm beneath the F-2/F-1 stratigraphic contact. This marks the likely position for the occupation and is consistent with the highest artifact concentrations occurring in or near the lower part of the paleosol (S-1; Figure 4). Both the lithics and ocher are distributed across approximately 35 cm vertically, while most of the bone is spread over 50 cm (Figure 6). We suspect that the

bone has a larger distribution because not all the fragments present are associated with the archaeological occupation, although all obvious microfauna remains were excluded from this analysis. In either case, all three distributions are similarly dispersed, suggesting that the artifacts and the majority of bone were deposited at the same time and have been subjected to the same postdepositional processes.

Horizontal Spatial Distributions. Spatial distributions can also help determine whether artifacts were redeposited on the site by establishing the horizontal spatial integrity of the La Prele deposits. If materials were disturbed or redeposited onto the site, we would expect to see a homogeneous distribution of artifacts across the site from their source (Gregg et al. 1991). Based on the artifact frequency distributions, artifacts are not distributed homogeneously across the site; instead, each block encompasses distinct clusters with areas of low artifact densities separating clusters (Figures 7–8).

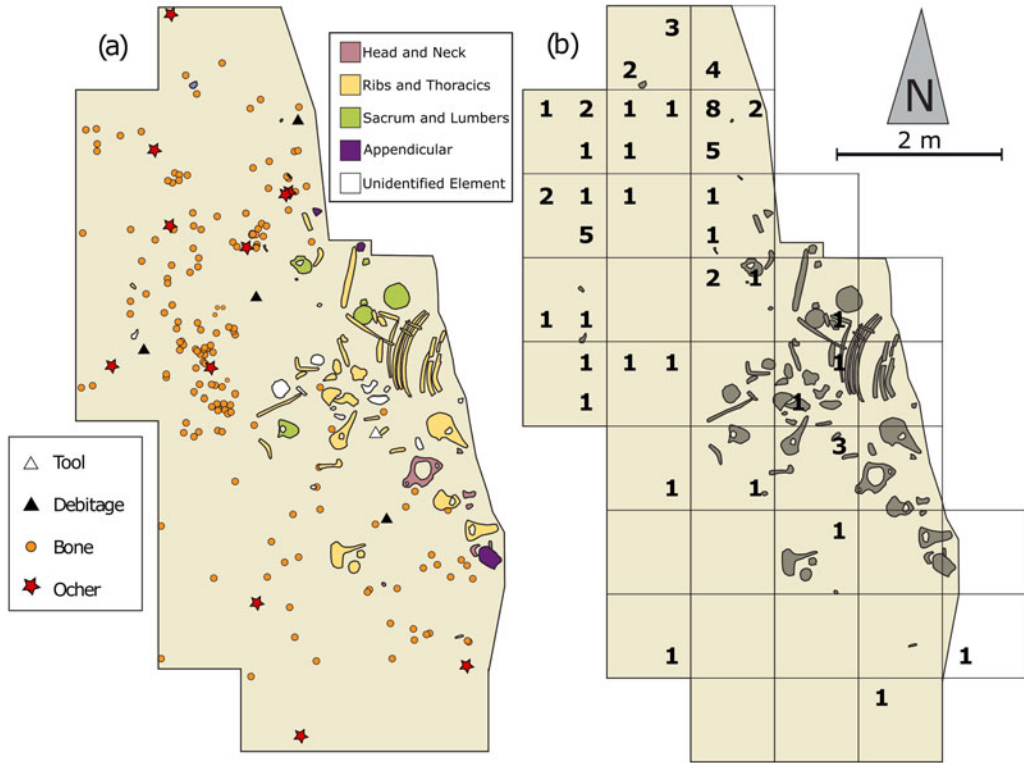


Figure 7. Map of Block A including 1987 and recent excavations: (a) artifact point plots and mammoth elements coded by portion; (b) lithic totals as of 2019 by 50 × 50 cm quadrant. (Color online)

This heterogeneous artifact distribution suggests that the horizontal spatial distributions on-site are relatively intact and that redeposition is not responsible for the artifacts found in the bone bed.

