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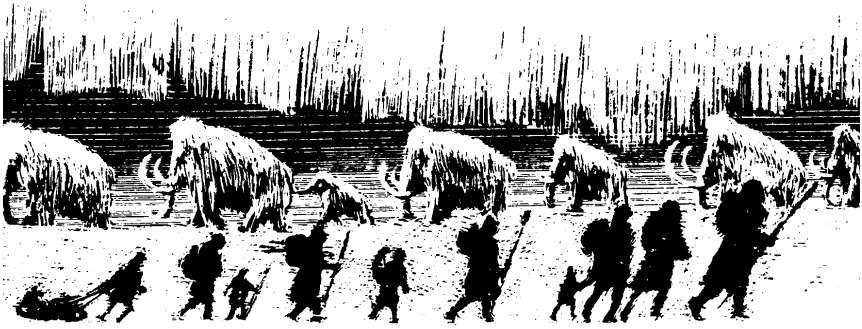

A Peopling of the Americas Publication

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Patterns in the Early Production of Lithic Artifacts at Agua de la Cueva—Sector Sur (Argentina)

Alejandro García

➤ **Keywords**: Lithic Analysis, Technological Organization, West Argentina

The rockshelter of Agua de la Cueva—Sector Sur (32° 372′ S, 69° 092′ W, 2,900 m a.s.l.), central west Argentina, has yielded a large collection of cultural remains from early human occupations dating between 10,950 ± 190 (Beta-61409) and 7450 ± 140 (Beta-90740) RCYBP (García 1995; García et al. 1999). Many of these items are lithic artifacts. A total of 16,959 pieces of lithic debris and 828 stone tools have been recovered. Analysis of a sample of lithic debris (n = 3,674) and all the tools has detected patterns associated with lithic technology, especially regarding toolstone selection, retouching, and fracturing.

1) Local raw materials were almost exclusively used. These include rhyolite (468 tools and 884 debris), quartz (164 tools and 2,261 debris), and chalcedony (127 tools and 345 debris), all of which can be located within a radius of less than 5 km from the site. These were used to manufacture lithic instruments for specific purposes. Conversely, non-local rocks (> 5 km distance from the site) were used much less frequently (basalt and quartzite: 34 tools and 21 debris), and exotic rocks are rare (only obsidian, one instrument, and one debris).
2) Tools were not elaborately worked and show a low level of sophistication. This is reflected by (a) a high quantity of artifacts with cortex (almost 25 percent); (b) frequent use of unmodified rocks, blanks, and external flakes as tool blanks (31.4 percent of the instruments); c) high frequency of marginal flaking (86.4 percent of determined cases) and low frequency of instruments exhibiting deep flaking; (d) scant evidence of bifacial tool production (16 bifacial thinning flakes); (e) within the debris sample, high frequency of platforms either smooth (single faceted) or cortical (70 percent of the determined cases); (f) high frequency of pieces with natural, probably utilized, borders (n = 208, 24.5 percent); and (g) low frequency of pieces with bifacial

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retouch (n = 15, 1.8 percent). Most of the analyzed tools show evidence of continuous, regular retouching, polished edges, or use micro-flaking.

3) Tools were abandoned at their place of use (with the exception of projectile points), not transported to other sites as is consistent with conservative practices.
4) Raw materials were not stored or stockpiled within the site, behavior associated with readily available abundant resources.

These patterns of acquisition and use of lithic raw materials during the Pleistocene-Holocene transition characterize an expedient technology (Nelson 1991), as already observed at several early South American sites (e.g. Borrero 1996; Núñez et al. 1994; Jackson et al. 1997–98).

Although some of these patterns coincide with patterns observed in sites with readily available local lithic resources (expedient instruments, marked predominance of local rocks, high proportion of tools with cortex, etc.), other patterns do not. For instance, the relatively large number of small tools (< 25 mm length) (n = 87, 10.5 percent of the sample) and tools with multiple used edges (n = 247, 30.4 percent) clearly indicates that neither the size of the item nor the degree of utilization of available edges reflects behavior associated with abundant lithic resources. Moreover, whereas some authors (e.g., Bamforth 1986) expect a low frequency of retouched artifacts and fracturing when abundant raw material is available, the grade of retouching (n = 642, 77.7 percent) and fracturing (64.5 percent, n = 490 from a total sample of 763) of tools at Agua de la Cueva appears to be inconsistent with abundant raw material.

Consequently, this analysis characterizes the lithic technology of early occupations at Agua de la Cueva as expedient, and it concludes that raw material availability, although an important factor, did not govern other important aspects of lithic tool production at the site.

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Early-Archaic Occupation (9265 CALYBP) on the Semiarid Coast of Chile

Donald Jackson, Antonio Maldonado, and Matthieu Carré

➤ **Keywords**: Hunter-Gatherers, Early Holocene, Northern Chile

Recent excavations were carried out at the locality of Quebrada de Quereo, situated 2.5 km south of the village of Los Vilos (Choapa Province, ca. 32° S latitude) along the semiarid coast of Chile to sample a strategic profile for palynological analyses. The presence of various occupational events segregated stratigraphically was revealed, the oldest one corresponding to an occupation dating to the early Holocene.

The exposed cut is situated in a swamp forest refuge around 600 m west of the current coastline and some 100 m from the former excavations of the Quereo Paleoindian site (Montané and Bahomondes 1973; Núñez et al. 1994). The profile shows a stratigraphic sequence (1.40 m thick) made up of intercalated layers of sand, clay, and peat, among which at least three human occupation events were detected and ^{14}C dated (Table 1).

Table 1. Radiocarbon dates (AMS) of the Quereo 2B profile; early (Q2B T5), middle (Q2B T3) and late (Q2B T1) Archaic occupations.

Lab. No.	^{14}C date, RCYBP	Calibrated age, CALYBP (2σ)	Calibrated midpoint, CALYBP	Stratigraphic provenience	Material
OS-68052	4220 ± 30	4630–4853	4741 ± 111	Q2B T1	Charcoal
OS-68033	5640 ± 30	6320–6491	6405 ± 85	Q2B T3	Charcoal
OS-68032	8280 ± 50	9094–9436	9265 ± 171	Q2B T5	Sediment

The earliest occupation (9265 ± 171 CALYBP) was found in a 25-cm-thick layer of dark gray clay (Q2B T5). It contained remains of at least 10 species of marine mollusks, some echinoderms, fragments of mammal bones, and charcoal particles, as well as lithic cores, scrapers, flakes, and debitage on local raw materials. We also recovered some debitage from quartz crystal, whose nearest source is situated about 30 km inland (Rivano and Sepúlveda 1986). Another noteworthy finding is a fragment of an earring made of combarbalite stone, a raw material from about 70 km from the site (Rivano and Sepúlveda 1986). These findings show the wide range of mobility of the early-Holocene inhabitants of the coast.

This early occupation is attributed to the Huentelauquén complex and is possibly spatially and functionally linked to another nearby site (L.V.067)

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(Prado 2000), situated just 500 m west of the Quereo 2B profile and dated to a time of warmer regional climatic conditions (Maldonado and Villagrán 2006).

This complex was identified by the presence of lanceolate stemmed projectile points, other typologically diagnostic instruments, and some characteristic geometric lithic pieces. These occupations correspond to the first groups of hunter-gatherers adapted to the coastline, who occupied the region between about 13,000 and 11,000 CALYBP and used a consistent and diverse set of coastal resources (Jackson and Méndez 2005).

The two subsequent occupations consist of deposits of shells made up of a variety of mollusk species, bone remains, and lithic instruments made on local and exotic raw materials. The Quereo 2B T3 (6405 ± 85 CALYBP) was occupied by hunter-gatherers from the middle Holocene, known regionally as the Papudo complex, who intermittently occupied the coast (Jackson 2002), whereas the occupants of Quereo 2B T1 (4741 ± 111 CALYBP) would have been late hunters who occupied the regional coastline more consistently (Méndez 2003).

Previous studies carried out in the lower course of Quebrada de Quereo showed evidence of wildlife made extinct as a result of anthropogenic activity between 13,500 and 13,000 CALYBP (Núñez et al., 1994). These authors also found later evidence of hunter-gatherers and pottery users from the late Holocene. The absence of human occupations between the final Pleistocene and the late Holocene suggests a period of environmental instability.

Although the region became intensely arid during the early and middle Holocene (Villagrán and Varela 1990), the Quereo 2B profile shows evidence that, contrary to common belief, Quebrada de Quereo was repeatedly occupied by humans during that time. Tectonic and geomorphologic conditions created abundant aqueous resources, albeit ephemeral, during a large part of the Holocene (Varela 1981). These conditions concentrated resources in a localized swamp forest that attracted wildlife and human groups from the end of the Pleistocene and during most of the Holocene.

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New Radiocarbon Dates from the Campo Laborde Site (Pampean Region, Argentina) Support the Holocene Survival of Giant Ground Sloth and Glyptodonts

Pablo G. Messineo and Gustavo G. Politis

➤ **Keywords**: Megamammal Extinctions, Peopling of the Americas, Pampean Region

Evidence obtained for the extinction of megafauna and the survival of some species into the early Holocene is scarce in South America. Most of the evidence comes from the Pampean region (Messineo and Politis 2008; Politis and Gutiérrez 1998; Politis et al. 2003). One of these archaeological sites that can help clarify this issue is Campo Laborde (37° 00′ 36″ S and 60° 23′ 05″ W), a single-component site located along a tributary stream in the upper basin of the Tapalqué Creek (Pampean region, Argentina). Until recently, chronology of the archaeological component has been a little unclear owing to the range of ^{14}C dates from megafaunal bones (see discussion in Politis and Messineo 2008) from about 9700 to 6750 RCYBP. In this paper, we present new conventional ^{14}C dates obtained from soil organic matter collected from the archaeological deposit and we discuss the chronology and contextual association between humans and megafauna during the early Holocene.

The Campo Laborde site was discovered in 2000 and excavated between 2001 and 2003. A great number of giant ground sloth bones (*Megatherium americanum,* NISP = 108) along with very scarce remains of two extinct glyptodont taxa (*Neosclerocalyptus* sp., NISP = 1, and *Doedicurus* sp. NISP = 1) and a large number of dermal bones (NISP = 142) were recovered from paleoswamp sediments. Two quartzite tools (a sidescraper and fragment of a bifacial projectile point), a flake, and 128 microflakes (less than 1 cm) from

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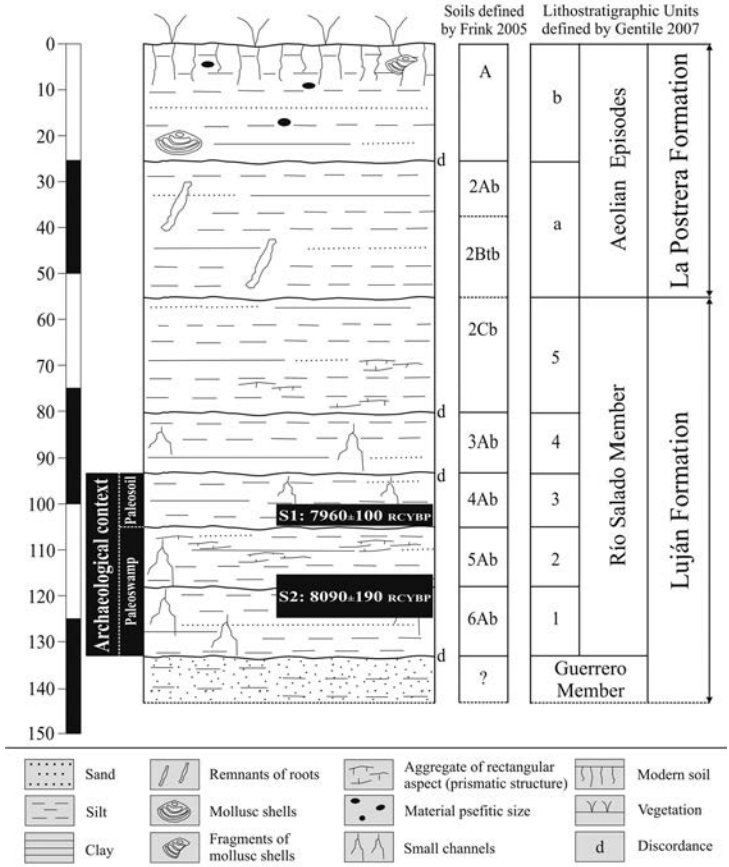
various types of raw material were found in close stratigraphic association with these megafaunal bones (Messineo 2008). Within the same deposit, bones from extant species were also recovered: Patagonian hare (*Dolichotis patagonum*, NISP = 12), vizcacha (*Lagostomus maximus*, NISP = 12), peccary (*Tayassu* sp. NISP = 1), fox (*Dusicyon* sp., NISP = 2), armadillo (*Chaetophractus villosus* and *Zaedyus pichiy*, NISP = 9), bird (Rheidae, NISP = 1), Camelidae (probably *Lama* sp., NISP = 5), and an undetermined number of microfaunal bones (e.g., *Galea musteloides*, *Reithrodon auritus*, *Akodon molinae*, and *Ctenomys* sp.). With the exception of *Megatherium americanum* and *Dolichotis patagonum,* the bone remains do not seem to be related to the human occupation at the site.

Taphonomic study carried out indicates that the bone assemblage was modified by environmental factors (i.e., chemical and subaerial weathering) affecting the bone surface, although cultural modifications were also recognized. These include cutmarks on *Megatherium americanum* and *Dolichotis patagonum* bones, some helical fracture debris, and two informal megafaunal bone tools (manufactured from rib bones). Human activity at this site has been interpreted as a single event involving the butchering of a giant ground sloth (Messineo 2008; Politis and Messineo 2008).

Geologic studies carried out at the northern profile of Campo Laborde identified two lithostratigraphic units, Luján Formation (ULI) and La Postrera Formation (ULII), which were divided into sections (Gentile 2008). In the lower section of ULI, lacustrine and paleolacustrine sediments (loamy sand) corresponding to the green Guerrero Member are exposed. Above this member, the sediments of the upper section of ULI are assigned to the Río Salado Member, a fluvial deposit representing an aggrading floodplain that corresponds to the early Holocene (Figure 1). This member was divided into different stratigraphic levels. The archaeological component was recovered from a paleoswamp (or paleosols 6Ab and 5Ab, *sensu* Frink pers. comm. 2005) and a paleosol (4Ab) located in the lower section (levels 1, 2, and 3, *sensu* Gentile 2008).

Six bone samples (five from *Megatherium americanum*, one that could not be determined) were processed and yielded ages between 9730 ± 290 and 6740 ± 480 RCYBP (Figure 1); five additional samples could not be dated owing to poor collagen preservation and low carbon content. Different lines of evidence suggest that *Megatherium americanum* bones correspond to a single individual (see discussion in Politis and Messineo 2008:109). Other sources were sought to understand the chronology of the site (i.e., correlation with local geological units from the Tapalqué Creek and OCR dating). Two soil organic matter samples were obtained from the northern profile of the site in the same sector from where the OCR date was taken (Figure 1). A sample from paleosol 4Ab (1.00–1.05 m below Level 0) gave a date of 7960 ± 100 RCYBP (LP-1983). A second sample, taken from the paleoswamp (between 1.15 and 1.25 m below level 0) where there was the highest proportion of bones and stone materials, provided an age of 8090 ± 190 RCYBP (LP-2003). These results should be taken with caution because dates obtained from soil organic matter must be considered minimum age of soil formation and do not necessarily



Laboratory Number	Sample	Element	$\delta^{13}C$	^{14}C age (RCYBP)	Calibrated age(1σ)	Calibrated age(2σ)
AA-71665	*Megatherium americanum* bone■	Metacarpal	-18.70	9730 ± 290	10600–11650	10250–12150
AA-55119	Unidentified megammamal bone■	Unidentified	-19	8720 ± 190	9500–10150	9400–10250
AA-55118	*Megatherium americanum* bone■	Rib	-18.77	8080 ± 200	8650–9300	8450–9500
AA-55117	*Megatherium americanum* bone■	Rib	-18.90	7750 ± 250	8350–9000	7950–9250
AA-71666	*Megatherium americanum* bone■	Metacarpal	-17.20	7630 ± 460	7950–9050	7550–9550
AA-71667	*Megatherium americanum* bone■	Phalange	-20.50	6740 ± 480	7150–8250	6550–8550
LP-1983	Soil organic matter (S1)	—	—	7960 ± 100	8700–8990	8500–9100
LP-2003	Soil organic matter (S2)	—	—	8090 ± 190	8700–9300	8500–9500

■See collagen and carbon percentages values in Politis and Messineo (2008: Table 3).

Figure 1. Stratigraphic profile at Campo Laborde site showing location of soil organic matter samples, their ^{14}C dates, and radiocarbon dates (calibrated ages 1σ and 2σ, OxCal v.3.1, Bronk Ramsey 2005).

reflect the period of human occupation (Martin and Johnson 1995). However, the new dates are synchronic with the two preferred dates (based on collagen content, see discussion in Politis and Messineo 2008) from *Megatherium americanum* bone collagen: 7750 ± 250 RCYBP (AA-55117) and 8080 ± 200 RCYBP (AA-5518).

The results presented here shed new light on the chronology of the archaeological component at the Campo Laborde site. The group of ages obtained through different dating methods, such as ^{14}C dating of *Megatherium americanum* bones (only taking into consideration the bones best preserved), OCR dating (Messineo 2008; Politis and Messineo 2008), known ages of the stratigraphic units (Figini et al. 1998; Tonni et al. 2001, 2003), and new dates of soil organic matter place this archaeological component at about 8000 RCYBP. To sum up, we propose the survival of giant ground sloth (*Megatherium americanum*) and both glyptodonts (*Doedicurus* sp. and *Neosclerocalyptus* sp.) into the early Holocene within the Pampean region.

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Crystal Quartz and Fishtail Projectile Points: Considerations on Raw-Material Selection by Paleo South Americans

Hugo G. Nami

➤ **Keywords**: Fishtail Points, Toolstone Procurement, Uruguay

"Fishtail" or "Fell" projectile points (ca. 11,000–10,000 RCYBP) show a broad continental distribution from Central America to the southern tip of South America. Since the end of the 19th century they have been found in the eastern part of the southern cone of South America, particularly in the Republic of Uruguay (Figueira 1892). Most specimens were made using excellent toolstone, typically flint-like materials, although some were made on other types of rock, among them quartz (Figure 1).

My recent field work and the studies of private collections have led to the discovery of new finds and new information about the Paleoindian lithic technology in the Negro River basin in the central part of Uruguay. There the Arroyo Cacique site (AC) has yielded a significant number of latest-Pleistocene finds (Nami 2007: Fig. 4). Several recent visits to the site have yielded new Paleoindian artifacts, among them several made on glass-like crystal quartz. The first of these is a Fishtail point (27.5 mm long, 18.8 mm wide, 7.8 mm thick) showing signs of strong resharpening and fractures from use (Figure 1A). A flake starting at the tip, probably produced by impact, eliminated a great part of the blade. The blade does not have enough mass to warrant resharpening and for this reason was probably discarded. This is a common occurrence among other Fishtail points from South America (Nami 1998, 2000). The second quartz artifact is a broken bifacial specimen (Figure 1B), probably an early-stage biface (26.8 mm long, 27.5 mm wide, 11.2 mm thick); the third is a piece of debitage of translucent crystal quartz.

An additional quartz artifact has been recovered from Collares, an archaeo-

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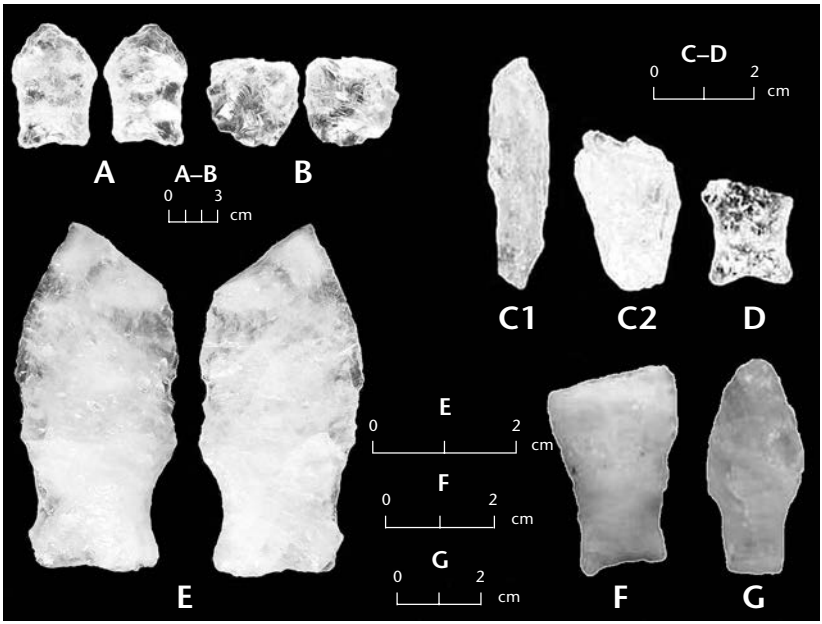

Figure 1. Quartz raw material and Fell points from Uruguay and crystal quartz artifacts from Arroyo Cacique. **A,** Fishtail projectile point; **B,** bifacial artifact; **C,** nodules of crystal quartz; **D,** Fishtail projectile-point stem found at Collares; **E,** Arroyo Molle Quintero (white and translucent quartz); **F–G,** Laguna Negra and Santa Lucía (milky glass quartz).

logical locality also located in the middle Negro River basin, Uruguay. At Collares, a number of surface and buried sites are being eroded by fluvial action. The artifact in question is the stem fragment of a Fishtail point made on glass-like translucent crystal quartz (22.0 mm long, 19.0 mm wide, 6.5 mm thick). One face is fluted; the opposite face has short pressure-flaked scars along its lateral margins and base (Figure 1D). There are impurities in the rock, which a fissure crosses transversally. AC and Collares stems were carefully abraded along both edges, a common feature of Fell points.

A recent survey of Collares along the eroded shorelines of Rincón del Bonete Lake identified outcrops of pebbles of varied lithology and size, as well as isolated pieces of quartz crystals (Figure 1C), providing a local source of raw material for the prehistoric population. There are also small nodules of glass-like crystal quartz at AC. These resources support the procurement model proposed for the Pali Aike area, indicating that Fell hunter-gatherers readily recognized local raw materials for making stone tools (Nami 1994, 2007:167). Certainly suitable rocks for stone tools manufacture have subtly different workability qualities (Callahan 1979: 16, Jones 2009). Despite some fissure problems, good crystal-quality quartz is brittle, not tough, and can be worked like glass or obsidian (Jones 2009).