We can also test whether the artifacts are spatially associated with the mammoth remains in Block A (Figure 7). A simple test is to calculate the average distance of lithic artifacts from the closest large faunal element and compare that with the average distance seen in a random (null) artifact distribution (Giusti et al. 2018). If artifacts are associated with mammoth remains, we would expect the distance between the observed artifact distribution and the closest bone elements to be smaller than the distance from the randomly generated artifact locations to mammoth elements. To run the analysis, we took the number of artifacts recovered as of 2019 from Block A (n = 63) and randomized their location within their respective 50 × 50 cm quadrants (Figure 7). The same number of

artifacts were randomly plotted across the entire excavation block to create random distributions. The average distance of the observed and random artifact distributions to mammoth elements was recorded, and the analysis was repeated. Twenty thousand iterations confirm that the observed assemblage ($\bar{x} = 49.6$ cm) was significantly closer ($p = .0454$) than the randomly distributed artifacts ($\bar{x} = 60.9$ cm) to faunal remains. This supports the hypothesis that artifacts were deposited in association with the faunal remains and indicates that horizontal distributions are relatively intact on-site.

The close spatial association of the mammoth remains and artifacts is also significant as the La Prele Mammoth site sits at an unremarkable location. La Prele Creek flows continuously for more than 40 km from its head in the Laramie Range to its confluence with the North Platte 1.6 km downstream of the site, and there are no obvious point attractors adjacent to the site for human or

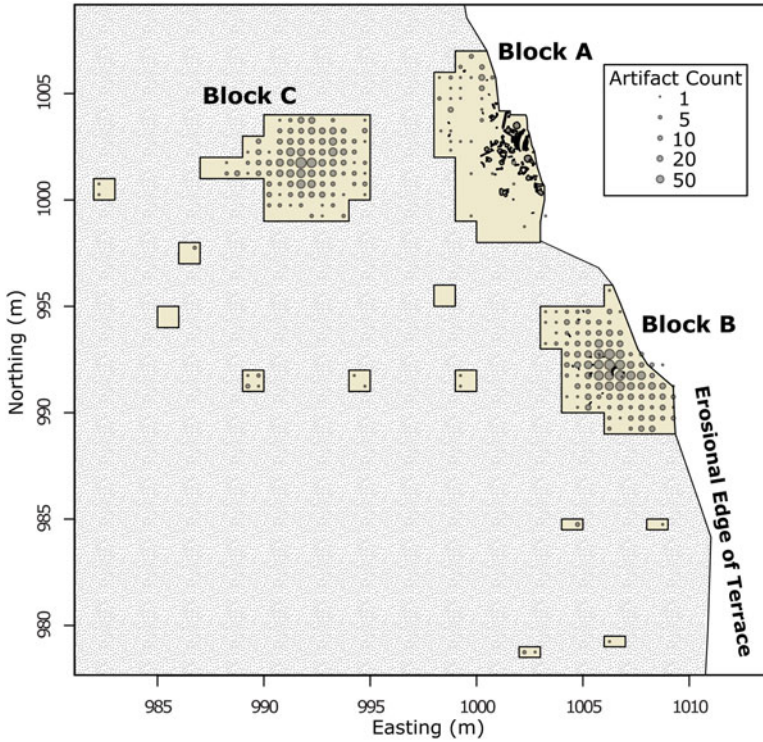


Figure 8. Frequency of lithics across the excavation blocks at the La Prele Mammoth site. Large piece-plotted bone is indicated including the 1987 bone bed in Block A. Block C screen processing is ongoing, so counts should be treated as preliminary. (Color online)

mammoth occupation, such as a spring. While we do not have a strong grasp of the age on the uppermost terrace deposits, we do know that the terrace continued to aggrade at least through the early Holocene and ceased before a cut and fill located above the mammoth was formed in the middle Holocene (Supplemental Text 1). No archaeological materials, other than Clovis, have been identified anywhere else in this sequence. It appears that the only human occupation of this locality occurred in the same stratigraphic position and in close spatial proximity to the mammoth. The chances of this spot on the landscape being the location of a natural mammoth mortality followed shortly by a Clovis occupation to never be used again seem exceedingly unlikely (Mackie 2019:52–87), especially at a time when human populations in Wyoming were very low (Kelly et al. 2013; Kornfeld et al. 2010). The most parsimonious explanation is that the mammoth remains and artifacts are associated.