In Uruguay, Fell points made using diverse varieties of quartz have been found at several places: Urupez (Meneghin 2004, Nami 2007: Fig. 7b); Arroyo

Molle Quintero, Durazno department (Fig. 1E); Laguna Negra, Rocha department (Fig. 1F), and Santa Lucía river (Fig. 1G). In other parts of South America, Fell points made of quartz have been found on Margarita Island, Venezuela (Personal observation 2007); Monte Caseros, Corrientes, Argentina (Nami 2007: Fig. 1c); and Rio Grande do Sul, Brazil (Schobinger 1974). Translucent crystal quartz has been found at Tagua-Tagua 2, Chile (Núñez et al. 1994); Pampa de Cupisnique, Perú (Chauchat et al. 1998); and Villa del Dique, Córdoba, Argentina (Schobinger 1974: Fig. 6). The use of crystal quartz has been identified in assemblages dated about 11,000–10,000 RCYBP from Caverna da Pedra Pintada, Brazil (Roosevelt et al. 1996). The widespread use of translucent crystal quartz by Paleo South Americans suggests that raw material was not selected solely for its optimal flaking qualities and economical considerations. Other social and cultural considerations—esthetic or ideological?—suggest that its attractive glass-like translucency might also have been a factor in its choice.

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Unifacial Fishtail Points: Considerations about the Archaeological Record of Paleo South Americans

Rafael Suárez

➤ **Keywords**: Technology, Point Manufacture Variability, Uruguay

Fishtail points were first recognized as tools of early hunter-gatherers of South America with the stratigraphic excavations of J. Bird (1938) in Fell's Cave. However, Fishtail points were previously reported at the end of the 19th century. Ameghino (1918, Plate 1, 42 [1880]) published one Fishtail from Pampa; and a pioneer of Uruguayan archaeology, J. H. Figueira (1892:210), published two Fishtail points recovered from surface sites on dunes in the area of Valizas on the Atlantic coast.

Bifacial Fishtail points have been registered widely in several countries of South and Central America, but reports of unifacial Fishtail points are scarce. The term "unifacial" Fishtail point is used here in a wide sense, referring not strictly to a point with flake scars on one face only, but also to one that may present a few flake scars on an opposite face. Generally a Fishtail point has thinning on both faces; in all examples of the unifacial Fishtail class, however, at least one surface of the original flake blank remains essentially unmodified (Figure 1).

Bell (1960) and Mayer-Oakes (1966, 1986) described Fishtail points from the El Inga site in highland Ecuador. Mayer-Oakes (1966:650–52) provided a detailed description of these artifacts; he discussed three points, having unmodified surfaces of the original flakes, that were used as blanks (1966: Figures 7b, 8b, 9b).

In Uruguay, unifacial Fishtail points were first reported by Bosch et al. (1980: Figure 2-17). In the Argentinean Pampas, three examples have been reported by Martínez (1997), Mazzanti (2003), Valverde (2003) and Flegenheimer et al. (2003).

To date, I have recorded nine unifacial Fishtail points in Uruguay, in the basins of the middle Río Negro and Río de la Plata, and on the Atlantic coast. They range in length from 35.2 to 63 mm, are manufactured on silicified

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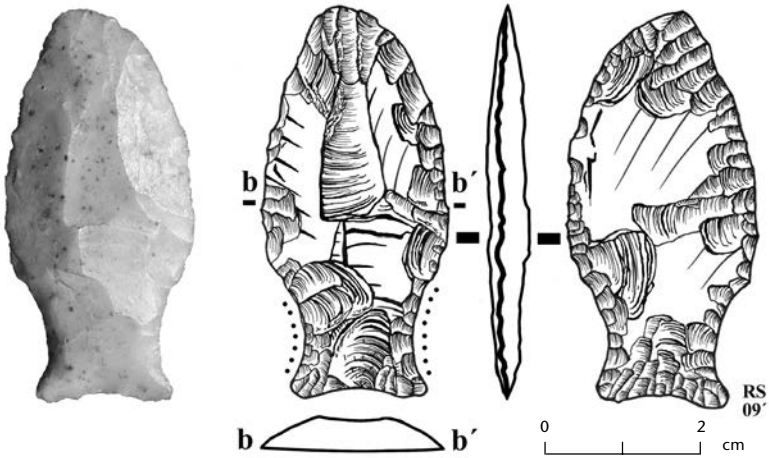

Figure 1. Unifacial Fishtail point from the middle Río Negro basin, Uruguay (Collection of Museo Histórico Casa de Rivera, Durazno). This point, which is made on a thin flake of a white variant of SLQF, is 51.1 mm long, 24.6 mm wide, and 5.9 mm thick, has a single short fluting scar 11.9 mm long on one face of the base of the stem, has thinning with irregular laminar retouch on the reverse face of the stem, and is trapezoidal in cross section.

limestone of the Queguay formation (SLQF) (n = 6), opal (n = 1), silicified sandstone (n = 1), and an unknown raw material (n = 1). They show no evidence of intensive resharpening of the blade, a fact that can indicate a long use life (Shott 1989, Suárez 2006). The assemblage of unifacial Fishtail points from Uruguay resembles the size, form, and design of bifacial Fishtail points, but differs in demonstrating a simpler flaking process, less standardization, and elaboration. They reflect a different reduction sequence that involves fewer stages, with only few flake scars on both faces that do not totally eliminate the interior face and crests on the exterior face of the original flake used as the base form. Frequently these points have very irregular and marginal retouch on the blade and careful but limited retouch on the stem. Another important difference is the trapezoidal or plano-convex cross section of unifacial Fishtail points; generally bifacial Fishtail points are biconvex or lenticular in cross section.

The unifacial reduction technique for making these Fishtail points cannot be explained as a result of low-quality raw material, because most of the unifacial points were manufactured on SLQF, a chert used to manufacture bifacial Fishtail points more than 100 mm long such as the Fishtail point illustrated in Suárez and López (2003:73, Figure 5). Regional geographic variation also does not work as an explanation, because unifacial Fishtail points come from three regions of Uruguay as well as two other geographic regions, Ecuador and the Argentinean Pampas.

On the basis of ethnoarchaeological data, Politis (1998:15) suggested that some classes of artifacts, such as miniature Fishtail points, may have been manufactured and used by children imitating the design of artifacts made and

used by adults. A similar interpretation of the unifacial Fishtail points may be reasonable; perhaps they represent the archaeological record of young apprentices of artisan-flintknappers who successfully replicated the design and form of the bifacial Fishtail points, but still could not master the complete lithic reduction sequence of bifacial point production (Jackson 2002).

Recently, I suggested that the variability of Fishtail points can be explained by technological or functional causes (Suárez 2006:70); however, the variability in this class of artifact can also be a consequence of the age of the person who produced the point. Possibly an artifact and its reduction process have different technical qualities, depending upon whether the person making it was a child, young apprentice, or expert adult flintknapper. It is possible that part of the variability of the archaeological record can be attributed to factors other than those of a functional or technological nature. Wider perspectives may be able to enlarge our present understanding of the variability in the South American Fishtail points.

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Archaeology: Eurasia

New Data on the Early Upper Paleolithic of Northern Mongolia

Sergei Gladyshev and Andrei Tabarev

➤ **Keywords**: Mongolia, Paleolithic, Blade Industry

Despite a long history of archaeological research there are only a few known Paleolithic locations with representative stratigraphy in Mongolia. In this context recent investigations (2004–08) at the Tolbor sites in the Selenga River basin (northern Mongolia) are of highest interest and importance (Derevianko et al. 2007).

The multicomponent Tolbor-15 site (49° 16′ 22.8″ N, 102° 58′ 18.4″ E) is located on the second terrace (10–12 m) of the Ikh-Tulberijn-gol River (Selenga's right tributary) (Figure 1-1). The area of excavation is about 200 m^2, of which 30m^2 was uncovered during the 2008 season. Six litho-stratigraphic units (2.2 to 2.4 m thick) illustrate the whole sequence of several archaeological periods of the late Pleistocene through early Holocene. The total collection of lithics (preforms, cores, tools, debitage) includes more than 10,000 artifacts.

Horizon 1 is assignable to the early Holocene (10,000–8000 RCYBP) and contains microconical cores and microblades.

Horizons 2–4 are assignable to the final Upper Paleolithic (17,000–15,000 RCYBP) and contain typical "Northeast Asian" toolkits with wedge-shaped microcores and microblades along with blade cores (Figure 1-2).

Horizon 5 is assignable to the middle Upper Paleolithic (ca. 25,000 RCYBP). It does not contain any traces of microblade cores; it is instead completely dominated by prismatic blade technology.

Horizons 6–7 are assignable to the initial Upper Paleolithic period (ca. 32,000–30,000 RCYBP) and contain prismatic blade cores, massive blades, endscrapers with high working edge, large scrapers (i.e., skreblos), etc. (Figure 1-3). So far we have no evidences of dwelling features, but we suggest that

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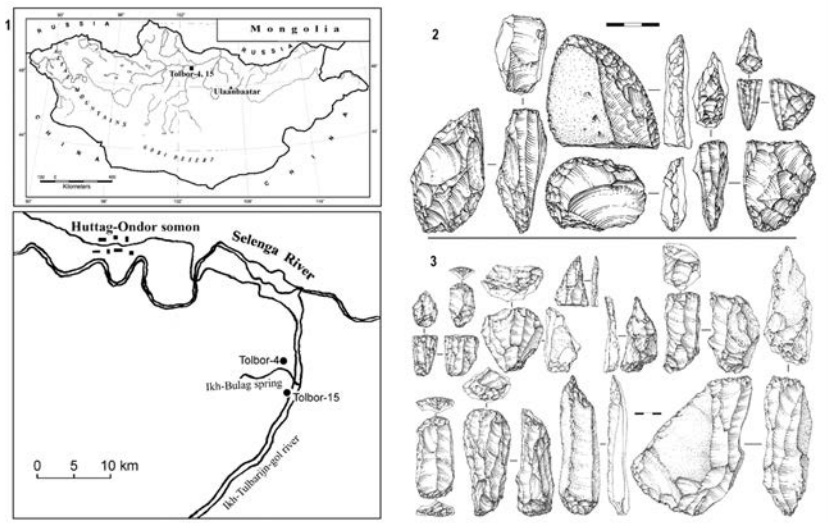

Figure 1. **1,** Maps showing location of the Tolbor sites in Mongolia; **2,** artifacts from horizons 1–4; **3,** artifacts from horizons 5–7.

five thin, round red stains found in Horizon 7 may be the traces of short-term hearths. There are also a number of organic remains (animal bones, ostrich egg shells) that provided samples for detailed ^{14}C dating of all the horizons.

Horizons 6–7 of Tolbor-15 clearly correlated with the other early Upper Paleolithic sites in Mongolia, including Dorolz-1, Orkhon-1, Orkhon-7, and Tolbor-4 (Horizon 4) (Gladyshev 2008). As for Tolbor-4 site (2.5 km north of Tolbor-15), its lower horizons (5–6) were recently dated by ^{14}C in frames of 40,000–37,000 RCYBP. Such dates raise the question about the timing and location in central Asia of where blade technology was originated. Was it the Altai region of Siberia or northern Mongolia? Or were there several centers of technological innovation? Additional investigations in the region should shed more light on the chronology and sequence of the late-Paleolithic cultures, and the origin of blade and microblade technologies, in northeast Asia.

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Use-Wear Analysis of Sugikubo-type Points from the Uenohara site in Central Japan

Akira Iwase

➤ **Keywords**: Use-Wear Analysis, Last Glacial Maximum, Japanese Archipelago

To understand the peopling of the Americas, archaeological evidence from northeast Asia around the time of the last glacial maximum (LGM) is worthy of note (e.g., Goebel 1999; Graf 2009; Madsen 2004). Graf (2009), for example, indicated that after the depopulation in Siberia at the LGM, a recolonization of the region originated from the maritime eastern Asia including Japan. Therefore investigating the technologies of the hunter-gatherers for adaptation to the temperate forests of the Japanese Archipelago, which differed from the cold and arid environments of the higher latitude of Asia, will contribute not only to understanding the reentering of Siberia, but also the peopling of the New World.

To be based on the above propositions, this paper reports results of a use-wear analysis of Sugikubo-type points of the Sugikubo blade industry from excavation 2 of the Uenohara site, Nagano Prefecture, central Japan (36° 48′ 46″ N, 138° 11′ 57″ E). This locality lies 600 m from excavation 5 (Iwase and Morisaki 2008; Nakamura et al. 2008). A total of 5,313 artifacts were recovered from excavation 2, from an area of about 1800 m^2. Uenohara locality 2 is a multicomponent Paleolithic site. Although separating the Sugikubo blade industry from other components by spatial distribution is difficult, it is easy to distinguish Sugikubo-type points and Kamiyama-type burins, which characterize this blade industry, by their techno-typological characteristics. The lithic industry contains various raw materials such as hard shale, tuff, andesite, and obsidian for manufacturing Sugikubo-type points (Nakamura and Iwase 2008).

The Sugikubo industry dates to roughly 20,000–18,000 RCYBP in north-central Japan. The Sugikubo-type point has a tip formed by abrupt retouch and a pointed base formed by flat retouch on the ventral side. Both lateral edges are usually unretouched (Figure 1A–B). These points are considered to be chiefly used as spear heads; however, little analysis has been done to investigate their functions.

The use-wear analysis of Sugikubo-type points presented here followed the high-power approach developed by Keeley (1980). A digital microscope (KEYENCE VHX) was used, and identifications were made following Midoshima (1986), a reference of use-wear types on obsidian artifacts.

From a total of 20 Sugikubo-type points, 11 obsidian artifacts were sampled for analysis. Seven specimens showed traces of use. Six representative photo-

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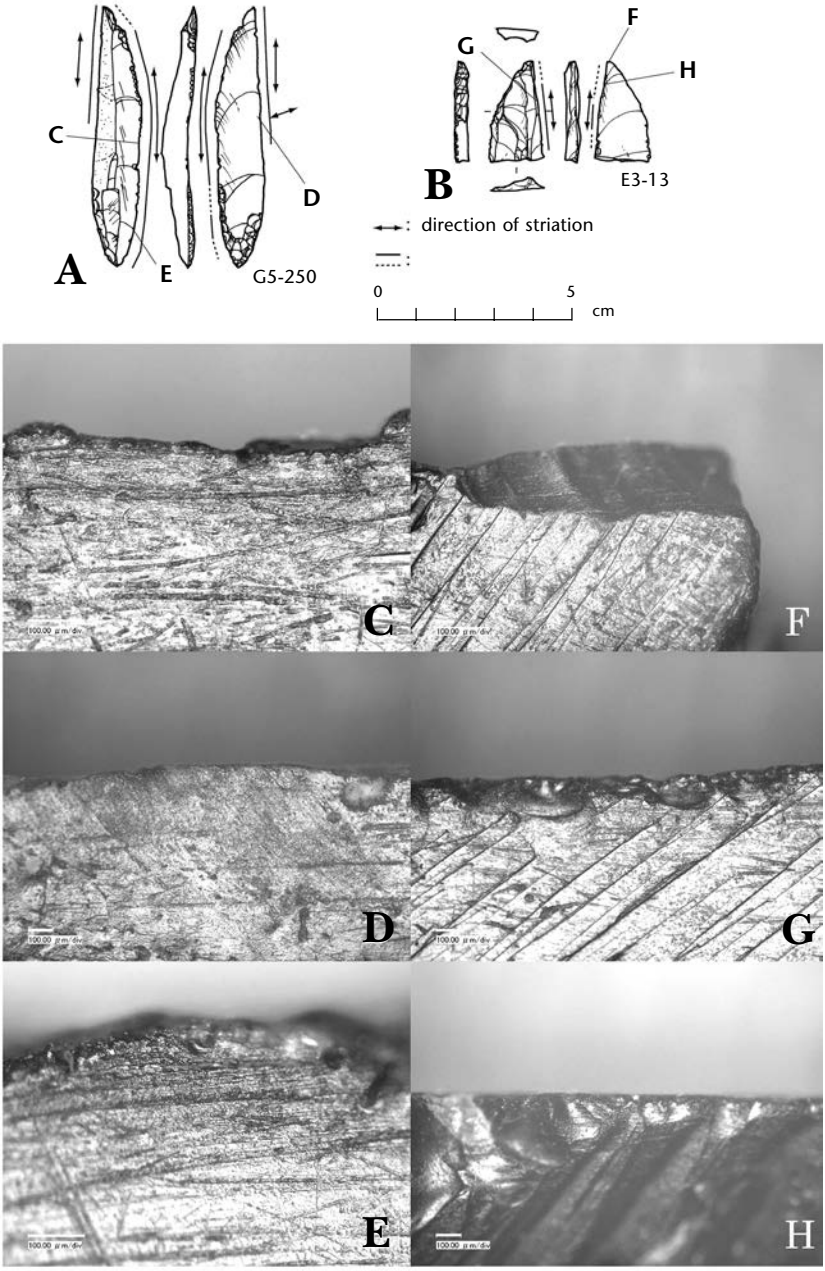

Figure 1. **A–B,** Sugikubo-type points; **C–H,** microscopic traces of use wear on the points. Letters in upper illustrations correspond to lower photographs.

graphs of use-wear are shown in Figure 1. Specimen G5-250 (Figure 1A) shows remarkable striations accompanied by well-developed abrasion on both lateral edges. The striations running parallel to each working edge are formed both on the ventral and dorsal faces (Figure 1C, E). At the halfway point along the left margin (with the piece oriented tip up and base down, and dorsal face visible), the striations extend obliquely to the working edge on the ventral face (Figure 1D). The directions of striation suggest that this artifact was used for cutting or sawing and whittling. Although polish was not recognized, the marked abrasion suggests that these traces were formed by contact with a soft material such as meat or hide. The striations on the base suggest that this artifact was used without being hafted (Figure 1E). Specimen E3-13 is the tip of a Sugikubo-type point. On the right margin, microscars and striations running parallel to the working edge were observed both on the ventral and dorsal faces (Figure 1G, H). Polish was not recognized. Figure 1F shows a burin-like spall that could be described as an "impact fracture" (e.g., Bergman and Newcomer 1983) from the very tip of the piece. The striation and burin-like fracture indicate that this artifact was used not only as a spear head but also as a knife. Three other specimens also show the striations along working edges; two others have burin-like spalls.

The use-wear traces described above suggest that Sugikubo-type points had at least two functions, as spear head and knife. The impact fracture and striation also indicate that some were used successively in hunting and butchering activities. Similarly to the Kamiyama-type burin (Iwase and Morisaki 2008), this multifunctionality of Sugikubo-type point also shows the Sugikubo industry is another phenotype of Mode-4 blade industries (Clark 1977). The hunter-gatherers probably developed these versatile tools to be adapted to the temperate forests of central Japan.

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A New Upper Paleolithic Site in Kamchatka (Russia)

Andrei V. Ptashinski

➤ **Keywords**: Microblade Production, Obsidian, Kamchatka

In 2008 the author discovered Anavgai-II, an archaeological site situated along the right 12-m terrace of the Anavgai River, 650 m from its confluence with the Bystraia River (360 m a.s.l.). Earlier, a disturbed site (Anavgai-I) with artifacts of Upper Paleolithic character was found nearby at Anavgai village (Ptashinski 2006). Excavations at Anavgai-II in 2008 exposed an area of about 20 m^2. In this paper I present the preliminary results of this excavation.

In the east wall of the excavation the following stratigraphy was tracked. Layer 1 is the modern turf formed by a dense interlacing of trunks and stalks of tundra vegetation, and the modern soil horizon densely penetrated by roots (10–13 cm thick). Layer 2 is a thin layer of dark brown humus of uneven thickness (1–3.5 cm). Layer 3 is a dark gray volcanic ash with inclusions of ferruginous color (3–7 cm). In its lower part layer 3 becomes dark brown in color, and its lower contact with layer 4 is uneven. Layer 4 is a dark brown dense sandy loam with occasional artifacts and small fragments of calcined bone; this layer reaches 15–25 cm. Layer 5 is a light grayish brown volcanic ash, very soft with a wavy upper contact with layer 4 (5–15 cm). Layer 6 is a dark brown sandy loam, similar to layer 4 (3–7 cm). Layer 7 consists of lenses of dull gray volcanic ash (2–8 cm). Layer 8 is a dark brown dense sandy loam with artifacts and pieces of charcoal (1–3.5 cm). Layer 9 is a tan-gray sandy loam interdigitated with a band of dark brown volcanic ash with isolated pieces of charcoal (2–4 cm). Layer 10 is a tan-gray schistosic volcanic sand (15–23 cm). Layer 11, finally, is a densely packed deposit of boulders with rare pebbles (exposed to base of excavation). The Upper Paleolithic cultural layer occurred in layer 8.

The volcanic ash of layer 5 has been assigned to an eruption of the Hangar volcano dating to about 6850 RCYBP. The layer 7 lenses of volcanic ash originated from an eruption of the Shiveluch volcano dating to about 8300 RCYBP (Ponomareva et al. 2007: Table 3). These tephras were identified

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visually by tephrochronologists I. V. Melekestzev and M. Pevzner. Stratigraphic gaps between the volcanic ashes, their waviness, and sharp tongues extending in a vertical direction are associated with cryoturbation. The presence of permafrost is led to the reorientation of artifacts toward vertical positions. The maximum depth of artifacts is 62 cm below the surface.

In the excavation we found 748 artifacts. Most are made on high-quality obsidian (72 percent), cherts (7.3 percent), jasper-like material (7.7 percent) and basalt (6.3 percent). In addition, we have recovered two pieces of pumice and seven small pieces of graphite. One of the pumice fragments has unequivocal traces of use. Ocher has not been found. Information on obsidian sources in Kamchatka can be found in Glascock et al. (2006). One major source occurs in the Anavgai region. This may be the origin of the obsidian recovered from Anavgai-II; however, geochemical analyses have not been completed.

The lithic assemblage from Anavgai-II is predominantly characterized by microblade production. We have recovered two wedge-shaped cores and more than 300 blades and microblades. Of the blades and microblades, medial and proximal fragments make up 55 and 30 percent, respectively. More than 30 crested blades and nearby 20 ski spalls have also been found. The tool assemblage consists of three knifes, the base of a small bifacial point, eight end scrapers on blades, nine lateral burins, a hammerstone, and a large axe-shaped tool. The rest of the assemblage consists of flakes and microflakes. Twelve artifacts have re-articulated fragments from as much as 3 m apart in the excavation.

In the cultural layer we exposed one hearth, and a sample of charcoal from it yielded an AMS ^{14}C date 10,870 ± 40 RCYBP (IAAA-80842). This date was obtained by K. Takase (Meiji University, Tokyo), who participated in the final stage of the excavation. After water-screening, we recovered a large number of small calcined bone fragments and microdebitage, both showing traces of fire. Under the hearth we uncovered the poorly preserved jaw of a cervid (probably reindeer) in a small recess.

N. N. Dikov was the first to discover the Upper Paleolithic of Kamchatka in 1964, on the basis of materials from the Ushki sites (Dikov 1979). Despite a long history of research, until now the only Upper Paleolithic material known from the peninsula was from the banks of Ushki Lake. Anavgai-II is located 65 km west of Ushki Lake, still in the basin of the largest river of the peninsula, the Kamchatka River. The new site dates to the same time as the late Ushki Upper Paleolithic culture (represented there by cultural layer 6). At Ushki-V the similar superposition of volcanic ash layers from the Hangar and Shiveluch volcanoes has been recorded. Typologically the materials of Anavgai-II correspond to the collection of materials from cultural layer 6 at Ushki-I. Radiocarbon dates between the two also coincide. Thus, Anavgai-II is a stratified site of the Upper Paleolithic period, the second after Ushki in Kamchatka.

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On a Wedge-shaped Core Variation in Beringia

Sergei B. Slobodin

➤ **Keywords**: Bi-frontal Wedge-shaped Core, Microblade Technology, Beringia

Recent research in the Upper Kolyma region, northeast Russia, resulted in the discovery of a bi-frontal wedge-shaped core (BWC) along with a typical single-front wedge-shaped core (made on a biface) on the surface of the Omchik II (Loc. A) site (61° 14′ 14″ N, 149° 10′ 42″ E) (Figure 1A, C).

Omchik II is located on a pass (868 m a.s.l.) between two tributaries of the Kolyma River. The BWC is made on a flat bifacially retouched blank. It has a distinct keel and two fronts on its narrow ends. On both fronts are negatives from microblade removals. Angles between the platform and both fronts exceed 90°. The core platform is very short (0.63 cm); it was regenerated by short spalls from both fronts**.** The core is exhausted and very small. Its length (along the keel) is 1.4 cm, height is 1.8 cm, and front width is 0.8 cm.

I consider BWCs in the same context as typical wedge-shaped cores because their preparation is based on the technique used for producing wedge-shaped cores. Moreover, BWC's were initially monofrontal wedge-shaped cores modified into bi-frontal cores during the last stage of core treatment. BWCs had a keel, narrow fronts for microblade detachment located on opposite ends, wide sides flattened by retouch, and one platform, regenerated mostly with frontal spalls. On the last stages of wear, cores usually have fronts with parallel removals converging at the core base. Specifically, the Omchik II BWC is a rare variety of bi-frontal cores, with the blunt angle between the platform and fronts and, consequently, shorter platform and a longer keel.

Wedge-shaped cores became the cultural and chronological markers testifying to the ancient migration of people from Asia to Alaska (Nelson 1937). They are distributed across Mongolia, Korea, Japan, eastern Siberia, Yakutia,

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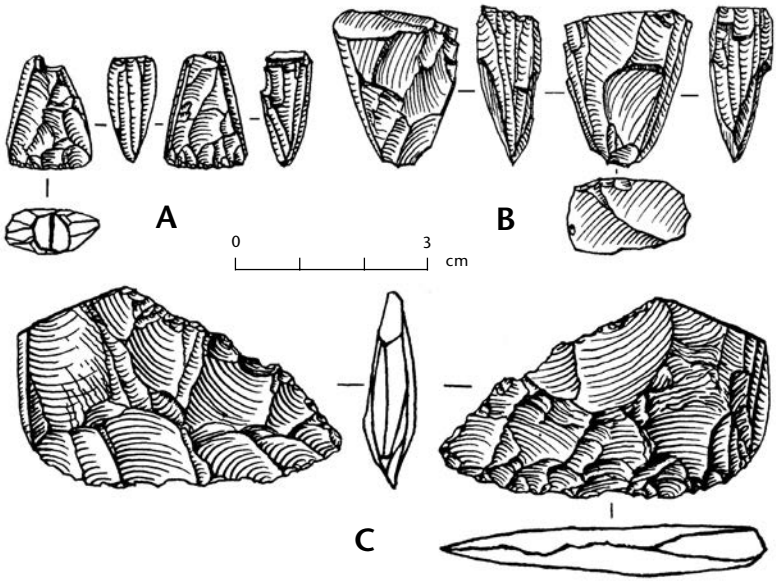

Figure 1. Wedge-shaped microblade cores from Omchik II (**A,C**) and Ushki I (level VI) sites. **A–B,** bi-frontal cores; **C,** a more typical uni-frontal microblade core.

Chukotka, Kamchatka, and Alaska. They have been the object of comprehensive study (Abramova 1986; Andrefsky 1987; Dikov 1979; Hayashi 1968; Morlan 1970), and many wedge-shaped core types have been defined, based on preform shape, platform preparation and rejuvenation. However, these schemes disregarded the bi-frontal variety of wedge-shaped cores.

Among BWCs there are subtypes that differ in the angle between the platform and front, keel availability, used preform, and the technique used for core processing. BWCs have been found in the Baikal region, Primorye, the Amur basin, Kamchatka, and Alaska. In the Baikal region, BWCs from Verkholenskaya Gora I (level 1) are defined as "wedge-shaped cores with two fronts" (Aksenov 1980). In Primorye, BWCs were found at Molodyozhnaya (Sakanasi 1998) and Ustinovka IV (Krupyanko 1991). In the Amur basin, such cores are known from the Khummi (Lapshina 2000) and Barkasnaya Sopka III sites (Derevyanko et al. 1998). More than 10 BWCs have been identified in the Ushki I (level VI) collection from Kamchatka (Figure 1B). In Chukotka, an artifact similar to that from Omchik II was found at Kurupka I (Dikov 1993: Figure 17.12). In Alaska, BWCs were described at Red Dog (Gerlach and Hall 1996), Broken Mammoth (Holmes 1996), and Little Panguingue Creek (Hoffecker and Powers 1996).

The age of BWCs is determined by their being part of the assemblages with wedge-shaped cores at the complexes dated to the late Pleistocene/early Holocene and referred to as Paleolithic (Slobodin 2001). In Alaska both bi-frontal and single-fronted wedge-shaped cores existed longer, up to the middle Holocene, perhaps even later.

The BWC found at Omchik II in the Upper Kolyma establishes the chain of this wedge-shaped core variation from Primorye and the Baikal region to Alaska. The materials analyzed show that BWCs appearing in some Beringian Paleolithic complexes are associated not with lithic raw materials, environment, or behavior, but with cultural differences.

Judging by publications, BWCs have not been found in Yakutia (Alekseev 1987; Mochanov 1977). This particularly can testify to a more essential influence or spread not only of the Dyuktai culture but also of the Far East and Amur Paleolithic traditions to Kamchatka, Kolyma, and Alaska.

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Broken Projectile Points from Mattobara, and Leaf-shaped Points Assemblages during the Late Upper Paleolithic in Japan

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➤ **Keyword**: Projectile Point, Late Upper Paleolithic, Japan

Mattobara (37° 13′ 42″ N, 138° 46′ 22″ E) is a late Upper Paleolithic campsite located in Ojiya-City, Niigata Prefecture, in north-central Japan. The site is composed of four localities (A–D). Lithic assemblages from locality A, locality B, and locality C are all very similar in both technology and tool types. Both blade technology and bifacial technology are confirmed in these assemblages. Tool types in these assemblages are leaf-shaped points, scrapers, gravers, and so on. Leaf-shaped points are especially abundant in each locality. No microblade, microblade core, or typical backed blade was found in these localities. Technological and morpho-typological position of these assemblages therefore belongs to the time range between the end of backed-blade phase and the beginning of the microblade phase. The most significant horizon of these assemblages lies between the AT marker-tephra (independently dated to ca. 25,000–26,000 RCYBP) and AS-YPk tephra (ca. 14,000–13,000 RCYBP) (Ono 1997, 2002). The date of these assemblages has been estimated at 17,000–14,000 RCYBP from the dates of similar assemblages in a neighboring region based on tephrochronology (Sakashita 2002).

Here I present details about the formation of the point assemblage from localities A and C, their presumed function, and the activities they represent.

The locality A lithic assemblage (n = 3,568) includes 82 points (Ono 2002), while the locality C assemblage (n = 4,446) includes 94 points (Ono 1997). The form of these points is thin-leaf shape or small-leaf shape. They were made on various blanks such as blades, elongated flakes, and other flakes. These

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points were made by various combinations of invasive and marginal retouching to adjust various blank forms. They include completely unifacial points with marginal inverse retouch, only marginal retouched points, partly bifacial points, and so on, as well as completely bifacial points.

Figure 1A shows length-to-width distributions of unbroken points and the base (or the tip) of broken points. They show that the width of most of the unbroken points is about 2 cm or less, suggesting that the width may have been intentionally adjusted to fit a haft. Figure 1B shows broken points with clear impact fractures (Barton and Bergman 1982), indicating that leaf-shaped points from the site were used as projectile tips in other places, transported to Mattobara, removed from hafts, and abandoned at the site where projectiles were repaired. Figure 1A also shows a concentrated distribution of broken point size less than 3 cm long and 2 cm wide. Many of the fragmented point bases (Figure 1C) fit within this size distribution, further suggesting they were replaced at the site. Interestingly, on some of the wider broken points (more than 2 cm) secondary retouch is not so intensive (Figure 1D). These latter point fragments may have been broken during manufacture. Thus, at Mattobara, projectile points were formed in two behavioral contexts—some were manufactured and used away from Mattobara and discarded there in fragmented form, while others were made on site for future use, sometimes breaking during manufacture. Some of these points were hafted and used as projectiles, but they were also brought back to the site and discarded.

These findings are supported by the refitting analyses (Ono et al. 1997). A refitting group from locality C (Figure 1E) representing a bifacial reduction sequence consists of 82 flakes, 2 points and one bifacial core, all restored into a single nodule of a flat pebble (Naganuma 2006). This nodule appears to have been reduced in a relatively short period of time at a single location. A broken point with impact fractures (Figure 1B-3) is included in the refitting group, indicating that the broken point was manufactured in locality C, used as a projectile point in another place, brought back to locality C after being broken, and, finally removed from the haft and abandoned. These data provide clear evidence of logistical mobility (Binford 1980; Habu 1994) of hunter-gatherers during the Upper Paleolithic.

Recently, the research about the peopling of the north Pacific and Americas seems to need more reliable and abundant data about Upper Paleolithic assemblages in north and east Asia (Madsen 2004). The date of the lithic assemblages from Mattobara Locality A, B and C have been estimated at 17,000–14,000 RCYBP, and the age of assemblages with bifacial points from neighboring regions may have been slightly older. These assemblages with bifacial technology seem to be also significant in the context of the peopling to the north Pacific and Americas.

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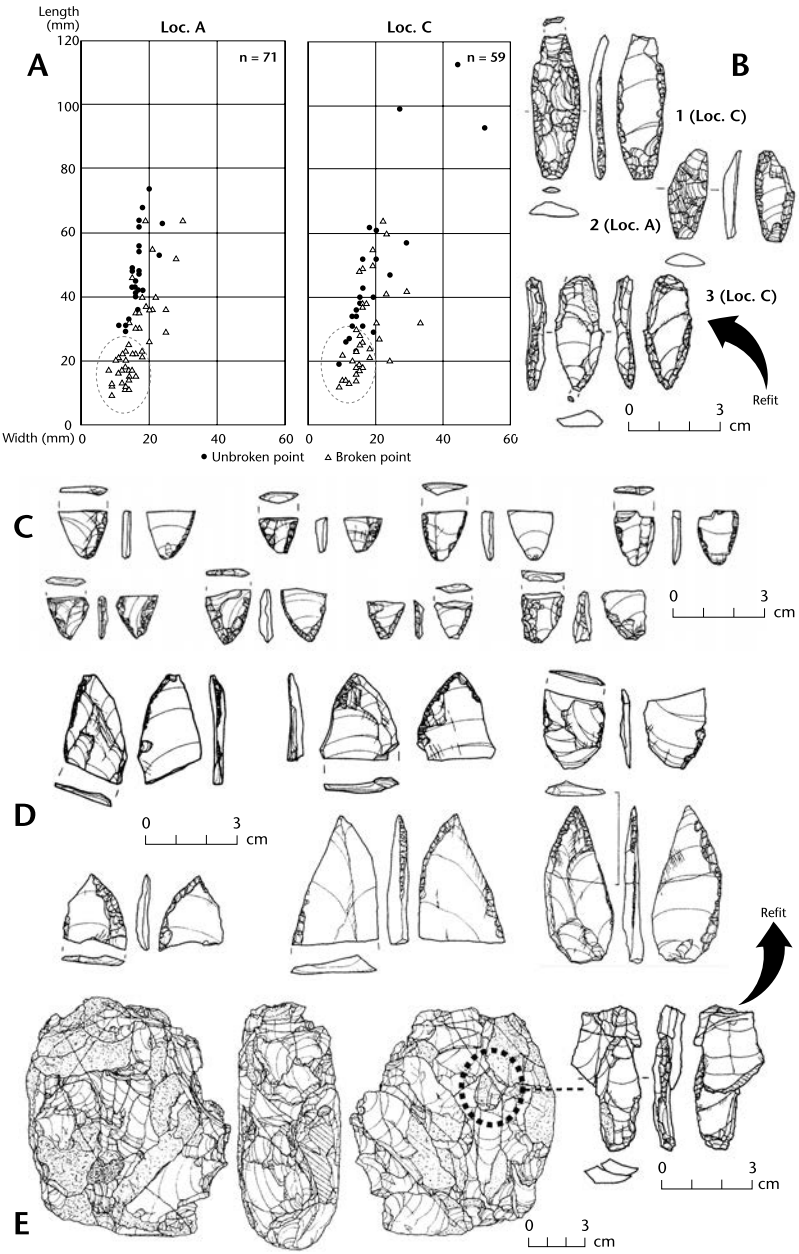

Figure 1. Broken projectile points from Mattobara (after Ono 1997, 2002). **A,** length-width distribution of points; **B,** points with impact fractures; **C,** broken points (upper from Loc. A, lower from Loc. C); **D,** broken points (upper from Loc. A, lower from Loc. C); **E,** refitting group from Loc. C, including a broken point with impact fractures.

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Yankito, the Oldest Archaeological Site Cluster on the Kurile Islands (Russian Far East)

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➤ **Keywords**: Early Neolithic, Pottery, Kurile Islands

The Kurile (Kuril) Islands are the most remote part of the Russian Far East, situated between the open northwestern part of the Pacific Ocean and Okhotsk Sea (Stephan 1974; Suslov 1961:401–11). The archaeology of this region is still poorly studied compared with the neighboring Hokkaido and Sakhalin islands, and only a very general knowledge of the prehistory and chronology of the Kuriles exists (e.g., Fitzhugh et al. 2002; Kuzmin 2005:106–13; Nelson et al. 2006:19–38, 166; Vasilevsky et al. 2003; Zaitseva et al. 1993). The question, "When did the settling of the Kurile Islands begin?" remains open, and this issue could prove to be fundamental to our understanding of Pleistocene routes followed during the peopling of the New World (e.g., Erlandson et al. 2007). It is quite possible that the Kuriles were one of the migration paths used in the terminal Pleistocene to reach North America from Northeast Asia, including Japanese Islands and the southern Russian Far East (e.g., Erlandson 2002:71).

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In 1988, Y. V. Knorozov discovered the Yankito 1 site on the western coast of central Iturup Island (also known as Etorofu in Japan). It is located 2.5 km north of the Kitovy (Yasnoe) Village, in the foothills of the Bogdan Khmelnitsky volcano. The geographic coordinates of the site are 45°16¢ N latitude and 147° 53′ E longitude. The area is positioned on a terrace-like surface, approximately 10–12 m above the level of the Okhotsk Sea. In 1988–90, stone artifacts, Urahoro-type pottery of the early Jomon, and charcoal were collected, although not with systematic excavations (see Prokofiev 2003). Two charcoal samples taken presumably from the cultural layer returned ^{14}C ages of 6980 ± 50 RCYBP (LE-3230) (Zaitseva et al. 1993) and 7030 ± 130 RCYBP (I-?; Teledyne Brown Engineering Environmental Services, Westwood, NJ, USA; Lab No. is not given; Y. V. Knorozov, pers. comm. 1991; see also Prokoviev 2003). This made the Yankito 1 site the earliest from the Kuriles although doubt has remained because of the lack of proper excavations.

The study of this settlement continued in 2007, and the Yankito 1 site was observed to be nearly destroyed. Some artifacts were collected from a restricted space that might have been a dwelling. A second site, Yankito 2, was discovered 600 m north of Yankito 1. An area of about 1,000 m^2 was surveyed, and test pits revealed a cultural layer still preserved in situ in several places. Below a surface sod layer (0.1–0.2 m thick) is a compact black loam (0.35–0.60 m thick) that contains artifacts. Beneath this layer is bedrock consisting of weathered basalt. The excavation pit of 10.5 m^2 yielded numerous artifacts. The potsherds (89 fragments) are made of clay with addition of grass, and they have narrow surficial grooves. Pots are of simple form with flat bottoms and straight rims, and decorations are found only around mouth parts as horizontal and slanted lines of cord-wrapped stick impressions. Pottery is very similar to the Urahoro type of early Jomon pottery on neighboring Hokkaido Island dated to ca. 7400–7300 RCYBP (Yamahara 2007:11). Stone artifacts (143 total) include 136 flakes and several types of tools, including a bifacial spearhead and arrowheads (2 items), unifacial knives (2), grindstone-hammerstone, and hoe. The raw material is mainly basalt and siliceous rock, and rarely obsidian.

The AMS ^{14}C dating of two charcoal samples collected during the 2007 excavation in primary association with artifacts and pottery was conducted. A sample taken from the lower part of the black loam (small pieces of charcoal spread in the cultural layer) yielded an age of 7055 ± 45 RCYBP (AA-78928). A second sample of dispersed charcoal, collected in the vicinity of the first one and 5 cm below it, returned a date of 6895 ± 55 RCYBP (AA-78927). Calibrated ages of both values (7970–7790 and 7850–7620 CALYBP, respectively) overlap at ± 2 sigma.

The close resemblance of the Yankito 1 and 2 pottery with the Urahoro type of Jomon ceramics from Hokkaido suggests that these regions were in communication in the early middle Holocene, ca. 7000 RCYBP, and possibly earlier. The environmental background of the southern Kurile Islands and Hokkaido at that time was presented by broad-leaved and coniferous-broad-leaved forests (Igarashi 1993; Korotky et al. 2000; Razjigaeva et al. 2002, 2008). The Okhotsk Sea level at the time of the site's habitation exceeded the modern

one, and estimates vary from 1 m (Bulgakov 1996) to 3.5 m (Korotky et al. 2000; Razjigaeva and Ganzei 2006:193).

Thus, the Yankito site cluster represents the oldest firmly documented evidence of human settlement in the Kuriles, and can be associated with the early Neolithic, ca. 7050–6900 RCYBP. On the neighboring Hokkaido and Sakhalin islands, occupation goes back to at least ca. 37,000-19,000 RCYBP (Ono et al. 2002; Vasil'ev et al. 2002). It is possible that older sites existed on the Kurile Islands, as surface finds of artifacts with Upper Paleolithic appearance testify (Prokofiev 1988; Salova 1976), but they remain to be discovered in buried, datable contexts.

There is another important aspect in the study of the Yankito cluster. Its material is close in some features to the final late-Pleistocene complexes of the Amur River basin (Russian Far East), which contain very old pottery (Osipovka and Gromatukha cultures dated to ca. 13,000–10,000 RCYBP; e.g., Nelson et al. 2005:22). This resemblance is displayed by pottery technology (grass in ceramic paste, surficial grooves, and cord-wrapped stick impressions) and lithics (adze- and scraper-shaped bifacial tools). This observation suggests to us that the final late-Pleistocene cultures of the Asian mainland took part in creating some of the Jomon complexes on the Japanese Islands (Yanshina et al. 2008).

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Archaeology: North America

The Sinclair Site (40Wy111): A Clovis Quarry along the Buffalo River in Wayne County, Tennessee

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➤ **Keywords**: Tennessee, Clovis, Quarry

Avocational archaeologist and flintknapper Rex Moore discovered the Sinclair site while searching along a series of hillsides for high-quality Buffalo River chert. Throughout the area where eroded outcrops of chert occur, Mr. Moore found two complete Clovis projectile points and several broken fluted bifaces along with large blades, bifaces, and uniface tools (Figure 1). Mr. Moore recognized the importance of this discovery and brought some of these artifacts to the 2008 Old Stone Fort Knap-In in Manchester, Tennessee, to share this information with a professional archaeologist.

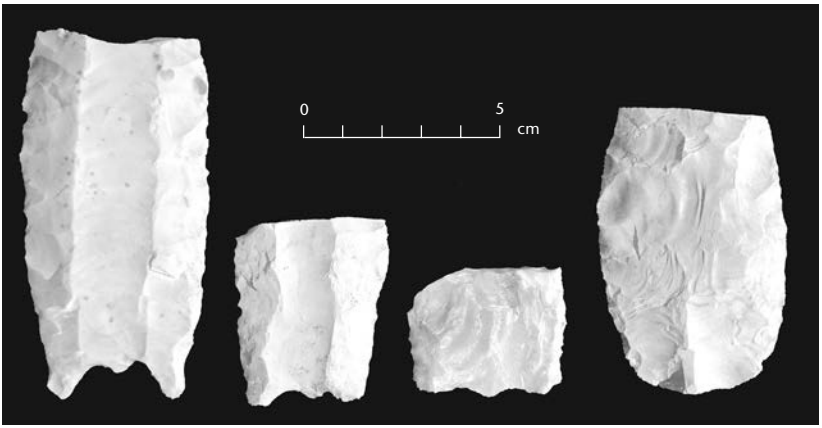

Figure 1. Late-Clovis preforms from the Sinclair site (40Wy111).

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In 2008, Mr. Moore showed us the site. He has collected over 4,000 Clovis artifacts from the surface of the site. We were allowed to take an additional surface collection of several hundred Clovis artifacts including preforms, blades, blade cores, blade tools, and debitage. The landowner, Mr. Ross Sinclair, had greatly altered the site with bulldozing and plowing to prepare it for conversion to pastureland. Nearly all the pine trees on the ridge top had been cut and the stumps removed with the bulldozer. Much of the site had been pushed over the edge of the ridge, and we made surface collections from these highly altered areas. The site contains primarily Clovis-age artifacts. However, a small concentration of Beaver Lake projectile point bases was located by Mr. Moore within one area of the site. These bases were associated with numerous biface reduction flakes.

This site is located within the Western Highland Rim physiographic region of middle Tennessee (Miller 1974). High-quality cherts are found embedded in weathered Mississippian-period limestones throughout this region. Chert-bearing Silurian and Devonian limestones also occur along portions of the western boundary of this region.