Artifact Assemblage Attribute Analysis. A second source for redeposition of artifacts is the possibility that one of the close artifact clusters is the source of the Block A artifact assemblage. Although slope analysis and the gap in artifact density between areas suggest that this is not the case, we can test this hypothesis using the size of a sample of debitage from Block A ($n = 41$) and Block B ($n = 926$; Table 2). Since matrix picking and lithic analysis of Block C is ongoing, its artifact assemblage was not included in this analysis. If the materials from Block B

Table 2. Summary of Block A and Block B Debitage Dimensions.

	Length (mm)		Mass (g)	
	Block A	Block B	Block A	Block B
Number	39	166	41	926
Average	8.156	6.942	0.274	0.053
Standard Deviation	4.735	4.463	0.685	0.611

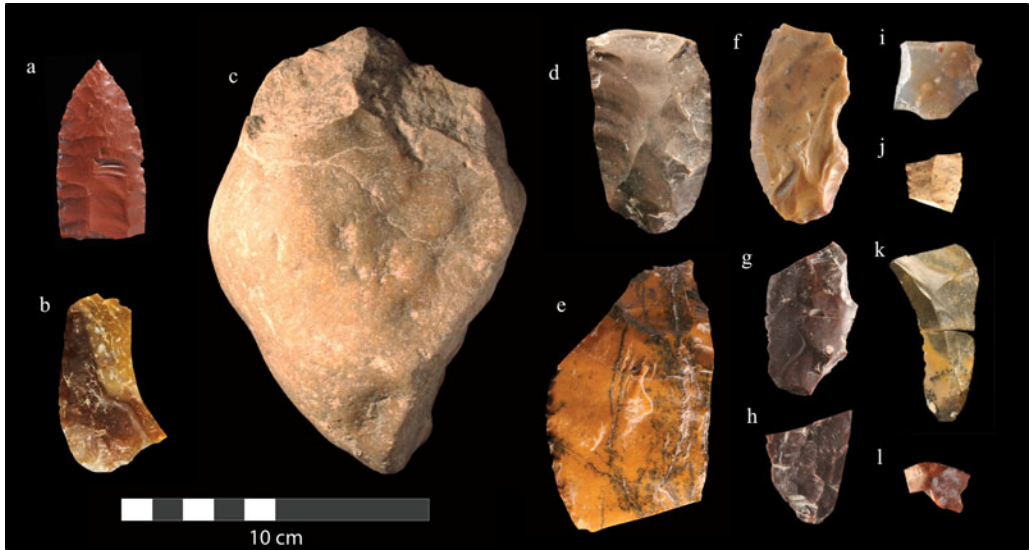


Figure 9. La Prele Mammoth site tool assemblage from (a) a test unit, (b) Block A, and (c–l) Block B: (a) partial Clovis point from approximately 20 m south of Block A; (b) flake tool recovered from within bone bed in Block A in 1987 excavations (FS 16); (c) cobble chopper (FS 354); (d) flake tool with graver (FS 1326); (e) flake tool with graver (FS 1547); (f) spokeshave/flake tool (FS 2970); (g) conjoined flake tool fragment (FS 3840 and FS 4399); (h) partial flake tool (FS 3055); (i) flake tool fragment (FS 3013); (j) flake tool fragment (FS 1349); (k) conjoined flake tool (FS 1917 and FS 1922); (l) partial burned endscraper (FS 4624). (Color online)

were redeposited to Block A, we would expect the Block A lithics to be smaller than the Block B lithics, as lighter lithics require less energy to be moved and would be preferentially transported (Byers et al. 2015; Sheppard and Kleindienst 1996). In fact, the opposite pattern is apparent, as a sample of Block A flakes are ($\bar{x} = 0.27$ g, $s = 0.685$, $n = 41$), on average, significantly heavier ($t = 2.066$, $df = 40$, $p = .0226$, one sample) than Block B debitage ($\bar{x} = 0.053$, $s = 0.611$, $n = 926$).