The main activity at Sinclair appears to be quarrying of large nodules of chert and reducing them into early-stage bifaces and prismatic blades. The concentrations along the ridge have produced a number of final-stage preforms and complete Clovis projectiles, but relatively few unifacial blade tools. The low frequencies of formal unifaces and multipurpose tools at Sinclair is significantly different from what we have seen at the Carson-Conn-Short site (40BN190), which we consider to be a true base camp locale (Norton and Broster 2008). We believe the lower frequencies of unifaces at Sinclair suggest that this site represents a series of short-term visits for chert procurement by only a portion of the social group. A base camp associated with this site has not yet been found, and it is possible that more than one group frequented this high-quality chert source during the same time period.

We are now in the process of obtaining permission to conduct more extensive controlled surface collections and test excavations from the 10 recorded concentrations of the site. It is hoped that intact deposits still exist in at least one or two of these areas.

We would like to thank Mr. Rex Moore and Mr. Ross Sinclair for making this research possible.

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Paleoindian Occupations along the Clear Fork of the Brazos River, Jones County, Texas: The Cunningham Paleoindian Site

Peter C. Condon, James M. Warnica, Jerry L. Bridwell, and Meghan R. Bruckse

➤ **Keywords**: Clear Fork–Brazos River, Cunningham Site, Clovis Blades

This paper presents a Paleoindian collection recovered 43 years ago from the Cunningham site situated along the Clear Fork of the Brazos River, Jones County, Texas. Located on private property approximately 24.14 km southwest of Anson, Texas, this site was initially investigated by Don Krieble and James M. Warnica, who collected a series of artifacts in 1965. Here we provide an overview of the site locale and briefly discuss the surface-collected artifacts.

In a setting similar to the Adair-Steadman site (Tunnel 1975), the Cunningham site is on a south-facing alluvial terrace overlooking the Clear Fork at an elevation of 538.0 m a.s.l. This terrace is characterized by Holocene-age sands, which overlie Pleistocene strata approximately 12.19 m above the Clear Fork drainage (Quigg et al. 2002). Noodle Creek, one of several nearby tributaries, empties into the Clear Fork approximately 2.18 km southeast of the site locale. The topography is distinguished by agricultural fields that were actively tilled during the site collection; in recent years, these have been allowed to lay fallow. The collected artifacts are of a distinctive gray-colored Edwards chert and were observed eroding from the Pleistocene-Holocene contact.

The assemblage of 88 artifacts includes one unidirectional core, 4 unmodified flakes, and 38 modified flake fragments. The assemblage also contained one overshot flake, one compass graver, and 7 non-diagnostic biface fragments. Of particular interest were 33 blade fragments, of which 9 exhibited extensive lateral modification. Ten blade fragments were fashioned into endscrapers characterized by acute edge angles and extensive retouch flaking (Figure 1A–F). The remaining 14 blade fragments were unmodified. Comparative data from the Gault site and Blackwater Locality No. 1 suggest that this blade assemblage exhibits characteristics analogous to previously documented Clovis-age blade assemblages (Collins 1999a; Collins 2003, pers. comm.; Collins 2007; Condon 2005; Green 1963). A possible Midland base (Figure 1G), Golondrina base (Figure 1H), and possible Plainview midsection complete the assemblage and indicate site use post-11,100 RCYBP (Bousman et al. 2004).

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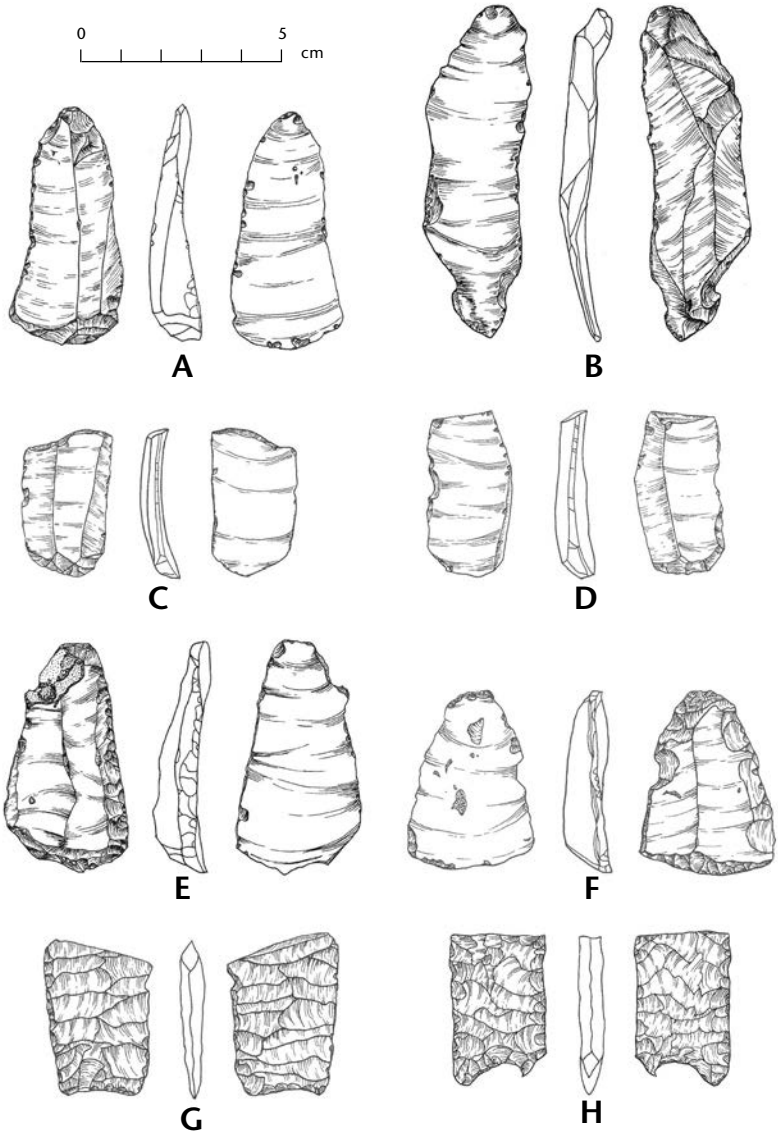

Figure 1. Artifacts from the Cunningham Paleoindian site: **A–F,** blade tools; **G,** possible Midland base; **H,** Golondrina base.

The purpose of this article is to review the artifacts collected from the Cunningham Paleoindian site and present the temporal and contextual environment they are associated with. Currently, the stratigraphic sequence of this site is unclear, as is the contextual relationship of the collected artifacts. Based

on Tunnell (1975) and Holliday (1997), however, there is the likelihood of buried Paleoindian components along the Clear Fork terraces. The diversity of artifact types tends to support this interpretation, although in a tentative manner, and suggests the possibility of a Clovis through late-Paleoindian presence at this site.

As such, future work at the Cunningham site may provide answers towards the use of the Clear Fork uplands between 11,500 and 8000 RCYBP and provide diachronic clues toward an ongoing synthesis of Paleoindian land use and material culture in northwest Texas.

The authors gratefully acknowledge M. Quigg and P. Lukowski for a review of this article.

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Jackson-Gore: An Early-Paleoamerican Occupation in the Green Mountains of Vermont

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➤ **Keywords**: Early Paleoamerican, Green Mountains, Vermont

The Jackson-Gore site is located in the middle of a narrow, ca. 50 km long, east-west trending pass through the Green Mountains that connects the southern end of the Champlain lowland to the west with the Connecticut River to the east. The site lies at 331 m a.s.l. on a level terrace near the base of Okemo Mountain (el. 1,019 ft a.s.l.) and overlooks Branch Brook, which flows east into the Black River portion of the Connecticut River drainage. The site was identified in advance of resort development. A portion of the site was sampled by the University of Vermont Consulting Archaeology Program (UVM CAP) as part of data-recovery mitigation, and the remainder is preserved and protected.

The larger of two main site loci is set back from the edge of the terrace landform. A total of 49.5 m^2 of excavation within Locus 1 produced lithic tools and debitage indicative of hunting-related activities. The assemblage from this locus, a significant proportion of which is composed of probable Champlain Valley black chert, includes several projectile-point fragments, two of which articulate to form a complete fluted projectile point diagnostic of the Michaud/Neponset phase, dated to ca. 10,300–10,200 RCYBP (ca. 12,200–11,800 CALYBP) in northeastern North America (Bradley et al. 2008; Newby et al. 2005). The second, smaller site locus approximately 100 m away is positioned at the head of a swale closer to the edge of the terrace. A total of 8 m^2 of excavation within Locus 2 revealed a lithic scatter of non-local red chert debitage. Two flake tools also were recovered from this smaller activity area, which may represent a hunting lookout.

The combined Locus 1 and Locus 2 site assemblage contains a diverse sample of lithic raw materials. Overall, the inventory of debitage (n = 2,682) is composed of gray chert of unknown origin (46 percent), red chert macroscopically similar to material from Munsungan Lake in northern Maine (26 percent), semi-translucent black chert probably from the Champlain Valley (21 percent), Vermont quartzite (3 percent), unidentified chert(s) (2 percent), greenish chert macroscopically similar to Hudson Valley material (1 percent), yellow-brown chert macroscopically similar to Pennsylvania jasper (.5 percent), quartz (.5 percent), and felsite, possibly from Mt. Ascutney in Vermont. These tentative attributions offer some insight into the group's wide ranging movements and/or the breadth of their exchange networks.

The lithics recovered from the Jackson-Gore site appear heavily curated

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judging from the small size of the debitage and several artifacts that represent attempts to manufacture projectile points from smaller flakes. The character of the overall site assemblage suggests that toolstone supplies were limited and that the group was in transit to or from the Champlain lowland to the west.

At the time the site was occupied, the Champlain lowland was home to the Champlain Sea, an inland ocean connected to the Atlantic via what is now the St. Lawrence River valley. Although a correlation between Paleoamerican groups and the Champlain Sea has been proposed by various researchers since Ritchie's studies at the Reagan site (Ritchie 1953, 1957; see Loring 1980), Quaternary geological research and better dating techniques only recently have convincingly demonstrated the coevality of these early groups and the inland sea (Cronin et al. 2008; Newby et al. 2005; Rayburn et al. 2007; Ridge 2003; Robinson 2008; Robinson and Crock 2008). As such, it appears likely that marine resources of the Champlain Sea and the hospitable environmental regime of the valley attracted human populations for at least part of the Paleoamerican period (Newby and Bradley 2007).

The productive "magnetism" of the Champlain Sea undoubtedly played a significant role in shaping early-Paleoamerican patterns of transhumance and settlement in the Northeast, likely including those of the Jackson-Gore site occupants. Regular travel by Paleoamerican groups to and from the Champlain Sea is implied by lithic assemblages from early sites such as Jackson-Gore that contain high proportions of Champlain Valley materials as well as non-local lithics from sources to the east (chert from Maine and rhyolite from the Connecticut River Valley) and west (chert from New York and "jasper" from Pennsylvania). Until recently, it has been more difficult to be specific about the directionality or seasonality of early travel routes to and from the valley owing to the very limited number of systematically excavated sites from this era and the lowland, valley-centric nature of the dataset. The location of the Jackson-Gore site along a passage through the southern Green Mountains of Vermont indicates that this was one route utilized by Paleoamericans during the late Pleistocene.

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Paleoarchaic Incised Stones from Barton Gulch, Southwest Montana

Leslie B. Davis, Matthew J. Root, Stephen A. Aaberg, and William P. Eckerle

➤ **Keywords**: Paleoarchaic, Incised Stones, Middle Rockies

The Barton Gulch site (24MA171) in the Middle Rockies, southwest Montana, contains abundant evidence of a Paleoarchaic, Alder complex foraging adaptation. This component is a base camp with dates ranging from 9410 ± 140 RCYBP (Beta-23215) to 9340 ± 120 RCYBP (TX-7564). Carbonized macrofossils found in and around 16 feature aggregates composed of braziers, postmolds, and roasting ovens include prickly pear cactus, goosefoot, limber pine, bullrush, and sunflower. Willow, sagebrush, and cottonwood provided fuel. Faunal remains include whitetail and mule deer, jackrabbit, mountain cottontail, mink, and porcupine. Associated artifacts include eyed bone needles, a box elder foreshaft, bone awls, handstones, anvils, choppers, scrapers, knives, gravers, and lanceolate Ruby Valley points (Aaberg et al. 1996; Davis et al. 1989, 1994).

Two incised stone tablets are from the Alder complex deposit. Paleoamerican precedents occur in Clovis deposits at Gault (Collins 2002; Collins et al. 1992) and Folsom deposits at Blackwater Draw (Hester 1972:Fig. 93g). The Alder complex artifacts have rectilinear designs that resemble motifs of the Great

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Basin incised tradition, which begins at ca. 5500 RCYBP (Carpenter 1988:951–87; Thomas 1983a, 1983b). The Barton Gulch artifacts are tabular pieces of weakly indurated, mica-rich sedimentary or metasedimentary stone, which crops out upslope. Tablet makers shaped both pieces by marginal percussion flaking before incising the designs, indicated by lines that overlap flaked surfaces.

One tablet is incised on only one face with pairs of parallel lines, three intersecting lines, and other lightly striated, subparallel lines (Figure 1A). All lines are shallow with U-shaped cross sections.

The second tablet is elaborately incised on both faces. One face (Figure 1B, left) has a crosshatched design crosscut by a deep oblique line. This oblique line is crosscut by four prominent subparallel lines deeper than all others. The opposite face (Figure 1B, right) is bisected by a prominent baseline that forms

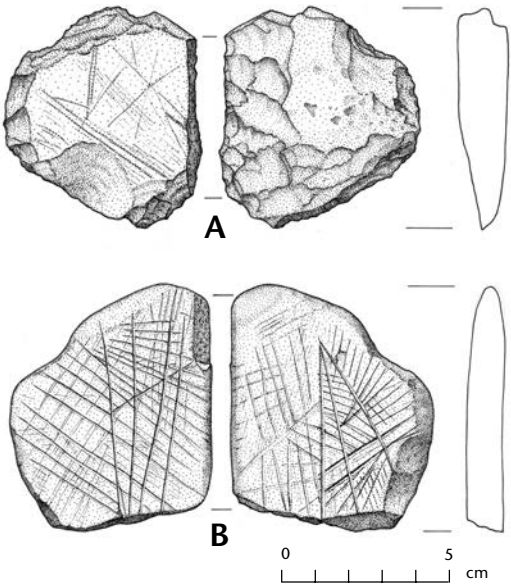

Figure 1. Incised tablets from Barton Gulch (illustrations by Sarah Moore).

a boundary for an oblique baseline on the left part of the tablet. This oblique baseline forms a boundary for two quadrants of crosshatching and subparallel lines. Two prominent lines form chevrons with the first baseline on the right side, and these form baselines for additional rows of lines. The chevron is deep and V-shaped in cross section, contrasting with other lines, which are U-shaped. Gravers, or even flakes, are potential incising implements.

Incised stones are present at sites ranging from temporary hunting camps to villages across western North America (e.g., Carpenter 1988:891–1011), suggesting that individuals carried them as possessions. Carpenter (1988:925–33) infers that incised stones from Gatecliff Shelter, which postdate the Barton Gulch stones by 4,000 years, represent decorative designs for clothing that were handed down for millennia. Whether the Barton Gulch tablets represent ancient vestmental designs or simple tallies is unknown. They are, however,

likely precursors to similar artifacts made by the later Archaic foragers who lived across the Desert West.

The Barton Gulch project was sponsored by the Kokopelli Archaeological Research Fund as a project of the First Montanans Search Program, Museum of the Rockies, MSU-Bozeman.

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Jasper Endscrapers from the Connecticut River Valley, Massachusetts

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➤ **Keywords**: Uniface, Jasper, Massachusetts

Recent research in the Deerfield area has led to the identification of a unifacial scraping tool believed to be Paleoindian in origin. The artifact was recovered in 1989 from the ground surface during a walkover of a plowed field, as part of a cultural resource management survey for a proposed technol-

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ogy park (Nassaney et al. 1989). A project undertaken in 2008 in the same vicinity included background research, at which time the artifact was reexamined and found to be strikingly similar to unifacial endscrapers identified from Paleoindian contexts in the immediate area.

The site producing the unifacial scraper, 19-FR-331, located in the southern portion of the town of Deerfield, also yielded a white quartz unifacial scraper and a clear quartz triangular projectile point of uncertain age. Test pits conducted in the vicinity of these surface finds did not expose additional artifacts. It is unclear what remains of the site.

The artifact of interest is a large flake of mustard yellow jasper measuring 78 mm from platform to distal end, ca. 33 mm in width, and 18 mm in maximum thickness at the platform (Figure 1, A1). The distal end has been heavily retouched along one face to produce a steep working edge of about 70 degrees (Figure 1, A2). The lateral edges of the flake are largely unmodified.

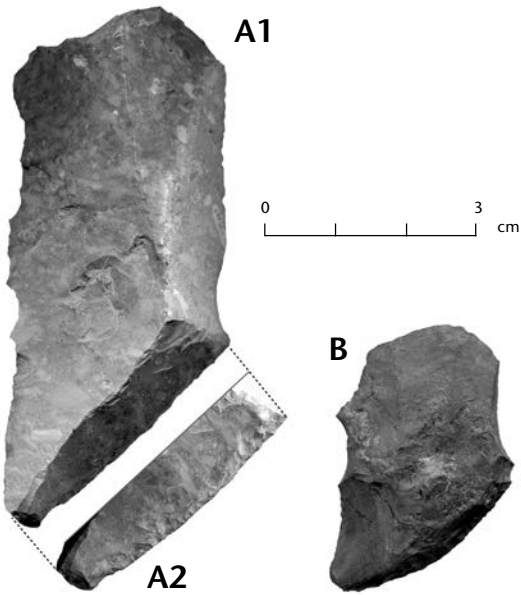

Figure 1. Jasper endscrapers from the Connecticut River valley. **A,** site 19-FR-331; **B,** Turners Falls site (19-FR-324).

A very similar artifact was recovered from the Turners Falls Paleoindian site (19-FR-324) in 2004 (Figure 1, B). The flake tool from Turners Falls is smaller, measuring 42 mm from platform to distal end, 28 mm in width, and 5 mm in maximum thickness, but is the same in form, consisting of a large flake, also of yellow jasper, that has been heavily retouched along one face of the distal end. Both artifacts thus have the same shape, are made from simple flakes of jasper, and were retouched in the same manner. The endscraper from 19-FR-324 came from a *single-component* Paleoindian locus. A high proportion of the artifacts from the Turners Falls Paleoindian loci (ca. 97 percent) are of jasper (Binzen 2005) of undetermined origin, probably from a source not as yet identified (see Spiess et al. 1998:240).

Site 19-FR-331 lies 3.6 km to the northwest of the DEDIC site (19-FR-157) (Ulrich 1978, 1979), and 12.6 km to the southwest of the Turners Falls Paleoindian site (19-FR-324) (Binzen 2005; Hasenstab 1987). The presence of jasper at two known Paleoindian sites in the immediate vicinity and the form of the tool from 19-FR-331 may indicate another locus of Paleoindian activity that has not yet been explored, and may provide additional evidence of Paleoindian presence in this part of the Connecticut River valley.

Our thanks to Kit Curran for information about the artifact collections from the DEDIC site, and the artifact illustration.

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Wisconsin-Interstadial(?), Terminal-Pleistocene, and Early-Holocene Radiocarbon Dates from the Little John Site, Southwest Yukon Territory, Canada

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➤ **Keywords**: Little John Site, Radiocarbon Dates, Southwest Yukon

The Little John site (Borden # KdVo-6) is located at the extreme southeastern edge of Pleistocene Beringia in Yukon Territory, Canada, 2 km due east of the international boundary with Alaska. The site contains evidence of human occupation from the most recent past to the terminal Pleistocene (Crossen et al. 2009; Easton 2007, 2008; Easton and MacKay 2008; Easton et al. 2007, 2008, 2009). In 2008 a well-developed paleosol representing a probable Wisconsin interstadial was discovered on the site. Here we report on the Pleistocene and early-Holocene AMS ^{14}C dates from throughout the site accumulated between 2002 and 2008 (Figure 1).

AMS ^{14}C dates on five bones from the East Lobe paleosol complex indicate an age range of 8890–10,000 RCYBP (2σ calibrated results range from 9780 to 11,760 CALYBP) for this stratigraphic unit. (For an image of the stratigraphic profile, see Crossen et al. in press.) Most of the bones from which these ^{14}C samples were drawn displayed cultural modification in the form of spiral fractures or cutmarks, and all were found in association with lithic artifacts, including formed foliate bifaces argued to be diagnostic of West's (1967) Denali complex, as well as flake cores, hammerstones, debitage, and a single microblade.[1] Based on the emergent evidence from the Little John site we are uncertain whether the cultural historical sequence of the site is coeval with the separation of human occupations in the terminal Pleistocene in the region into Denali and Nenana complexes, or their conflation, or something entirely different (Easton et al. 2009). Nonetheless, the dates from the East Lobe paleosol complex lie in the same range as those of occupations at Gerstle

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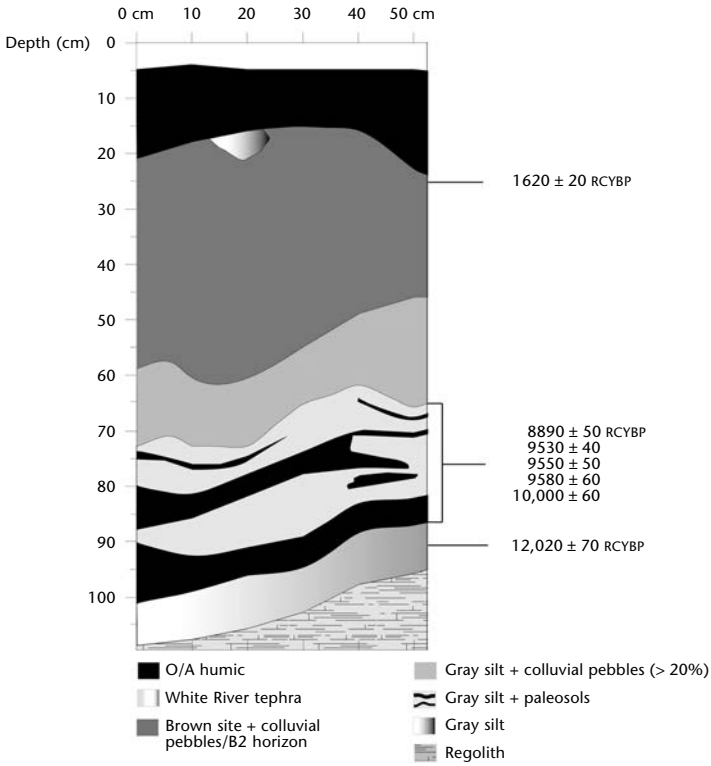
[1] We make reference here to materials recovered from the East Lobe paleosol deposits. Previously (Easton and MacKay 2008) we have tentatively tied these deposits to materials from the West Lobe, including irregular flake core fragments with microblade removal scars, scrapers, and burins; here we restrict our associations to materials from the East Lobe deposits.



Lab #	^{14}C age (RCYBP)	Calibrated2σ age (CALYBP)	Stratum	Lobe	DBS (cm)	Material	^{13}C/^{12}C (‰)	Comments
Beta 182798	8890 ± 50	10,190 – 9865, 9855 – 9780	Paleosol	East	67	Bone collagen, *Rangifer*?	-19.7	AMS
Beta-217279	9530 ± 40	11,090 – 10,930 10,880 – 10,690	Paleosol	East	70	Bone collagen, *Rangifer*	-19.8	AMS
Beta-218235	9550 ± 50	11,120 – 10,690	Paleosol	East	54.5	Bone collagen, *Cygnus* femur	-19.1	AMS
Beta-241522	9580 ± 60	11,170 – 10,700	Paleosol	East	98	Bone collagen, *Bison* radius	-20.3	AMS
Beta-241525	10,000 ± 60	11,760 – 11,250	Paleosol	East	84	Bone collagen, *Cervus* phalanx	-20.4	AMS
Beta-241523	12,020 ± 70	14,050 – 13,720	Loess below paleosol	East	85	Bone collagen, *Bison* vertebra	-19.1	AMS
Beta-231794	38,160 ± 310	n/a	Surface	Road	0	Bone collagen, ivory *Mammuthus*?	-21.2	AMS■
Beta-246741	42,480 ± 1460	n/a	Swale paleosol	Swale	250	Wood	-26.7	AMS
Beta-246711	> 46,000	n/a	Swale paleosol	Swale	280	Wood	-28.0	AMS

■Fragment eroded from hillside across road from KdVo6.

Figure 1. Stratigraphic profile of the Little John site (Borden # KdVo-6), and Pleistocene and late-Holocene AMS ^{14}C dates.

Quarry, 8760–9080 RCYBP (Potter 2005), and Cultural Zone 3 at the Broken Mammoth site, 9300–10,500 RCYBP (Holmes 1996), as well as others within West's Denali complex designation.

Two additional ^{14}C samples were also processed from the East lobe loess located below the paleosol complex (Figure 1). A *Canis* sp. humerus was found to be lacking any collagen suitable for dating, suggesting greater antiquity and a post-depositional taphonomy different from the overlying paleosol complex fauna. Dated portions of a *Bison* sp. vertebra from the East Lobe loess below the paleosol complex confirmed this suspicion, generating a date of 12,020 ± 70 RCYBP (2σ calibrated results range from 13,720 to 14,050 CALYBP). A small assemblage of lithic artifacts (a flake core, hammerstones, and debitage) has been recovered from this stratum. A new discontinuous paleosol stratum within this lower loess in the East Lobe was identified in 2008 and will be explored further in 2009. Unfortunately, no material suitable for ^{14}C dating has been recovered from the West Lobe loess stratum that holds the Chindadn/Nenana complex assemblage in the West Lobe loess.

Finally, a series of Pleistocene dates have been obtained on paleosol strata and fauna predating human occupation at the site. A fragment of ivory (presumably *Mammuthus* sp.) from a scatter of this material found eroding from a hillside across the highway from the Little John site produced a date of 38,160 ± 310 RCYBP. Additional Pleistocene fauna has been recovered in this area (recovered ca. 2 km from the site) representing specimens of *Bison* sp., *Mammuthus* sp., *Rangifer* sp., *Saiga* sp., and *Equus* sp. (Hare 1994), including an *Equus lambei* specimen, which has been ^{14}C dated to 20,660 ± 100 RCYBP (Beta-70102) (MacIntosh 1997:84). In combination, these non-cultural fauna suggest that the area about the Little John site supported a range of megafauna during the mid- to late-Wisconsin glacial period from at least 38,000 years ago.

In 2008 we excavated a trench through the northern extent of the site in which previous testing had identified a deep swale in the underlying geography. At depths of 2.5 to 3 m below surface we encountered a well-defined paleosol containing macroflora material. Subsequent AMS ^{14}C dates on wood material from this stratum produced two dates of 42,480 ± 1460 and > 46,000 RCYBP. Thus, the Little John site contains a well-preserved stratum related to either a Wisconsin Interstadial or, based on the second infinite radiocarbon date, perhaps even a Last Interglacial (ca. 130–120 Kya) ecological record; in either case, it is clear that the Little John site is offering us the opportunity to investigate a record of stratified history unparalleled to our knowledge within a single site in the interior western Subarctic that may eventually lead to a clearer perspective of the paleoecology and human occupation of the late Pleistocene in eastern Beringia. Palynological and additional studies of this stratum are ongoing. Additional excavation of the Little John site and regional survey to expand our understanding of the technological and ecological contexts of these Pleistocene and early-Holocene deposits are planned for 2009–11.

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Bird and Fish Remains from Lime Hills Cave, SW Alaska

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➤ **Keywords**: Beringia, Denali, Fauna

Lime Hills Cave is located in the Kuskokwim drainage near Lime Village, Alaska. Excavations in 1993 and 1995 produced 79 artifacts, mostly associated with an early-Holocene Denali-complex occupation dating between about 10,500 and 8000 RCYBP (Ackerman 1996; Endacott 2008). Over 29,000 faunal remains were also recovered. Most of these specimens are from mammalian taxa with smaller numbers of bird, fish, and gastropod remains (Endacott 2008; Endacott and Ackerman 2006). Faunal remains were most abundant in stratum 3, which yielded the Denali-complex component.

While identifications of the mammalian taxa from Lime Hills Cave and the site's general ^{14}C chronology and stratigraphic descriptions have been previously published (Ackerman 1996; Endacott and Ackerman 2006), the fish and bird identifications have not. Although abundant data exist to infer the large mammal prey base available to the Denali-complex inhabitants of eastern Beringia (Cinq-Mars 1979, 1990; Cinq-Mars and Morlan 1999; Dixon 1984; Endacott 2008; Endacott and Ackerman 2006; Georgina 2001; Guthrie 1990, 2006; Harington 2003; Larsen 1968; Morlan 1989; Morlan and Cinq-Mars 1982; Sattler 1991, 1997; Sattler et al. 2001; Vinson 1993), fewer data are available on bird and fish resources (for notable exceptions see Yesner 1996, 2001).

Lime Hills Cave yielded 1,006 bird remains; 303 of these specimens were identified to one of 17 taxonomic categories at the level of order or lower. These taxonomic categories are: seabirds (*Gavia* sp. NISP = 1, *Podiceps* sp. NISP = 3, *Phalacrocorax* sp. NISP = 2); waterfowl (Anserini NISP = 5, *Branta bernicula* NISP = 5, *Branta canadensis* NISP = 3, *Branta* cf. *canadensis* NISP = 1, *Anas* sp. NISP = 35, *Aythya* sp. NISP = 6, Mergini NISP = 1); shorebirds (*Pluvialis* sp. NISP = 2, *Grus canadensis* NISP = 2); gallinaceous birds (Tetraoninae cf. *Lagopus* sp. NISP = 162); gulls (*Larus* sp. NISP = 3); owls (*Bubo* cf. *virginianus* NISP = 2); woodpeckers and allies (Picidae NISP = 1) and passerine birds (Passiformes NISP = 69). All these taxa but plover and sandhill crane were recovered from the site's early-Holocene/terminal-Pleistocene stratum 3 and were likely available for exploitation by the Denali-complex inhabitants of Lime Hills Cave. It is highly unlikely, however, that the tiny passerine birds are interpretable as part of the diet of the Denali-complex inhabitants. More than likely they are simply denizens of the cave whose remains became incorporated in the sediments. The presence of duck and

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geese during deposition of stratum 3 and deeper deposits indicates that the antiquity of the North Pacific avian flyway and summer breeding areas, involving portions of Alaska, extended well back into the Pleistocene.

Approximately 637 fish specimens were recovered from Lime Hills Cave; 176 of these were identifiable to one of 10 taxonomic categories at the level of family or lower, or as comparing favorably with one of these categories. These categories are: pike (*Esox lucius* NISP = 69 and cf. *Esox lucius* NISP = 4), codfish (*Lota lota* NISP = 2), suckers (*Catostomus catostomus* NISP = 6, *Catostomus* sp. NISP = 8) salmonids (Salmonidae NISP = 1), salmon and trout (*Onchorynchus* sp. NISP = 48, cf. *Onchorynchus* sp. NISP = 11, *Salvelinus* cf. *malma* NISP = 1, *Salvelinus* sp. NISP = 2), whitefish (Coregoninae NISP = 22), grayling (*Thymallus arcticus* NISP = 1, 8 scales were also recovered from flotation samples, cf. *Thymallus arcticus* NISP = 1).

All these fish taxa were present in stratum 3 and likely available to early-Holocene/terminal-Pleistocene inhabitants of Lime Hills Cave. This suggests a greater diversity of fish resources were exploited by early Beringians than has been previously established archaeologically. Perhaps of greatest significance is the presence of salmon/trout during this period. This indicates that salmon, one of the most valuable food resources for the Native people of the region, has great antiquity in southwestern Alaska. This inference must be made with caution, since large trout and salmon cannot be distinguished by most skeletal elements. One *Onchorynchus* tooth specimen from stratum 3 is, however, too large for trout and is definitely a large salmon, possibly a Chinook (king) salmon (*Oncorhynchus tsawytscha*) (R. Wigen, pers. comm. 2005).

In sum, a variety of bird and fish species, including salmonids and migratory waterfowl, were present in the area surrounding Lime Hills Cave and undoubtedly exploited during the proliferation of the Denali-complex in eastern Beringia. In addition to the well-documented array of large mammals, these were undoubtedly valuable resources for the people of the region.

We owe debts of gratitude to too many individuals to list here, but wish to thank the staff of those institutions that provided comparative material for our identifications. These institutions are: 1) the Conner Zoological Museum at Washington State University; 2) Burke Museum at the University of Washington; 3) University of Alaska Museum; 4) Pacific Identification; 5) Museum of Vertebrate Zoology at University of California at Berkeley and 6) zooarchaeology laboratory, Department of Anthropology, Washington State University. A. Ruter's (1999) work on site stratigraphy and pollen sequence is invaluable to our understanding of the cave's depositional history. D. Georgina (2001) preliminarily identified a portion of the data presented here. The National Science Foundation AMS ^{14}C dating facility at the University of Arizona allowed free dating of 15 samples.

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A 9,000-year-old Paleocoastal Shell Midden at CA-SMI-527, San Miguel Island, California

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➤ **Keywords**: Early Holocene, Shell Midden, Northern Channel Islands

In recent years, archaeological surveys along the northwest coast of California's San Miguel Island have identified several early-Holocene shell middens dated between ca. 10,200 and 8500 CALYBP (Erlandson and Braje 2007; Erlandson and Rick 2002; Erlandson et al. 2004, 2009). These sites have provided important new data on the settlement, subsistence, and technologies of some of the earliest maritime peoples in North America. In this paper, we report on another Paleocoastal shell midden from northwest San Miguel, CA-SMI-527, with a basal component dated to roughly 8900 CALYBP.

Located near the west end of San Miguel Island, CA-SMI-527 is a large multicomponent shell midden where several discrete loci have been identified eroding from a long linear sand dune. In 2005, Erlandson discovered a small low-density shell midden eroding from a deeply buried paleosol exposed in the sea cliff at the north end of the site. The stratigraphic context of this locus—formed in a weakly developed dune paleosol about 1 m above the terminal-Pleistocene Simonton Soil (Erlandson et al. 2005)—suggested that the midden dated to the early Holocene. Analysis of a well-preserved California mussel (*Mytilus californianus*) shell from the midden confirmed our age estimate, producing a conventional ^{14}C age of 8560 ± 80 (Beta-218875) RCYBP and a calibrated age range ($\Delta R = 150 \pm 25$) of 9070–8880 CALYBP. This date suggests that dune building began in this location prior to about 9,000 years ago.

In 2007 Erlandson, Braje, and Watts returned to the site with Chumash tribal consultant Gilbert Unzueta to evaluate the effects of marine erosion on this early component. We found that erosion had removed roughly 1 m of the site, removing a thin and sparse midden about 3 m wide, but exposing a denser midden feature embedded in a 1-by-1-m patch of very dark dune soil. Because the destruction of this feature was imminent, we excavated 28 l of sandy soil containing numerous shell fragments and small flecks of charcoal. We screened this sample over 1/16-inch mesh in the field and transported the remnants to the University of Oregon (UO) for detailed analysis. At the UO, the sample was screened over 1/8-inch mesh; the residues were sorted into broad categories and shellfish remains identified to the most specific taxon possible.

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Field observations of eroding sea cliff exposures in 2005 and 2007 suggested that the Paleocoastal component at CA-SMI-527 represented a short-term occupation by a small group of people. The excavated sample supports this idea, producing no artifacts or animal bone, 690.7 g of marine shell (MNI = 47), 82.2 g of land snail (*Helminthoglypytes ayresiana*) shell, and small amounts of charcoal. Within the marine shell sample recovered, California mussel (646.5 g, 93.6 percent) dominates the assemblage, followed by small acorn barnacles (*Balanus* sp.; 17.2 g, 2.5 percent), owl limpet (*Lottia gigantea;* 14.7 g, 2.1 percent), unidentified shell (7.7 g, 1.1 percent), and the remains of four other taxa (black abalone, *Haliotis cracherodii;* black turban, *Tegula funebralis;* volcano limpet, *Fissurella volcano;* and tube worm shell, *Squamigerus* spp.) found in trace amounts. Only a few of these taxa are likely food remains including the mussels, limpets (*Lottia*, *Fissurella*), abalone (*Haliotis*), and turbans (*Tegula*). The others are epifauna commonly found attached to the larger taxa. Although land snails were relatively abundant in the feature, they also seem likely to be a natural site constituent. They are notoriously difficult to collect alive on San Miguel Island, for instance, and their shells are distributed relatively evenly through the paleosol and adjacent dune deposits—as well as other non-cultural island soils—where their fragile shells are rarely burned or broken.

An unknown amount of this 9000-year-old site has been lost to erosion, and other site deposits may lie hidden below the large dune ridge to the south. What we know about this Paleocoastal component, however, especially compared with other early shell middens studied in the area (see Erlandson and Rick 2002; Erlandson et al. 2004, 2008), suggests that it was a short-term campsite—perhaps similar to briefly occupied "dinner-time camps" described by Meehan (1982) for the Anbarra of Australia—located some distance inland from the early-Holocene coast. Nearby springs may have attracted early maritime peoples to this inland or pericoastal locale.

Although the sample recovered from CA-SMI-527 is small, it adds to our knowledge of the highly variable location, structure, and contents of Paleocoastal sites on the Channel Islands and the California Coast (see Erlandson, Moss, et al. 2008). It also adds to the growing evidence for a relatively substantial population of early maritime peoples on San Miguel Island, where terrestrial foods were limited but marine resources appear to have been both diverse and abundant. As coastal erosion proceeds, we will continue to monitor CA-SMI-527 in the hopes of gaining further insights into the structure and contents of this Paleocoastal shell midden as well as the nature of early-Holocene ecosystems on San Miguel Island.

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Four Additional Fluted Points from Jakes Valley, Nevada

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➤ **Keywords**: Paleoindian, Lithic Analysis, Great Basin

Archaeological investigation conducted by the University of Nevada, Reno, recovered one complete and two fragmentary fluted points from surface contexts during pedestrian survey of areas adjacent to the Jakes Valley playa, located in eastern Nevada in 2006 (Estes 2008, 2009; Estes and Goebel 2007). Another fluted-point fragment was identified during reanalysis of Paleoindian surface assemblages collected in 2003 from Jakes Valley (Estes 2009). These four pieces are described below. Previously, six other fluted points from Jakes Valley were recovered in 2002–03 and have been described elsewhere (Rondeau 2006; Rondeau et al. 2007).

The single-component Paleoindian site 26Wp7729 yielded two fluted points, one complete and one fragmentary. Specimen 7729-1, a complete though highly resharpened fluted point, is made from a tan/brown-colored cryptocrystalline silicate (CCS) with a deeply concave base and one broken ear (Figure 1A). It measures 49 mm long, 30 mm wide, 9 mm thick, and has a basal depth of 5 mm and basal width of 21 mm. This specimen exhibits two flute scars on the obverse face and one on the reverse face; none show abrasion or scratches. Both lateral margins and the base are ground. An impact fracture scar running from the tip of the obverse side is overlapped by point tip retouch scars and one of the flute scars, indicating that this specimen was resharpened and refluted.

The second specimen 7729-4, a basal corner fragment, is made of a semi-translucent, light gray-colored CCS with dark speckles (Figure 1B). It measures 18 mm long, 22 mm wide, 6 mm thick, and has a basal depth of 5 mm. It exhibits one flute scar on the obverse face and two on the reverse face, all of

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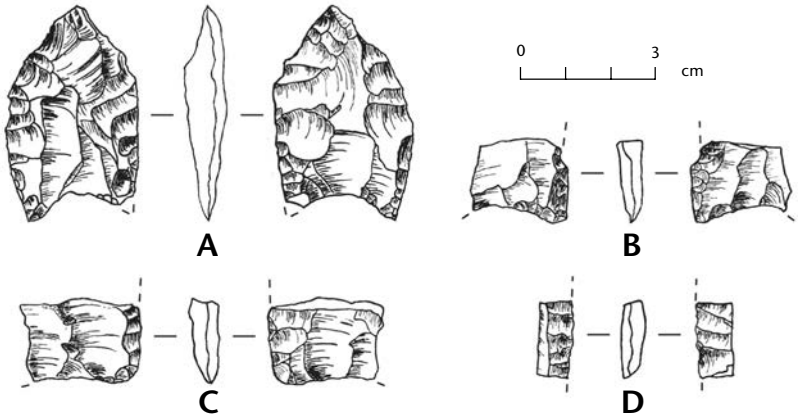

Figure 1. Fluted points recovered from Paleoindian sites in Jakes Valley: **A,** 7729-1; **B,** 7729-4; **C,** 7735-4; and **D,** 1177-18. Illustration by Mark B. Estes.

which are truncated by the transverse break; none show abrasion or scratches. The intact lateral and basal margins are ground.

A fluted-point fragment was recovered from the single-component Paleoindian site 26Wp7735. Specimen 7735-4, a basal corner fragment, is made of a deep orange-colored CCS with white mottling and several inclusions that may have contributed to its failure (Figure 1C). It measures 17 mm long, 25 mm wide, 7 mm thick, and has a basal depth of 2 mm. This specimen has two flute scars on the obverse face and one on the reverse face, all of which are truncated by the transverse break; none show abrasion or scratches. The intact portions of the lateral and basal margins have edge grinding.

The multicomponent Paleoindian site 26Wp1177 yielded a single fluted-point fragment and five stemmed-point fragments (Estes 2009). Specimen 1177-18, a lateral margin fragment made of Modena obsidian (Figure 1D), was discovered during reanalysis of Paleoindian assemblages collected in 2003. It measures 17 mm long, 8 mm wide, and 6 mm thick. This lightly ground edge fragment exhibits a flute scar on one face (showing no abrasions or scratches) that truncates five edge-trimming scars.

Four fluted points from Jakes Valley have been described herein. The analysis and reporting of these artifacts adds to the growing fluted-point database for Jakes Valley and the Great Basin (see Taylor 2003) and may contribute to studies of Paleoindian technology and migrations (Beck and Jones 2007).

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Last Canyon Cave: Late-Pleistocene Fauna and People

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➤ **Keywords**: Early Paleoindians, Paleoenvironments, Rockshelters

Last Canyon Cave is a small rockshelter (approximately 30 m^2) in the southwest foothills of the Pryor Mountains of south-central Montana. The unremarkable shelter was first recorded during an archaeological survey of the Pryor Mountains (Loendorf 1974). At the time a looter's hole had been dug in the center of the shelter and 1.3 m of sediment depth was noted. Cultural material was observed, but its nature was not identified. Last Canyon Cave might have been forgotten were it not for Glade Haden of the Bureau of Land Management (BLM), who noted looting in the shelter in 2004. Based on this observation the BLM requested an evaluation of the site. So far the investigation consists of removing the loose sediment from the looted hole (derived from sloughing of the pit walls after the looting), screening the removed sediment and recovering the content, cleaning the walls of the pit for photographing and profiling, sampling the intact profiles for sediment and ^{14}C analysis, and analyzing the recovered material for content and age.

The approximately 1,000 liters of disturbed sediment produced 4 chipped

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stone items and 530 bones. About half the bone was not identifiable to species or element, being composed of cancellous or other indistinct fragments. However, 278 specimens could be identified to element and some of these could also be identified to species or animal body size class (Brain 1981). Seven taxa are represented in the sample: bird (raptor), *Neotoma* spp., *Spermophilus elegans*, *Lepus* spp., *Sylvilagus nuttallii*, *Ovis catclawensis* (based on the size of the distal tibia that is larger than any modern, even large male, comparative specimen), and *Equus* sp. At least one of these (sheep) is a Pleistocene species. About one quarter of the bone was burned; however, no clear human contribution to the bone assemblage could be established (such as cutmarks, impact fractures, or bone flakes). On the other hand, the only burned areas in the profiles were two cultural features, a hearth and another burned area of unclear function. The zooarchaeological analysis identified five potential depositional contexts on the basis of bone color, rodent gnawing, burning, carnivore damage, and digenetic condition. Controlled excavation will be required to verify the veracity of these contexts. The hearth and the burned area are on top of stratum 2c dating to 11,000 RCYBP (Beta 242806; all dates are presented as uncorrected RCYBP). The burned area is indistinct; however, the hearth is basin shaped and at least partially covered with stratum 2d. Both are overlain with stratum 3, a more recent packrat midden.

Other ^{14}C assays yielded dates from 39,570 ± 800 RCYBP (Beta-242808) on bighorn sheep dung from the second stratum from the bottom to 120 ± 40 RCYBP (Beta-242810) from an amberized packrat midden on the surface. Most interesting are the assays on horse bone (13,860 ± 50 RCYBP, Beta-242809) and hearth charcoal (10,860 ± 40 RCYBP, Beta-242805). The former demonstrates that the specimen is of Pleistocene age, while the hearth indicates an early-Paleoindian occupation of the shelter. The Pleistocene dates on the bottom of the stratigraphic sequence indicate that the shelter has been accumulating sediments since about 40,000 RCYBP. The dated horse bone and Pleistocene bighorn sheep bones, as well as the sheep and possibly other animal feces, the latter in sediment as old as 40,000 RCYBP, are evidence of early use of the shelter by animals. The dates suggest continuous accumulation of the sediment in the shelter without evidence of erosion.