Direct Evidence of Association

The final test to establish an association between the cultural activities and the mammoth remains is direct association. The lack of traditional indications of butchery, such as cutmarks, does not necessarily support a natural mammoth death. Ethnographic/ethnoarchaeological studies have shown that cutmarks may not be produced during carcass processing or could be obscured by weathering (e.g., Crader 1983; Frison 1989; Haynes 1988, 1991:303; Haynes and Klimowicz 2015). In fact, other accepted Clovis proboscidean kill/scavenge sites also lack clear butchery

marks (Frison and Todd 1986; Hofman 2001; Sanchez et al. 2014). Additionally, the La Prele mammoth lacks many elements, including most of its appendicular elements, and many of the present faunal remains are weathered, obscuring any possible surface cutmarks (Byers 2002). It is unclear whether the absent elements are missing because they washed down La Prele Creek from the truncated portion of the site or whether they were moved to a yet unexcavated portion of the terrace. We assume that some portions of the mammoth were lost to site erosion based on the presence of rib and enamel plates on the terrace riser when the site was discovered in 1986. Instead we look to alternative methods to identify direct associations, specifically blood residue and lithic microwear analysis. Both analyses were run on the stone tools recovered from Blocks A and B, including the 1987 flake tool, a cobble tool, a Clovis point, and a set of flake tools (Figure 9). If the tools were used to butcher the mammoth, we would expect positive proboscidean blood residue results and microwear characteristics consistent with animal butchery.

Table 3. Summaries of Crossover Immunoelectrophoresis and Microwear Lithic Analysis on Block A and Block B Stone Tools.

Field Specimen Number	Artifact	Crossover Immunoelectrophoresis	
		Results	Microwear Results
16	Flake tool	Elephant	Soft material butchery
354	Cobble chopping tool	Elephant	Not analyzed
1326	Flake tool with graver	Not analyzed	Soft material butchery, hide cutting
1349	Flake tool fragment	Not analyzed	Possible butchery, longitudinal use
1547	Flake tool with graver	Not analyzed	Soft material butchery, hide cutting, pouch polish
1917 and 1922	Conjoined flake tool	Not analyzed	Butchery
2970	Spokeshave	Bovine, elephant (weak)	Not analyzed
3013	Flake tool fragment	Negative	Unutilized
3055	Flake tool fragment	Swine	Indeterminate
3840	Flake tool (conjoins 4399)	Horse, elephant (weak)	Butchery
4399	Flake tool (conjoins 3840)	Horse, elephant (weak), sheep	Butchery
4624	Scraper (burned)	Negative	Hide scraping
6862	Clovis point	Negative	Projectile damage

Protein Residue Analysis. Protein blood residue analysis identifies plant and animal residues on flaked- and ground-stone lithic artifacts using immunological responses (Allen et al. 1995; Gerlach et al. 1996; Henrikson et al. 1998, 2017; Hyland et al. 1990; Kooyman et al. 2001; Petraglia et al. 1996; Shanks et al. 1999; Yohe et al. 1991). This method identifies the animal species artifacts may have contacted, although there are questions about its reliability (Eisele et al. 1995; Fiedel 1996). In this case, we used crossover immunoelectrophoresis (CIEP) to test archaeological residues using procedures developed by the Royal Canadian Mounted Police Serology Laboratory (1983). The samples were analyzed at the Laboratory of Archaeological Sciences located at California State University, Bakersfield. Reactions that produced particularly prominent or light precipitation lines were identified, respectively, as “strong” or “weak.” Tests were repeated multiple times, and soil samples were tested to rule out any false positives. Eight family-level antisera (pronghorn antelope, bovine, Camelidae, Cervidae, Elephantidae, equine, Caprinae, and porcine) were tested on nine stone tools (Figure 9). Two tools and the Clovis point (Figure 9; Table 3) did not return a positive result with any antisera. Six other tools tested positive with at least one antiserum, including elephant,