In conclusion, Last Canyon contains evidence of early-Paleoindian occupation of about 10,900 RCYBP, possibly later-Holocene human occupation (the chipped stone of unknown age), and a Pleistocene faunal record in a rockshelter of the Bighorn region of the central Rocky Mountains. Along with False Cougar Cave, Natural Trap Cave, and the smaller samples from Juniper Cave, and Little Canyon Creek Cave, Last Canyon Cave gives us another window into late-Pleistocene fauna and paleoenvironments (Bonnichsen 1979; Martin and Gilbert 1978; Ostrom 2006; Shaw 1982). The abundant fecal material from as early as 40,000 RCYBP will allow reconstruction of dietary composition, DNA, and other important studies informative of the region's paleoecology and paleoclimatic conditions that accompanied the arrival of the First Americans.

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Exotic Clovis Stone Tools from the Topper Site, 38AL23, Allendale County, South Carolina

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➤ **Keywords**: Clovis, Topper, American Southeast

Excavations at the Topper site in Allendale County, South Carolina, have yielded abundant chert artifacts related to Clovis quarrying, manufacturing and tool-using activities (Goodyear et al. 2007; Miller 2007). As of 2008, counting units on the terrace area and the hillside area overlooking the terrace, 578 m^2 has been excavated. Chert outcrops at the site at the eroding escarpment and in the river bed. Topper chert is described petrologically as a silicified grain stone from the Tertiary Flint River formation and is a member of the Allendale type (Upchurch 1984). This report summarizes the incidence of non-chert Clovis tools foreign to the site.

The exotics are represented by five metavolcanic artifacts and one quartz crystal artifact (Figure 1). These raw materials were checked against the lithic raw-material type collection curated at the South Carolina Institute of Archaeology and Anthropology, maintained by K. Derting.

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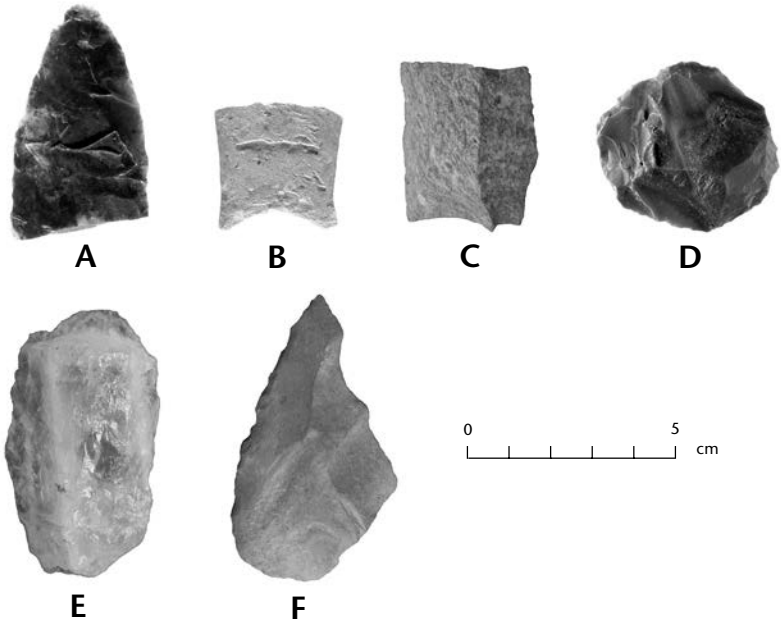

Figure 1. Exotic Clovis stone tools from excavated contexts at the Topper site, 38AL23.

Of the six artifacts, two fragments of Clovis points on exotic material have been recovered at Topper to date. One is the distal portion (Figure 1A) of a point (SC495) found in the terrace area. It is made of an unweathered black fine-grained rhyolite. The other is a Clovis base (SC489) (Figure 1B) made of a weathered porphyritic rhyolite with inclusions of quartz, feldspar, and iron pyrite. This base is from the hillside excavations. The three remaining metavolcanic artifacts, all from the hillside, are made of fine-grained tuffs. One of these (Figure 1C), on a differentially crystallized tuff, is the medial section of a flake, possibly a prismatic blade since it has three parallel scars. It is not retouched and macroscopically appears unused. The second (Figure 1D) is an endscraper on a flake made of dark green welded vitric tuff (Novick 1978:428). The material is very fine grained, unweathered, and translucent on the edges. The third (Figure 1F) is a lighter green, fine-grained tuff similar to Figure 1D, described above. It is unifacially retouched along the left margin with evidence of heavy wear damage on the right margin. The entire artifact feels dull, probably from use and transport. The last item (Figure 1E) is a quartz crystal flake from the hillside with expedient unifacial retouch on the left margin and distal end.

All the metavolcanics could be from the Uwharrie Mountains area of the central North Carolina Piedmont (cf. Daniel 1998). Quartz crystal is abundant in the Piedmont of Georgia and the Carolinas. Rhyolite origins are less definitive, since quarries are also known in the western South Carolina Piedmont. The three pieces made of tuff, however, are strongly suspected to be

from the Uwharrie Mountains area of North Carolina. Green tuff outcrops are known from near Ashboro, North Carolina (E. Poplin, pers. comm. 2009). If some of the artifacts described here came from the Uwharries, transport over a distance of 250–350 km is indicated. Since non-chert debitage is extremely rare at Topper (e.g., Miller 2007), all these pieces were likely carried in and discarded once at the quarry. As such, they may be as informative about where people came from as what they were used for at Topper.

We thank the members of the Allendale Paleoamerican Expedition, Clariant Corporation, owners of the Topper site, and Daryl P. Miller for photography.

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Clovis Obsidian Sources in the Central Rio Grande Rift Region of New Mexico

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➤ **Keywords**: Clovis, Obsidian, Rio Grande

Recent analyses of privately held collections (Hamilton 2008; Hill, et al. 2007) and excavations at Mockingbird Gap (Holliday, et al. 2009; Huckell, et al. 2008; Huckell, et al. 2007; Huckell, et al. 2006) indicate a substantial Clovis occupation of the central Rio Grande Rift region of New Mexico. Clovis tool-

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stone raw materials include various cherts, chalcedonies, and quartzites, but are dominated by rhyolites and obsidians, which are available throughout this part of the western Cordillera owing to a long geological history of volcanism, caldera formation, crustal extension, and block-faulting (Baldridge, et al. 1995). In this paper we report the results of sourcing 18 obsidian artifacts (15 point fragments and 3 flakes) from 3 Clovis assemblages from the central Rio Grande Rift region of the southwestern United States. The points are from the Robert H. Weber collection, and include 10 Clovis point fragments from the Mockingbird Gap surface collection, and 5 point fragments from Socorro and Catron counties in west central New Mexico. The three flakes were recovered in situ during the 2007 field season excavations at Mockingbird Gap (Huckell, et al. 2008). The artifacts were chemically characterized using energy-dispersive X-ray fluorescence (EDXRF) by the Geoarchaeological XRF lab at University of California, Berkeley (Shackley 2006). All artifacts were traced to known sources (Figure 1), including Cerro Toledo rhyolite, El Rechuelos, and Valles rhyolite from the Jemez Mountains of New Mexico (ca. 250 km from Mockingbird Gap), Grants Ridge obsidian, from Mt. Taylor, New Mexico (ca. 180 km), and Cow Canyon in east-central Arizona, (> 400 km) (Shackley 2005).

There was considerable overlap among obsidian sources across the three assemblages. Eight artifacts from Mockingbird Gap were sourced to the Jemez Mountains (six Cerro Toledo rhyolite and two Valles rhyolite), one to Mt. Taylor, and one to Cow Canyon. Four of the Socorro-Catron counties points were sourced to the Jemez Mountains (two Cerro Toledo rhyolite, and two El Rechuelos), and one to Cow Canyon. From the excavated sample, all three flakes sourced to Mt. Taylor, and a fourth was provisionally identified as Cerro Toledo rhyolite, but was too small for conclusive assignment. The Cow Canyon source is particularly interesting since it is also the principal source of obsidian recovered at the Murray Springs Clovis site, Arizona (Shackley 2007, Shackley 2008), and is present in both the Mockingbird Gap and survey assemblages. Whether this shared obsidian source indicates direct contact between Clovis populations in the Rio Grande Valley and the San Pedro River valley, or simply overlapping knowledge of a high-quality toolstone source is unknown.

Obsidian nodules from the Mount Taylor source are available in secondary contexts along the Rio Salado, and small obsidian nodules from both the Cerro Toledo and El Ruechelos sources are available in secondary contexts within the Tertiary-Quaternary alluvium along the Rio Grande, though not large enough for point manufacture as far south as Socorro (Church 2000; Shackley 2005). However, the Valles rhyolite obsidian is only available in the Valles Caldera, requiring direct procurement from the source.

The distribution of obsidian toolstone sources indicates that Clovis hunter-gatherers in the central Rio Grande Rift region had extensive knowledge of a wide region, including the Mogollon Rim country, the southern Rockies, the various mountain ranges west of the Rio Grande Valley, and the Valley itself. Indeed, these sources include many of the highest-quality obsidian sources in the region. Future toolstone sourcing of these assemblages will focus on the most dominant raw material, "Socorro Jasper", a silicified rhyolite with multiple sources in the mountains west and southwest of Socorro (Dello-Russo 2004).

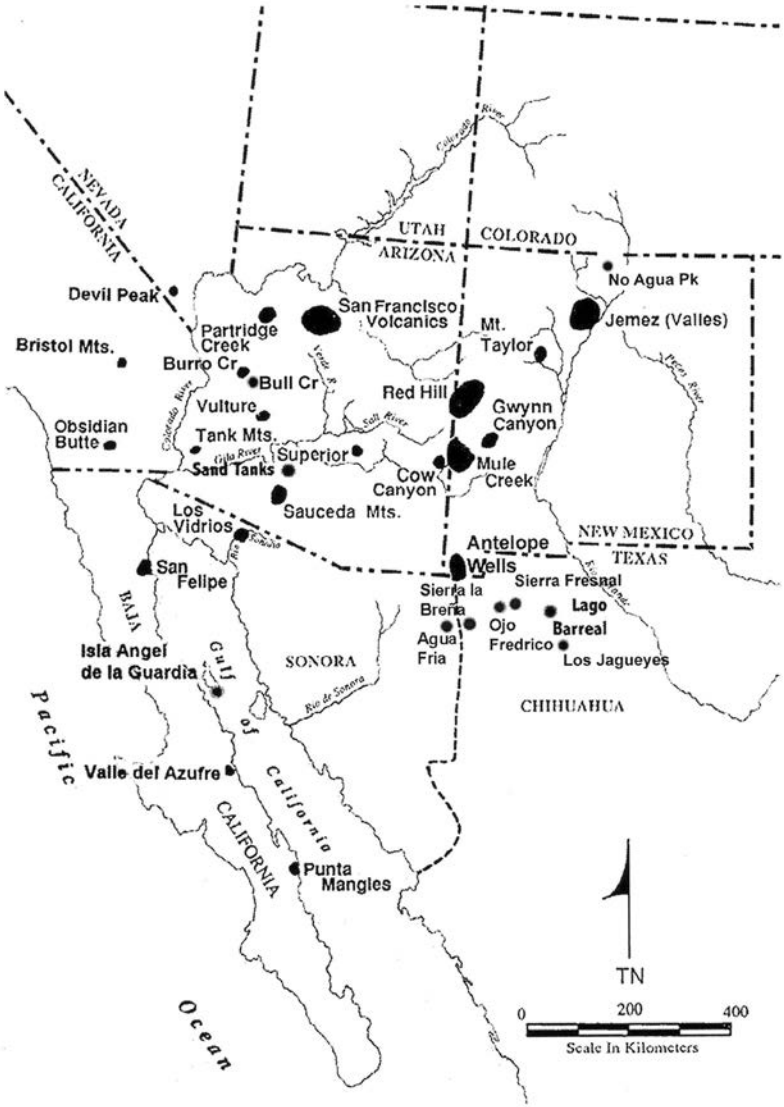

Figure 1. Known obsidian sources in the southwestern United States and northern Mexico,

First and foremost, we are indebted to the late Robert H. Weber for loan of the Clovis points used for this analysis. MJH gratefully acknowledges the Arizona Archaeological and Historical Society for a small grant that supported the costs of XRF.

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A Beveled Bone Rod from the Cody Component of the Lindenmeier Site

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➤ **Keywords**: Beveled Rods, Bone Technology, Lindenmeier Site

A beveled bone rod, similar to those found at several North American Paleoindian sites (Cotter 1937; Frison 1982; Jenks and Simpson 1941; Lahren and

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Bonnichsen 1974; Rainey 1940; Wilmeth 1968), was recently identified in the collection from the Lindenmeier site curated by the Denver Museum of Nature & Science, (DMNS). Lindenmeier is located in Larimer County, Colorado, USA. It is a multicomponent site featuring a Folsom campsite and associated bison kill dated to 10,660 ± 60 RCYBP (Haynes et. al. 1992). The beveled rod was excavated in 1935 by the Colorado Museum of Natural History, now DMNS, with John L. Cotter as the field supervisor, in cooperation with the Smithsonian Institution.

Based upon DMNS accession records, Cotter's field notes, and published data, the authors confirmed that two bone pieces found in Hole 13 and described as a bone awl in Cotter's published report (Cotter 1978), are the beveled bone rod in the DMNS collection. Though Cotter's records are not specific, almost all artifacts found in Hole 13 came from the base of the cultural layer.

The beveled bone rod is 175 mm long and 13.6 mm wide. It is made of cortical limb bone from an unknown species (Figure 1). It is oval in cross section with a maximum thickness of 10 mm (center). The bevel length is 41.5 mm. A snap fracture at the proximal end of the rod has removed part of the bevel. Like Clovis-age beveled rods, the artifact features crosshatching on the beveled end,

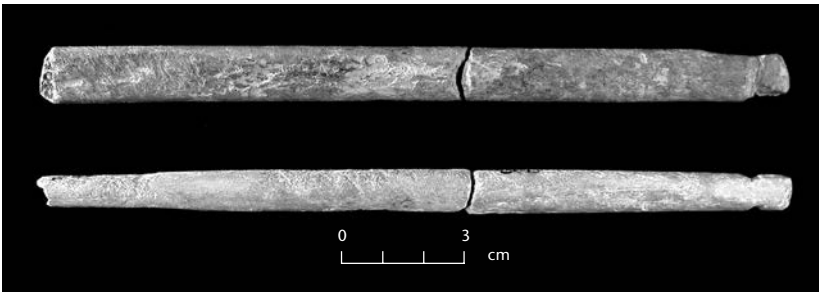

Figure 1. Beveled and lateral surfaces of the beveled bone rod recovered from the Cody component of the Lindenmeier site, Larimer County, Colorado.

highly polished areas indicative of use, and exposed cancellous bone near the bevel (Lyman et al. 1998; Redmond and Tankersley 2005). The tapered distal end has circumferential grooving and a shallow, concave area on the lateral surface. These two features have not been associated with Clovis-age beveled rods and are perhaps indicative of modification after manufacture.

Initial radiocarbon dating indicates an age of 9590 ± 35 RCYBP (NZA-29492). This date is consistent with Cody complex artifacts excavated from Hole 13 at Lindenmeier (LaBelle and Holen 2008). No beveled rod artifacts have previously been reported from Cody complex sites.

An age of 10,305 ± 15 RCYBP was recently obtained from the Agate Basin Sheaman beveled rod (Waters and Stafford 2007). These two dates support the hypothesis that beveled rod technology extended to other, more recent Paleoindian cultural complexes.

Beveled rods are proposed to have functioned as projectile points (Hester

1972), parts of composite flaking tools (Wilke et al. 1991), expedient prybars (Saunders and Daeschler 1994), and as foreshafts fitted to fluted points (Cotter 1938). The discovery of beveled rods associated with technological complexes that lack fluted points raises questions for further research as to their function.

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Beach: A Clovis Cache in Southwestern North Dakota

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➤ **Keywords**: Cache, Clovis, North Dakota

The most memorable outcome of Alan Miller's 1970 pheasant hunt turned out not to be birds but a large red porcellanite biface in a plowed field some 15 km northeast of Beach, southwestern North Dakota. Miller returned to the field several times over the next five years ultimately recovering 56 artifacts. In 1975, landowner Donald Abernethy and two friends discovered and excavated a series of small pits in a 4- to 5-m-diameter area of the field, each containing 8–10 bifaces; their efforts yielded 80 bifaces. Both Miller and Abernethy made unsuccessful efforts to learn more about their discoveries. In 2005, the cache was brought to our attention, and a 2006 visit convinced us that it was Clovis. The Beach Cache, as we named it, originally consisted of at least 136 artifacts; we have studied 103 that remain and conducted limited excavations at the find spot.

The Beach Cache was found in an unremarkable portion of the Missouri Plateau physiographic region, in a rolling ridge-and-swale landscape. It is positioned on the crown of a gently eastward-sloping ridge in a small spring-fed drainage headwaters area. Shallow plowing exposed the cache, dislodging the uppermost artifacts in the pits and scattering them downslope; artifacts deeper in the pits were left undisturbed. The organization of the cache into multiple small pits is unprecedented, and we are uncertain if it reflects a single or multiple episodes of caching. Fieldwork in 2007 verified the cache location through recovery of two surface artifacts including a biface fragment that refits to one found by Miller, and a large blade-like flake. Excavations produced the proximal portion of a blade and one piece of debitage.

Of the 103 extant artifacts, 99 are bifaces and 4 are blades; no fluted points were recovered. Of the 84 complete and 15 fragmentary bifaces, 4 display careful secondary finishing; the rest are preforms. We identify the cache as Clovis based on the frequent use of overshot flaking for biface manufacture. Nearly 67 percent of the complete bifaces display at least one overshot or near-overshot terminated flake on one face; almost 30 percent display overshot flakes on both faces. In addition, the cache contains four blade tools, and the three that retain striking platforms display the features typical of Clovis blade manufacture (Collins 1999).

The bifaces are primarily (56 percent) made of White River Group Silicates (WRGS) (Hoard et al. 1992, 1993); also represented are Rainy Buttes silicified wood (85 km to the southeast; Loendorf et al. 1984) at 10 percent, quartzite

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(possibly from Spanish Diggings or Black Hills sources) at 12 percent, and porcellanite at 3 percent; chert, agate, and petrified wood from unknown sources make up the remainder. A major source of WRGS chert lies atop and around Sentinel Butte (Blikre 1993) some 20 km southeast of the cache; this chert is a good visual match for the cache bifaces, and we hope that neutron activation analysis underway will determine whether it was the source of the chert. One of the blade tools is made of dendritic yellow chert, possibly derived from the Hartville Uplift, and two others are of Rainy Buttes silicified wood. The WRGS bifaces are the smallest in the cache, 61–132 mm long and 31–76 mm wide. Despite their small size, they exhibit overshot flaking at almost exactly the same frequency as the cache as a whole. The porcellanite, quartzite, and two Rainy Buttes bifaces are the largest, 150–303 mm long and 71–111 mm wide. Two overshot-flaked porcellanite bifaces are shown in Figure 1. Porcellanite is widely available on the northern Plains, principally in Wyoming and Montana but extending into western North Dakota as well.

At slightly more than 47° N latitude, the Beach Cache is one of the most northerly Clovis caches currently known. Given the raw materials in it that can be specifically or generally sourced, the cache appears to have been emplaced by a group moving in a northward direction. Kilby (2008) has demonstrated

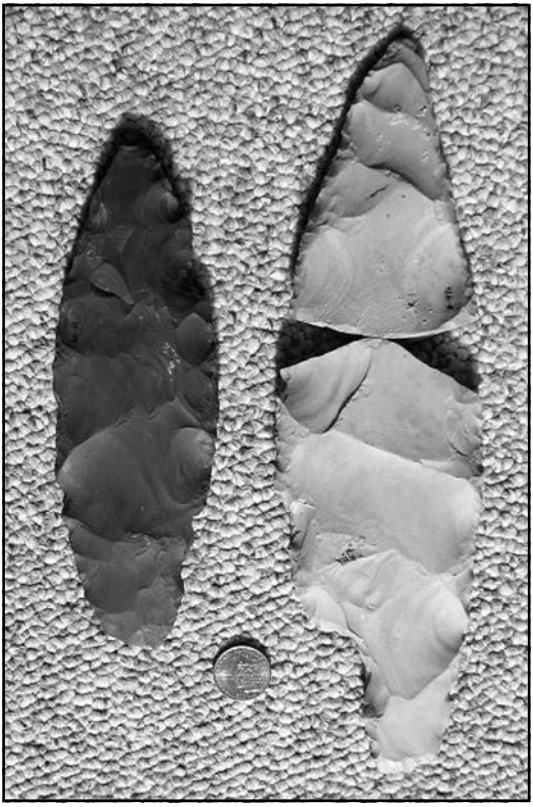

Figure 1. Porcellanite bifaces from the Beach Cache that exhibit overshot flaking. The coin in the image is a nickel.

that many of the known caches reflect this same pattern, with lithic materials being carried northward from sources to the cache location. This may reflect Clovis groups moving northward with the spring and summer, provisioning the landscape with caches of partially worked stone where no high-quality stone is otherwise available.

First and foremost we are indebted to Alan Miller, Donald Abernethy, Bob Jagd, and Ted Trinka for permitting us to study the Beach Cache specimens, and to Don for permission to excavate in the field where the cache came to light. The 2007 and 2008 field work was generously supported by the National Geographic Society (grants 8232-07 and 8531-08). Gary Vaughn brought the cache to our attention, helped immensely with local arrangements, and freely volunteered his labor. Fern Swenson and Paul Picha, State Historical Society of North Dakota, helped us through the permitting process. Thanks to UNM graduate students Caroline Gabe, Chris Merriman, and Christina Sinkovec for their dedicated work in the field.

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San Patrice Projectile Points from the Hardwick Site, a Paleoindian Locality on the Southern High Plains of New Mexico

Stance Hurst, Jim Warnica, and Eileen Johnson

➤ **Keywords**: San Patrice, Hardwick Site, Southern High Plains

The highest density of San Patrice points occurs in the woodlands of eastern Texas and Louisiana, and the region has been denoted as the San Patrice

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"heartland" (Story 1990). Based on the heartland perspective, San Patrice is described as a woodland adaptation suggesting less mobility compared with western Plains hunter-gatherers (Ensor 1986). San Patrice points, however, also are found on the Plains (Jennings 2008a, 2008b; Wyckoff 2008). They are associated with bison kills at Howard Gully (Hurst 2007) and Rex Rodgers (Hughes and Willey 1978) indicating San Patrice was also a Plains adaptation.