bovine, horse, swine, and sheep (Table 3). Multiple positive reactions for one flake tool could indicate repeated use of the same artifact or the species of materials used for hafting. Weak responses to elephant antiserum should be viewed with caution, as they could be the result of false positives, soil contamination, or protein degradation. While we do not have corollary evidence for all the species identified with CIEP, the strong reaction of two tools to proboscidean antiserum provides direct evidence of interaction between cultural materials and the mammoth remains (Table 3). Notably the two positive proboscidean reactions came from the flake tool recovered from within the bone bed in 1987 (Figure 9b) and the cobble chopping tool found in Block B (Figure 9c). The La Prele Mammoth cobble chopper is consistent with expedient cobble tools that have been found at other Clovis proboscidean kill sites (Frison and Todd 1986; Haury et al. 1959; Haynes and Huckell 2007), presenting another line of evidence for human use of the site.

Lithic Microwear Analysis. Since tool morphology is not always consistent with function (Jeske and Sterner-Miller 2015; Knutsson et al. 2015; Odell 1981; Rockwell 2017), lithic microwear studies aim to establish precise designations of tool functions using microscopic scarring patterns left on stone tools (Keeley 1974;

Odell 1975). Low-powered microscopic (10–120× magnification) use-wear analysis was conducted on 10 tools from the La Prele Mammoth assemblage using a Nikon SMZ800 microscope (Odell and Odell-Vereecken 1980; Tringham et al. 1974). Microwear patterns from the La Prele tools were compared with a reference collection of tools with known function to identify activities and contact materials consistent with observed scarring patterns (Supplemental Text 2). When possible, contact materials were further refined by the description of polish and striations.

Eight of the 10 flake tools analyzed showed characteristics consistent with butchery of soft materials or hide working (Table 3; Supplemental Text 2; Supplemental Table 3). Two of these tools had corners reworked into graver tips that had scarring patterns and polish on the lateral margins of the flakes; this is consistent with butchery and hide preparation (Figure 9d–e; Supplemental Figures 2–3). One flake tool has notable wear on body arrises consistent with pouch polish, indicating that the tool may have been carried or curated for an extended duration (Figure 9e). The Clovis point was broken on its proximal end likely within the haft as ground basal edges are present (Figure 9a). While microwear analysis cannot attribute a specific species, the presence of wear consistent with butchery is what would be expected for a mammoth butchery site and generally correlates with the CIEP results.

Conclusion

To recap, a true association between cultural materials and the mammoth remains would be supported by (1) a mechanism for vertical dispersal, (2) little evidence for horizontal movement, (3) bone and artifacts showing similar distributions, and (4) evidence of interaction between humans and the mammoth remains. There is support for all four hypotheses based on the geologic context of the site, observed spatial distributions, artifact assemblage attributes, and tests for direct associations between the cultural materials and the mammoth remains. The minimal slope of the paleosurface makes artifact redeposition unlikely, while the bioturbation provides a parsimonious explanation for the elevation

discrepancies identified by Byers (2002). The overlapping dates (Table 1), similar vertical distribution of artifacts (Figures 4 and 6), and spatial distributions (Figure 8) support the hypothesis that Blocks A, B, and C were contemporaneously occupied. The presence of distinct artifact clusters with minimal “smearing” by postdepositional processes indicates intact horizontal artifact distributions. The CIEP and lithic microwear analysis are consistent with animal butchery and, in the case of the CIEP results, directly link some artifacts to the mammoth remains (Table 3). Finally, it seems highly unlikely that two closely timed events (a mammoth dying and a Clovis occupation) would occur in such a small time period without being associated, particularly since the locality was never occupied again.