The Hardwick San Patrice site is located in New Mexico ca. 2.5 km east of the Clovis site (Hester 1972; Howard 1935) and 1 km north of Blackwater Draw. The site is situated on the uplands within a dune deposit. Most of the artifacts come from a blow-out area and were collected in the 1970s.

Four San Patrice projectile points have been found at Hardwick (Figure 1D). All four San Patrice are of the St. Johns variety (Lopinot et al. 2000) and made from Edwards Formation chert. Only point 1D is not basally ground. The blade of point 1A has no evidence of beveling. One to two large thinning

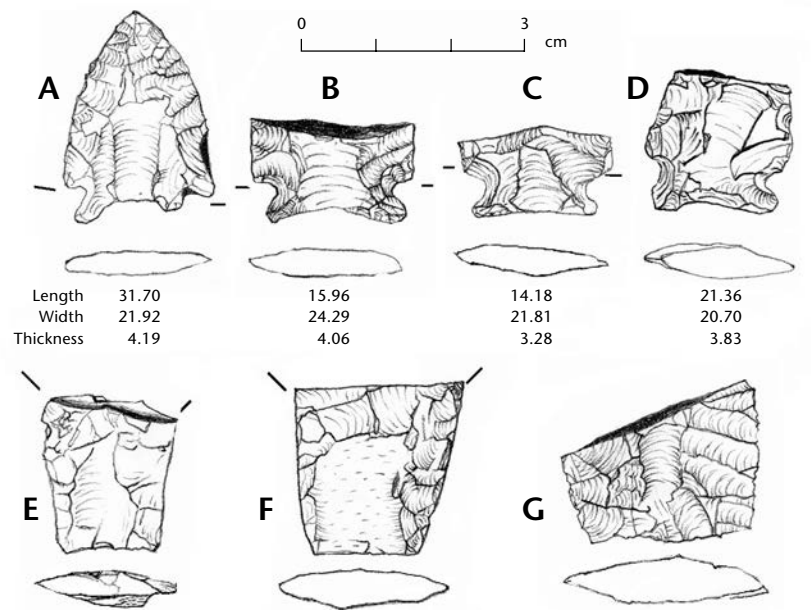

Figure 1. Paleoindian projectile points from the Hardwick site: **A–D,** St. Johns variety San Patrice points; **E–F,** late-Paleoindian points; **G,** Paleoindian point perform. Tick marks delineate limit of basal grinding. All dimensions are in millimeters.

flakes on each face have been detached for thinning the bases, except for one side of point 1C. On point 1C, a remnant ventral flake surface demonstrates this point was manufactured from a flake blank.

The remainder of the collection consists of two late-Paleoindian lanceolate projectile points (Figure 1E–F), one Paleoindian preform (Figure 1G), one Ceramic-age point, 5 biface fragments, 75 unifaces, 14 gravers, 1,234 debitage pieces (among them 64 biface thinning flakes), and 6 unidentifiable mammalian-bone fragments. Most of the unifaces and gravers are formalized and

resemble Paleoindian forms (Boldurian and Cotter 1999:41–42), but these cannot be directly linked to the San Patrice occupation. No diagnostic debitage of projectile-point manufacturing has been recovered. More than 93 percent of the artifacts are manufactured from Edwards Formation chert that outcrops over 250 km to the southeast. Alibates agatized dolomite, Potter quartzite, Tecovas jasper, and other unsourced cherts and quartzites also occur. Fewer than 20 percent of the artifacts possess cortex, suggesting most of the raw material was carried to the site in partially reduced form.

Hardwick is the westernmost San Patrice site recorded to date. Its location along the western edge of the southern High Plains is significant for further demonstrating San Patrice was also a Plains adaptation (Hurst 2007; Jennings 2008b). New sites in context are needed with dateable materials to establish the chronological relationship between Plains and Woodland San Patrice foragers and the technological connections between San Patrice and other Paleoindian point types. The study of San Patrice foragers has great potential for discerning how hunter-gatherers adapted to the changing environments of the early Holocene (Jennings 2008b).

Special thanks to Sophie Butler for illustrating the projectile points. The manuscript represents part of the ongoing Lubbock Lake Landmark regional research program into grasslands, hunter-gatherers, and adaptations to ecological change on the Southern Plains.

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Folsom Bone Preservation at the Nash Site, a Waterlogged Context on the Southern High Plains

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➤ **Keywords**: Burial Environment, Folsom, Southern High Plains

The Nash site (41LU35) is an extensive stratified, multicomponent valley site in Yellowhouse Draw in the southeastern portion of the Southern High Plains. The site is 1.5 km downstream from the Lubbock Lake Landmark (Holliday 1995; Johnson 1987) and shares a similar stratigraphy and cultural record (Johnson and Stafford 1976; Stafford 1981).

During initial fieldwork in the 1970s, an ephemeral Yellowhouse Creek flowed through the valley axis. Site deposits were dry and the water table below stratum 1. These conditions allowed for the recovery of a well-stratified assemblage, including faunal remains from Paleoindian strata 1 and 2. Shortly afterwards, the site was impacted by dredging and impoundment to create Canyon Lakes 2, one of several artificial lakes constructed by the City of Lubbock in the Yellowhouse system. The site area was submerged.

Almost 30 years later, the opportunity to assess site condition through trenching along the lake margins indicated much of the middle- and late-Holocene record had been destroyed. The early-Holocene and late-Pleistocene record had been impacted, but intact deposits still existed. Those deposits, while under the water table, could be considered preserved in situ. Among other things, research revealed very different bone preservation patterns (Backhouse et al. 2008).

The Nash site Folsom period bones (lower stratum 2) recovered in 1975 were stable and had came from what was then dry deposits. Those recovered during the recent investigation had a chalky surface and exhibited extreme fragility. Some were only shadows of bone and unrecoverable. Those bones that were recoverable required intensive conservation (Willett 2006). A sediment sample taken from buried deposits associated with the collected bone was the same deposit that encased the Folsom bone bed identified in 1975. Chemical constituent testing (Willett 2006) showed a pH of 8.1, well within

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the indicated range for good bone preservation (6.1–8.3; Child 1995). In waterlogged conditions, however, a pH of 6 to 8 can affect collagen adversely (O'Connor 2000).

Salts range from moderate to very high. High magnesium and potassium values appear to indicate the hydrolysis of hydroxyapatite. Moderate levels of calcium in the sediment indicate some leaching of the bone (Willett 2006). High P2 values are associated with dissolution activities, providing additional evidence of the translocation of bone mineral constituents. While bone associated with highly organic waterlogged deposits generally is well preserved, the organic matter percentage for the lower 2 deposits is very low. The various lines of evidence indicate that most likely both the organic and mineral constituents are being removed from the bone, weakening bone structure and increasing bone fragility.

Results from a broad investigation of bone degradation across the European Holocene (Nielsen-Marsh et al. 2007; Smith et al. 2007) identify type 4 bone, that of catastrophic mineral dissolution, as associated with a dissolution trajectory (Pike et al. 2001; Smith et al. 2007). Among the sediment characteristics for a "corrosive soil" that can lead to bone dissolution are a high phosphorus level and very low organic content (Nielsen-Marsh et al. 2007). Hydrological activity plays a key role in this trajectory, involving both the sediment-water interaction and water-bone interface (Hedges and Millard 1995; Pike et al. 2001). Bone on this trajectory would not be expected to survive on a long-term basis, and those that are recoverable are not as far along the trajectory path as those commonly found as bone silhouettes (Nielsen-Marsh et al. 2007).

Bone preservation depends on the burial environment rather than the length of burial (Child 1995). Bone decays in specific ways when exposed to water for extended periods of time, and water plays some role in almost all bone diagenetic processes (Pike et al. 2001). Water dissolves solids and is the mechanism for transport and dissolution (Buccianti and Pawlowsky-Glahn 2005). Sediment-water interaction directly affects objects in the burial environment.

Data indicate that at the Nash site, the interplay between sediment chemistry, a fluctuating water table, and water movement caused the damage to bone integrity. Folsom bone is undergoing dissolution and is on a catastrophic trajectory toward complete destruction. Implications coming out of the European study are that sites with corrosive-type sediments have no long-term preservation potential and in situ preservation of such sites is not viable. While the lithics associated with the Folsom bone bed, then, may be preserved in situ into the future, bone and other organics will not, greatly impacting the research potential of the site. Such materials at other Paleoindian sites downstream of the Nash site (Holliday 1995; Stafford 1981) also likely have been compromised.

Research at the Nash site was funded by the Museum of Texas Tech University and the City of Lubbock, and conducted under Texas Historical Commission Antiquities permit #2625. The Nash Site Collection is a state-associated collection housed at the Museum of Texas Tech University, held-in-trust for the people and State of Texas. The manuscript represents part of the ongoing Lubbock Lake Landmark regional research into grasslands hunter-gatherers and adaptation to ecological change on the Southern Plains.

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The Cobden Connection: Early-Paleoindian Lithic Procurement and Settlement Mobility in the American Midwest

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➤ **Keywords**: Clovis, Settlement Mobility, American Midwest

An ongoing fluted-point survey in Illinois has documented 50 early Paleoindian points (Clovis/Gainey) from Union County housed in public and

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private collections. Nearly half the points were collected a century ago and have no provenience information besides Union County. Many of these points were likely collected around the town of Cobden. Situated just south of the glacial maximum (Illinoian), Union County is blessed with many chert-bearing formations. The renowned Cobden and Kaolin chert sources are located adjacent to the town of Cobden (Koldehoff 2002; Ray 2007), and Cobden and Kaolin fluted points have been found across Illinois and in adjoining states (Koldehoff 2006; Loebel 2005; Tankersley 1987). Surprisingly, among the 50 points, Cobden and Kaolin are outnumbered by Burlington, a non-local chert with exposures along the Mississippi and Illinois River valleys 100–400 km to the north. Local cherts (within 50 km) account for 46 percent of the sample: Cobden 8, Kaolin 7, Bailey 4, Dover/Elco 2, Mill Creek 1, and Mounds 1. Non-local materials account for 54 percent: Burlington 15, Blair/St. David 3, Holland 2, Payson 2, Hixton 2, Oneota 1, Fern Glen 1, and Jefferson City 1. While Burlington, Blair, Fern Glen, and Jefferson City cherts are available within 100–200 km, the other non-local materials have sources much farther away: Payson (340 km) and Oneota (450 km) in northern Illinois, Hixton orthoquartzite (800 km) in central Wisconsin, and Holland (235 km) in southern Indiana.

The primary direction of raw-material movement into Union County is from the north. This movement involved groups retooling in the Cobden-Kaolin source area: The Burlington and other non-local points are all finished tools, many of which are resharpened or broken, whereas several Cobden and Kaolin specimens are late-stage production failures. Additional production failures likely litter workshop sites in the area but have gone uncollected. Such may be the case at the Jerrel workshop site (11U804), where four broken or resharpened Burlington Clovis points were recovered (Figure 1). The frequency of different non-local raw materials in the sample, chiefly Burlington, indicate high mobility and a redundant land-use pattern involving movement into and out of the unglaciated hill country of Union County. For instance, Cobben-chert Clovis points routinely occur in central and northern Illinois. This north-south movement of points is taken as an indicator of a land-use pattern involving high seasonal mobility, with one or more groups likely spending winters in the rugged hill country of Union County and retooling with Cobden and Kaolin cherts before trekking northward across the till plains of Illinois (Koldehoff 2006; Koldehoff and Loebel 2009; Koldehoff and Walthall 2004; Loebel 2005).

We are indebted to the Science Center in St. Louis and the Center for Archaeological Investigations at Southern Illinois University, Carbondale for providing access to collections. Figure 1 was prepared by Mera Hertel and is used here courtesy of the Illinois Transportation Archaeological Research Program.

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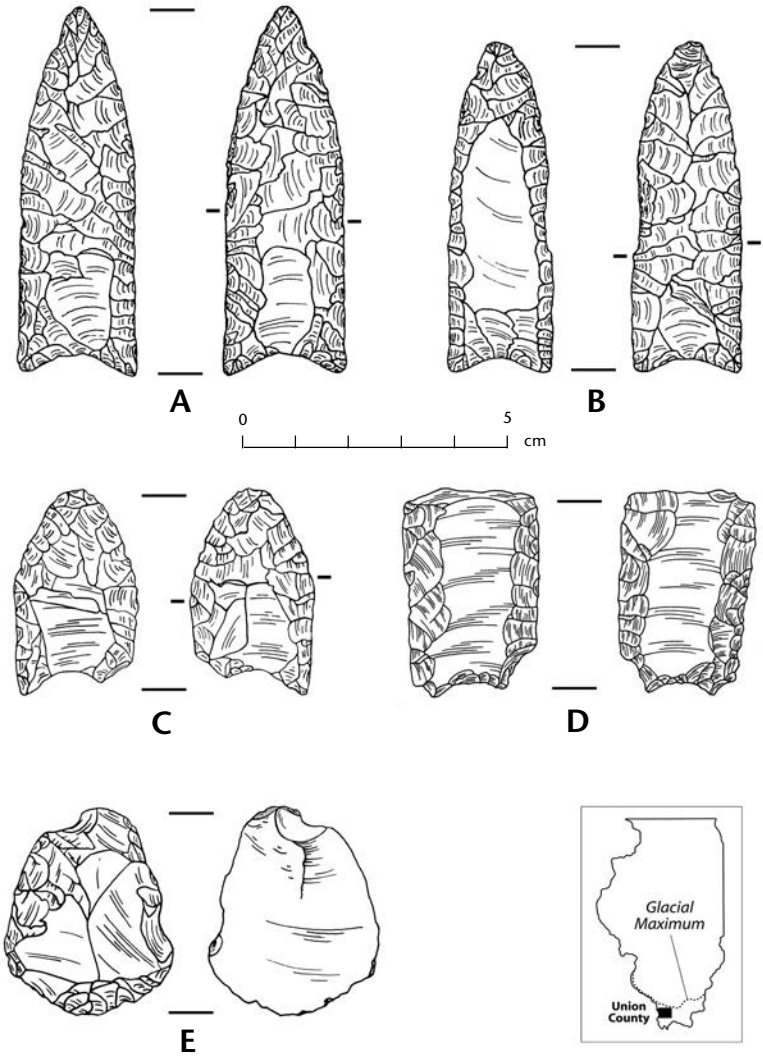

Figure 1. Jerrel site artifacts: **A–D,** Burlington-chert Clovis points (**B** shows flake blank remnant); **E,** Cobden-chert endscraper.

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The French Connection? Or Is It?

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➤ **Keywords**: Peopling of the Americas, Clovis, Bifacial Technology

European origin of the First Americans is a speculation that has appeared several times in the history of American archeology (Greenman 1963; Hibben 1941). Its most recent proponents are Stanford and Bradley (2002, 2006). They base their arguments on the spatial distribution of Clovis finds, ^{14}C dates, several aspects of osseous and chipped-stone technology, and most importantly the manufacturing techniques of Clovis and Solutrean bifacial implements. Specifically Stanford and Bradley note the presence of *outre-passé* flaking in both complexes. That is, outre passé as an intentional and systematic part of the production process, not flintknapping production errors (e.g., Sellet 1998). Consequently, they argue that the best antecedent to Clovis is the Solutrean complex of southwest Europe. There is a problem with the temporal dimension, as pointed out by Straus (2000; Straus et al. 2005); whereas the Solutrean occurs around 18,000 RCYBP, Clovis generally does not include dates older than 11,500 RCYBP (Haynes 1993; Waters and Stafford 2007).

Post-LGM-dated sites (18,000–11,000 RCYBP) in Far Eastern Asia, however, provide evidence of numerous bifacial techniques (Tabarev 2008). Although many, like Diuktai (Machanov 1978) are well known, their bifaces range from lanceolate to ovate with fairly thick cross sections and are not particularly good candidates for Clovis technological antecedents. Other sites, not well known to non-regional specialists, exhibit bifacing techniques that may be as good candidates for Clovis antecedents as the Solutrean technocomplex. In this paper we focus on several aspects of these Far Eastern bifacial techniques and

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suggest that there may be an alternative to the French Connection for the origin of Clovis bifacial technology.

The Mikoshiba site on the Japanese Archipelago dates between 14,000 and 15,000 RCYBP (Hayashi and the Kami-Ina Archaeological Society 2008). The Site has long, thin foliate bifaces. The average width-to-thickness ratio of the Mikoshiba bifaces is about 3:1. Although lower, this fits comfortably with Solutrean and Clovis ratios (about 4:1 for the thinner Fenn Cache specimens (Frison and Bradley 1999)). At Mikoshiba, flaking quality is clearly the result of extreme thinning with broad thin flakes extending over the midline nearly to the opposite edge, resulting in very flat specimens. It is presently unknown if *outre-passé* flaking is regularly and systematically present on these bifaces. More important, however, may be the manufacturing process of large thin bifaces that were first split into sections, then flaked into preforms, a technology also found among some Clovis specimens (Wilke et al. 1991). The same technique was used in the production of some Mikoshiba and other Japanese bifaces (Kimura 1990; Meiji University Museum Special Exhibition 2008:73). Suffice it to say that the Mikoshiba and similar bifaces in the Russian Far East (Figure 1), as well as the large biface-splitting method, are as good a fit to Clovis technology as (if not better than) Solutrean in both time and manufacturing technique. An alternative explanation to the origins of Clovis bifacial technology to that argued for by Bradley and Stanford (2004), then, may be that it originated in Far Eastern Asia. Even if future investigations do not establish the systematic use of *outre-passé* flaking on Japanese and other Far Eastern bifaces, it is easy to see how this technique could develop indepen-

Figure 1. Biface (length 15 cm) from the Osipovka site near Kavarovsk, Russia, showing outre-passé flaking (from Gerasimov 1928).

dently from bifacial manufacturing processes already in place. That is, it is a small step from extreme bifacial thinning to carrying flakes across the midline nearly to the opposite edge, to actually removing the opposite edge.

Thus, a more parsimonious alternative to the Solutrean Connection is the traditional Siberian entry route with the Clovis peoples bringing outre-passé practice from Far East Asia or overprinting the practice of outre-passé flaking on top of a Far Eastern bifacial manufacturing tradition. The interesting question is, Why? What are the contexts under which extreme thinning develops? What social or ecological conditions favor the development of extreme bifacial thinning? We will not be able to answer the Clovis riddle until we can answer these questions and understand the commonalities in Clovis, Solutrean, and Far Eastern bifacial techniques. The present paper is a start in that direction.

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Geochemistry of Paleoindian and Early-Archaic Obsidian Artifacts from New Mexico and Colorado

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➤ **Keywords**: Obsidian, XRF Analysis, American Southwest

In this paper we summarize X-ray fluorescence (XRF) data for Paleoindian and early-Archaic obsidian artifacts from 68 sites in New Mexico and Colorado that we have previously reported in segments (LeTourneau 2000, 2008; LeTourneau et al. 1996, 1998, 1999). All XRF analyses were conducted by Shackley (1996a, 1996b, 2005a, 2005b, 2007a, 2007b) and Kunselman (1998).

In the sample there are 8 Clovis artifacts (7 points, a scraper), 41 Folsom artifacts (6 points, 24 preforms, 11 channel flakes), an Agate Basin point, a Plainview flake, 27 Cody points, 4 Jay points, and 27 Bajada points (Table 1). One site is in central Colorado; the others are in New Mexico. Sites of different

Table 1. Sources of obsidian artifacts.

Period	No. of Sites	Cow Canyon	Grants Ridge	Canovas Canyon	Cerro Toledo	El Rechuelos	Valles	Total
Clovis	3	0	3	0	3	0	2	8
Folsom	23	0	3	0	4	1	33	41
Agate Basin	1	0	0	0	1	0	0	1
Plainview	1	0	0	0	1	0	0	1
Cody	25	0	2	0	7	11	7	27
Jay	4	0	2	0	0	0	2	4
Bajada	19	1	1	1	13	7	4	27
Total ■	—	1	11	1	29	19	48	109

■ Some sites contain artifacts from multiple periods, so total sites in Table 1 is greater than 68.

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ages have similar geographic distributions: most sites (75 percent to 100 percent) of each period are in central New Mexico, with the remainder scattered across northern and western New Mexico. The exceptions are a Plainview flake, Folsom point, and Clovis scraper from the High Plains of eastern New Mexico, a Folsom point from southeastern New Mexico, and a Cody point from central Colorado.

Six well-known obsidian sources are represented in the sample. All but two artifacts are made of obsidian from the same four New Mexico sources used extensively during the Folsom period (LeTourneau 2000; LeTourneau et al. 1996, 1998, 1999): Grants Ridge in the Mount Taylor volcanic field, and Cerro Toledo rhyolite, El Rechuelos rhyolite, and Valles rhyolite in the Jemez volcanic field. The two additional sources are the Canovas Canyon rhyolite in the Jemez volcanic field, and Cow Canyon in eastern Arizona.

Of the five New Mexico obsidians, sufficiently large pebbles and cobbles of all but the Valles glass have been documented in secondary contexts, primarily the Santa Fe Group (Church 2000; Church et al. 1996:93-95; LeTourneau 2000; LeTourneau et al. 1998; D. Love, pers. comm. 2007; Shackley 1998; G. Smith, pers. comm. 1998). Deposition of the Santa Fe Group (ca. 27.0–1.2 mya) ended prior to eruption of the Valles rhyolite (ca. 1.1–0.5 mya) (Spell and Harrison 1993), so Valles obsidian cannot be present in those deposits (G. Smith, pers. comm. 1998). Until quite recently, Valles obsidian of any size had not been identified anywhere outside the Valles Caldera; recent work has documented 1- to 2-cm-diameter pebbles in later-Pleistocene sediments along the Rio Grande near Albuquerque (Shackley, in prep). These pebbles, which may have originated in pyroclastic deposits outside the caldera on the Pajarito Plateau (Gardner et al. 2007; Reneau and MacDonald 1996), are not large enough for manufacturing Paleoindian and early-Archaic points discussed here. The only secondary deposits of Cow Canyon obsidian are in eastern Arizona (Shackley 2005c:51-53). Secondary deposits of all but the Valles rhyolite and Cow Canyon obsidians are generally closer than the primary sources to all the sites and may have been the actual sources used.