Generally, archaeologists use three criteria to evaluate the evidence for human-killed/scavenged megafauna: (1) contemporaneity, (2) association, and (3) utilization (Grayson and Meltzer 2002, 2015; Haynes and Stanford 1984). In the case of the La Prele Mammoth site, contemporaneity is supported by new radiocarbon dates and consistent stratigraphic association. The close spatial association of mammoth remains and artifacts provides a case for a strong association, while the new understanding of geologic setting offers a reasonable explanation for the previously raised doubts. Although this site does not have any traditional indicators of direct use (e.g., cutmarks), the identified tools have tested positive for proboscidean blood antigens and have lithic microwear consistent with animal butchery. We feel that the site rises to the “consonance of data” (Haynes and Stanford 1984:220) required to fulfill these three criteria. We propose that the La Prele Mammoth site is at least the sixteenth case of culturally associated megafauna kill/scavenge sites (Grayson and Meltzer 2015).

La Prele Mammoth demonstrates the value of reinvestigation of previously doubted archaeological kill/scavenge sites. Without further excavation and analysis, the site would have continued to be another doubted case of a human-mammoth association. As it represents the addition of another site to debates where the number of sites is often presented as evidence

against (e.g., Grayson 2001; Haynes and Stanford 1984; Meltzer 1986; Wroe et al. 2004) or for (Surovell and Grund 2012; Surovell and Waguespack 2008) Pleistocene overkill and Clovis large game specialization, La Prele serves as a reminder that there are likely other sites that are currently underinvestigated to be considered reliable enough to include in counts of terminal Pleistocene megafaunal kill/scavenge sites. The traditional three-part criteria (contemporaneity, direct association, and use) employed to evaluate Clovis kill/scavenge sites are reasonable but require a burden of proof that is not possible without significant investigation and careful excavation. Byers's (2002) doubt was reasonable given the limited artifact assemblage and minimal geologic context available. The results of new excavations at the La Prele Mammoth site should encourage the investigation of other proboscidean sites that are currently in limbo due to insufficient reporting or excavation.

Clarification of the number and type of proboscidean death/butchery sites can contribute to a variety of debates in Paleoindian archaeology, including overkill, Clovis subsistence, and the social and economic implications of procuring large animals. As at least the sixteenth identified extinct megafauna processing site, La Prele, and its expanded assemblage, is an important contribution to the Clovis literature. The presence of multiple artifact concentrations contemporaneously occupied during mammoth butchery is uncommon, with only one other case (or possibly two) reported (Haynes and Huckell 2007; Sanchez et al. 2014). Further excavation and analysis of these activity areas is ongoing and will contribute to our understanding of the full suite of activities that took place during megafauna butchery in the terminal Pleistocene.

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Data Availability Statement. All data and collections associated with the La Prele Mammoth site are housed at the University of Wyoming Department of Anthropology in Laramie, Wyoming.

Supplemental Materials. For supplementary material accompanying this essay, visit <https://doi.org/10.1017/aaq.2020.8>.

Supplemental Text 1. Description of geologic context for the La Prele Mammoth site.

Supplemental Text 2. Lithic microwear methods, blind test results, and wear descriptions for La Prele Mammoth (LPM) tools.

Supplemental Table 1. Radiocarbon dates from excavations (Blocks A and B) and Trench 1 at the La Prele Mammoth site.

Supplemental Table 2. Optically stimulated luminescence dates from Trench 1.

Supplemental Table 3. Microwear characteristics for tools listed in Table 3.

Supplemental Figure 1. Profile of Trench 1 from 2014 including all optically stimulated luminescence (OSL) and radiocarbon dates. Note that OSL dates are presented in calendar years before present while radiocarbon dates are presented in radiocarbon years before present.

Supplemental Figure 2. Examples of lithic microwear patterns observed on the La Prele Mammoth (LPM) tool assemblage and the polar coordinate system for identifying use locations.

Supplemental Figure 3. Examples of unmodified and retouched tools from an experimental collection.

Notes

1. Originally, 12 flakes were identified in cast sediments (Byers 2002); however, when we reviewed the original artifact assemblage, only seven could be identified as indisputable artifacts based on traditional debitage characteristics (e.g., sharp edges, platforms, bulb of percussion).

2. Based on the positioning of the original (1987) unit nails found in 2014, grid northing and easting could be reestablished with high confidence. Unfortunately, there was little means for establishing elevational control other than comparing artifact back plots and estimating the elevation of the floor of the 1987 excavations. As a result, we are less confident in our vertical reconstruction.

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