Because of the very different sample sizes for the different periods, we compare the Clovis, Folsom, later-Paleoindian (Agate Basin, Plainview, Cody), and early-Archaic (Jay, Bajada) periods. The three main Jemez sources dominate in all four periods (63–93 percent) with Grants Ridge obsidian the second most common source (7–38 percent). There are some interesting differences among the time periods in terms of individual sources used. Over 80 percent of Folsom artifacts are Valles rhyolite obsidian, compared with much lower proportions (19–25 percent) for the other periods. Only 10 percent of Folsom artifacts are Cerro Toledo rhyolite obsidian, whereas proportions of that source for the other three periods are roughly similar (31–42 percent). El Rechuelos rhyolite obsidian accounts for 38 percent of later-Paleoindian artifacts and 23 percent of early-Archaic artifacts, but 0 percent of Clovis and just 2 percent of Folsom artifacts. Grants Ridge obsidian accounts for 38 percent of Clovis artifacts, but fewer than 10 percent of artifacts from the other three periods.

The most striking difference among the periods is the strong preference

during the Folsom period for non-local Valles rhyolite obsidian from the Valles Caldera, whereas obsidian from local gravel sources dominates artifacts from the other periods.

The data on Paleoindian artifacts presented here are for all artifacts large enough to analyze using XRF out of approximately 250 studied by LeTourneau and represent one of the largest samples of Paleoindian obsidian artifacts to undergo geochemical analysis. The sample does not include all analyzed Paleoindian obsidian artifacts, either published (e.g., Hester et al. 1982, Shackley 2005d; Vierra et al. 2005,) or unpublished (J. Ferguson, pers. comm. 2007; J. LaBelle, pers. comm. 2007; C. Skinner, pers. comm. 2007). The data from these other studies are generally quite similar to those presented here. The data on early-Archaic artifacts are the result of a preliminary study and may not be representative. And, as noted above, obsidian accounts for only a small proportion of all Paleoindian artifacts, so information on obsidian procurement in terms of distance and direction is not representative of all toolstone procurement.

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Possible Lithic Artifacts from 2005–07 Excavations at the Wenas Creek Mammoth Site

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➤ **Keywords**: Mammoth, Flakes, Columbia Plateau

Annual field investigations at the Wenas Creek Mammoth site in central Washington State since 2005 have recovered bones of mammoth (*Mammuthus* sp.) and large bovid (cf. *Bison*) from a loess matrix-supported diamict (Stratum II) interpreted as colluvium (Lubinski et al. 2007). The 2σ age range from three bone dates is 15,547–17,097 CALYBP. The site sediment includes small cryptocrystalline rocks, most rounded or fractured through natural processes (unambiguous geofacts), but also some exhibiting characteristics consistent with human modification. The relationship (if any) of the possible artifacts to the bones is unclear, but they should be evaluated in light of their spatial proximity and potential association. Here we describe two possible artifacts from the 2005–07 field seasons. We note that the presence of geofacts does not preclude the possibility that these two are genuine artifacts, as a mixture is common at other locales with naturally occurring chert, including quarry sites (e.g., Andrews et al. 2004).

The best candidate for an artifact is specimen 176 (Figure 1A) found in situ. This flake fragment (Sullivan and Rosen 1985) lacking cortex has one intact lateral margin parallel with two prominent dorsal arrises, like a blade fragment. The length of one of these arrises has been traversed by a 1-mm-wide scar. A proximal notch-like feature exhibits 2–3 regular 1-mm-long unifacial flake scars. This feature and the intact lateral margin also exhibit discontinuous, unifacial chipping damage with scars < 0.5 mm. The specimen is made of red translucent chert, unique among the rocks found in the excavated matrix. The combination of patterned features, flake scars parallel to the medial axis, apparently non-local raw material, and lack of cortex imply this is an artifact (Patterson 1983; Peacock 1991), while the notch and edge chipping are more ambiguous (see Hosfield and Chambers 2003). This find was made about 15 cm above a mammoth-size metapodial within the same stratum (II).

Specimen 327 (Figure 1B) was recovered from 1/8-inch screen. It is a

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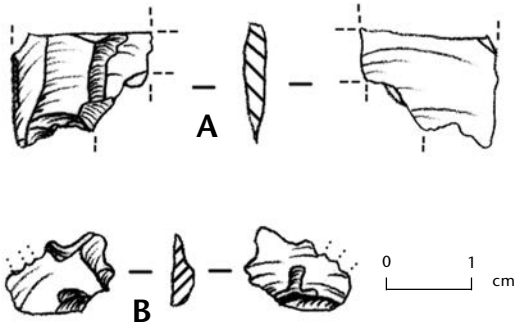

Figure 1. Two possible artifacts in dorsal (to left), side, and ventral (to right) views, with distal end to top. **A** is specimen 176, which measures about 13 x 16 x 3 mm; all edges are broken transversely, except for the feathered lateral margin at left, and the notched area at bottom left (dorsal view). **B** is specimen 327, which measures about 9 x 12 x 2 mm; the left distal margin is broken (dorsal view).

broken flake exhibiting a flat platform with an angle of 55°, an éraillure scar on a diffuse bulb of percussion, 5 dorsal flake scars (including two 1-mm-long scars adjacent to the platform), feather termination, and no cortex. All intact edges exhibit discontinuous chipping damage, with scars < 0.5 mm. The specimen is made of translucent tan chert visually similar to natural material in the excavation matrix. The éraillure, platform angle, and lack of cortex imply this is an artifact, while the diffuse bulb of percussion and apparently local raw material imply a geofact (Patterson 1983; Peacock 1991). The edge damage is ambiguous. The flake was found near the contact of Stratum II and the underlying, higher energy, alluvial Stratum III.

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Flake Tools from the Folsom Type Site: Removing a Case of Mistaken Identity

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➤ **Keywords**: Folsom Site, Lithics, Great Plains

In the late 1930s, Frank Roberts made passing mention of a "portion of a nondescript flake knife, and one example of a generalized type of scraper" from the Folsom type site in New Mexico (Roberts 1939:534). No more was known of the specimens beyond that vague reference, and the original artifacts were long thought to be lost to history. That was unfortunate, as the Folsom site produced singularly few artifacts beyond projectile points, though given the extent of the butchering of the bison killed there other tools must have been used.

Accordingly, it was with some interest when Meltzer, preparing his ***Folsom*** volume (Meltzer 2006), received from Fred Wendorf a vintage 35 mm slide labeled "Skinning knives Folsom NM." In the photograph were three artifacts: the center one was a quartzite knife, found at the Folsom site by Ele Baker in November 1936, which is today in the possession of the Baker family (Meltzer 2006:95, 254). Given the slide label, and that one of the specimens was known to have come from Folsom, Meltzer inferred the other two did as well, and perhaps were even the nondescript specimens mentioned by Roberts (Meltzer 2006:254). The photograph appears as Figure 8.3 in ***Folsom*** (recreated here as Figure 1) over the caption "Three of the four flake tools known from the Folsom site. The center specimen is the Baker knife [Figure 1b]; the whereabouts of the other two specimens are unknown."

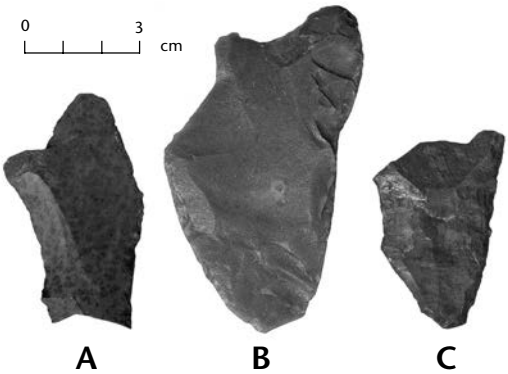

Figure 1. A, flake from Rio Rancho, New Mexico, locus 4146 (Maxwell Museum catalog no. 69.20.13); **B,** the Baker knife from the Folsom type site, New Mexico; **C,** flake tool from Rio Rancho, New Mexico, locus 4149 (Maxwell Museum catalog no. 87.1.129).

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The good news is the whereabouts of those two artifacts are no longer unknown; the bad news is they are not from the Folsom site.

Since 1999, Huckell has sought to organize and analyze the artifacts from the Rio Rancho Folsom–age locality in the Albuquerque Basin (Dawson and Judge 1969; Huckell and Kilby 2002). Recently, in closely examining Figure 8.3 in ***Folsom***, he realized the utilized flake tool (Figure 1C) to the right of the Baker knife was from Rio Rancho. The flake to the left (Figure 1a) of the Baker knife likewise visually rang a bell.

On checking the collections at the Maxwell Museum at the University of New Mexico, Huckell quickly found the first of the specimens (catalog no. 87.1.129). It was labeled 4149, which matched one of Jerry Dawson's locus numbers for the Rio Rancho site. Meltzer, in turn, checked Wendorf's original 35 mm slide and saw there were two numbers—"4146" and "4150"—written alongside "Skinning knives Folsom NM." A subsequent search by Huckell of the collection from Rio Rancho locus 4146 quickly turned up the other flake from the photograph (catalog no. 69.20.13). Why the slide identified the flake tool as coming from "4150" and not "4149" is unclear; "4150" is a Basketmaker II site, according to Dawson's notes.

So how did the three specimens from the two different sites end up in the same image? Ele Baker collected extensively in the Albuquerque Basin, worked with Dawson in the mid-late 1960s, and loaned the Baker knife to the Maxwell Museum in 1968. The artifacts from the two sites were likely in close proximity at certain times. Perhaps someone (Dawson?) took the photograph while all three tools were at the Museum, a copy of which ended up with Wendorf.

As for the nondescript specimens from Folsom mentioned by Roberts, they unfortunately remain lost to history.

We thank Tony Baker for (again) loaning us the Baker knife and making it possible for us to reunite these three specimens to make Figure 1, as well as for helpful comments on the discovery of that artifact. Our thanks also to Catherine Baudoin, Maxwell Museum Photoarchivist, for taking the image.

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A Study of Early-Paleoindian Settlement in the Coastal Plain of Alabama

Steven M. Meredith

➤ **Keywords**: Alabama, Clovis, Mobility Patterns

This paper presents the results of an inventory of known fluted points from the Alabama Gulf Coastal Plain. This area has been conspicuous in the limited number of recorded fluted points recorded, in contrast to the middle Tennessee Valley, 150 to 250 km from the study area, where large numbers of fluted points have been reported (Anderson 1996:31; Futato 1982:33; O'Donoughue 2007:127).

Fluted projectile points were the primary artifacts considered in this study so as to limit the span of time to the earliest recognized settlement in the region. Following the methods of Tankersley (1991), I have used the geologic origin of fluted-point raw materials found in the study area to trace movement of stone across the region, either through direct transport or exchange. Regardless of the method of movement, the raw material of each artifact demonstrates a human connection from its geologic origin to its deposition.

I have combined data regarding 56 fluted points from four sources:

1. The Alabama Paleoindian Point Survey (APPS), which is a contributing database of the Paleoindian Database of the Americas (PIDBA; http://pidba.utk.edu/). Before I began this study, only eight fluted points had been recorded within the Alabama Gulf Coastal Plain. Each of these artifacts are held in private collections.
2. Twenty-five artifacts held in private collections that had not previously been recorded in the APPS.
3. Eight artifacts recovered in archaeological survey or excavation that had not yet been included in APPS, but reported in Hurt (1975:25), Ensor (1981:103), and Waselkov (1980:155).
4. Data collected on 14 fluted points as a part of thesis research done by Moon (1999) in southeastern Alabama.

There is likely some temporal variation in the sample. Four of these artifacts conform to the Redstone type as described by Goodyear (2007:100), and one point is a fluted version of the Simpson type. Notably absent from the region is the Cumberland-type point.

Artifacts used in this study were made of five categories of raw materials, each having distinct geologic origins. In order of frequency, these are Ocalla/Coastal Plain chert (n = 26), Tallahatta sandstone (n = 12), Tallahatta chert (n = 12), quartz (n = 5), and Bangor chert (n = 1). The geologic source of the stone from which the artifacts in this study were made is used to infer the

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range of group movement. The beginning point of an artifact is assumed to be the geologic source of the raw material. The ending point is where the artifact was lost or discarded and later found. Minimal movement of stone through human action is determined by drawing a line from the nearest mapped outcrop of the artifact's geologic source to the location it was discovered. Five of the fluted points were made of quartz, which is found all over the Coastal Plain in the form of alluvial gravel; because of its widespread occurrence, it has little value for inferring movement. Ocalla/Coastal Plain chert originates near the eastern edge of the study area, Tallahatta chert is restricted to the western edge, and knappable Tallahatta sandstone is found in a band extending from the western limit to approximately the center of the study area.

With the exception of one Redstone, fluted points found in the Alabama Coastal Plain are made only of raw materials with a Coastal Plain geologic origin. The one aberrant Redstone is made of Bangor chert, which originates both in the Valley and Ridge and the Highland Rim to the north and northeast of the artifact discovery location. Discovery locations of fluted points in Alabama indicate considerable movement between the source areas of knappable stone, but only one instance of movement from northern Alabama, and no movement from the south to the north. Based on data available in the APPS and PIDBA, none of the hundreds of fluted points found above the fall line in Alabama are made of Coastal Plain rock. This pattern implies the early-Paleoindian population of the Alabama Gulf Coast was separate from that of the heavily populated Highland Rim, and had little to no movement of knappable stone between regions, unlike that found in other regions of eastern North America (c.f. Tankersley 1991:295).

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Paleoamerican Utilization of the Green River Shell Middens: The Chiggerville Site (150H1), Kentucky

Christopher R. Moore

➤ **Keywords**: Dalton, Shell Middens, Western Kentucky

The role that the Green River region of western Kentucky played in the development of the Archaic concept in eastern North America is widely known (Jefferies 1995). Less widely known is the region's role in early discussions of fluted-point complexes east of the Mississippi River. The Parrish Village site (15Hk45) was the first Eastern Paleoamerican site to undergo large-scale excavations specifically to determine the nature of the site's "Early Hunter" occupation (Freeman et al. 1996:395). Webb (1951) assigned a total of seven fluted points, four Agate Basin-like points, and several hundred scrapers and other tools to the Early Hunter component at the site. The nearby Carlston Annis site (15Bt5) yielded two additional fluted points (Webb 1950:305–09).

The author's recent reanalysis of the Chiggerville site assemblage resulted in the identification of four late-Paleoamerican Dalton cluster points (see Justice 1987:35–44), suggesting that Paleoamerican components are more common at these large midden sites than previously recognized. Unfortunately, all points were redeposited into the site's Archaic shell midden. One point was recovered from the plowzone, while the others were recovered from depths ranging from 2.5 to 4.5 ft below surface.

Three points (Figure 1A–C) are lanceolate Dalton cluster points manufactured from local Ste. Genevieve chert. The fourth (Figure 1D) is a side-notched Dalton cluster Greenbrier point (see Justice 1987:42–43) also of Ste. Genevieve chert. All four points have bases thinned by the removal of either single or multiple long, longitudinally oriented pressure flakes that result in a concave to beveled basal cross-section. Basal and lateral haft grinding is slight or absent on all but one point (Figure 1C), which exhibits heavy lateral haft

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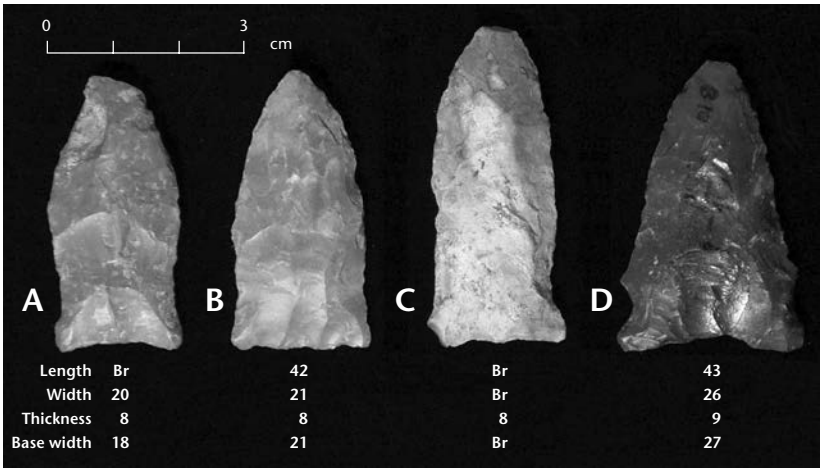

Figure 1. Paleoamerican Dalton Cluster projectile points from the Chiggerville site. All dimensions in millimeters; **Br,** broken.

grinding along one edge. Two of the lanceolate points exhibit biconvex cross sections; the other is lenticular. The Greenbrier point exhibits a rhomboidal cross section as a result of a steep, right-handed bevel. The complete lanceolate point weighs 7.6 g; the Greenbrier point weighs 8.4 g.

The presence of diagnostic Paleoamerican points in the Chiggerville assemblage suggests that use of the Green River midden sites commenced as early as the late Pleistocene. Given the size of the WPA excavations at these sites, the small number of points recovered suggests that occupations were short-term and that evidence of these occupations has been largely destroyed by subsequent late-middle to late-Archaic activities. Whether Paleoamerican groups were visiting the Green River to take advantage of mussel shoals or for some other purpose is currently unknown.

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Gainey-phase Occupation of the Steinman Site, Madison County, Illinois

Juliet E. Morrow and Brad Koldehoff

➤ **Keywords**: Paleoindian, Gainey Phase or Complex, American Midwest

The Steinman site (11MS1597) is a 77,757-m^2 multicomponent habitation on a cultivated upland interfluve at 169 m a.s.l. in west-central Illinois. Surface-collected artifacts include 2 fluted points, a fluted preform, a possible fluted point preform, 27 early-Archaic points/knives (ppks) (3 Dalton, an Agate Basin, 4 Thebes/Kessel/Lost Lake, 4 St. Charles, 2 Hardin, 8 Kirk, 3 Palmer, 2 LeCroy) and ppks representing minor later components, 35 sidescrapers, 43 endscrapers, a scraper plane, a graver, 3 retouched flakes, 9 point fragments of indeterminate age, 7 bifaces, and samples of debitage, cores, and cobble tools. The proportions of local (Burlington), extra-local (Blair), and exotic raw (Cobden) chipped-stone materials used for manufacturing Paleoindian artifacts in the Steinmann site collection are typical of early-Paleoindian sites in the Midwest.

The two finished fluted points are basal fragments made of Burlington chert (Figure 1A and B). Both exhibit moderate to heavily abraded lateral margins. The fluted preform, broken during the second flute removal, is also made of Burlington chert (Figure 1C), which occurs approximately 50 km (31 mi) from the site. This perform is characteristically boat shaped like Clovis performs but is substantially thinner and has a concave base more typical of Gainey performs (J. Morrow and T. Morrow 2002). One narrow bifacial preform of Blair chert may be an aborted fluted preform (Figure 1D). The base is thinned on both faces; haft grinding is absent. Other Blair chert artifacts include one retouched flake, one bipolar core, and 11 pieces of debitage. Blair chert occurs approximately 90 km (56 miles) south of the site.

The majority of the endscrapers are made of Burlington chert; three are made of Salem/St. Louis, one is made of Cobden, and two are made of an indeterminate chert. Salem/St. Louis chert is 60 km (37 mi) and Cobden chert is 180 km (111 mi) from the site. Endscrapers are common tools in many Gainey and Clovis complex site assemblages in the Midwest (Ellis and Deller 1990; J. Morrow 1997; Simons et al. 1984). Endscrapers are common in Dalton complex assemblages in the Midsouth (Morse 1997) and they are expected in the Midwest (Martens 2001). By at least 9500 RCYBP the triangular endscraper form was abandoned in favor of more irregular-shaped scraping tools (J. Morrow 1996; T. Morrow 1997). Therefore Paleoindians and possibly their

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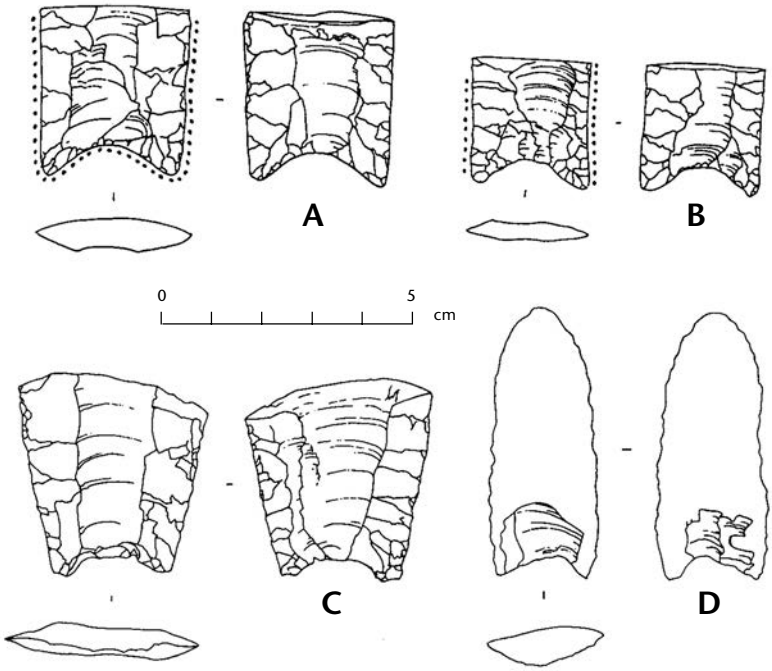

Figure 1. Selected Paleoindian chipped-stone bifaces from the Steinmann site. **A–B,** finished fluted-point haft fragments of Burlington chert; **C,** basal portion of a fluted preform of Burlington chert broken during the second flute removal; **D,** Possible fluted preform of Blair chert.

Dalton successors most likely made, used, and discarded the endscrapers at the Steinmann site.

Some of the 35 Burlington chert sidescrapers are probably associated with the Gainey-phase occupation. These "morphological" sidescrapers," retouched and utilized along an edge parallel to the long axis of the flake, may have been used for scraping or cutting (Ahler et al. 2000). Paleoindian flake tools classified as morphological sidescrapers, with smaller edge angles than the typical endscraper, are good analogs for precision cutting tools like those from the Murray Springs (Haynes and Huckell 2007) and Martens (Ahler et al. 2000) sites.

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A Newly Discovered Fluted Point from Northeastern Minnesota

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➤ **Keywords**: Hixton Silicified Sandstone, Gainey, Minnesota

The St. Louis River Hydroelectric Project, a series of reservoirs in northeastern Minnesota, has been investigated systematically since 1990 (Mulholland and Shafer 2000). Previous archaeological investigations by private collectors have preserved valuable data (Harrison et al. 1995; Mulholland 2002). Our ongoing collaboration with the collectors has identified a fluted-point base of Hixton silicified sandstone from surface collection in Boulder Lake Reservoir.

The point base suggests a general lanceolate shape with convex lateral edges that diverge from the base (Figure 1). The lateral edges are heavily ground with the break occurring just above the hafting area. Dimensions are: maximum length 34.10 mm; maximum width 36.28 mm; maximum thickness 7.63 mm; basal width 20.64 mm; basal concavity 2.22 mm; interfluve thickness 4.58 mm. The longitudinal profile is biconvex with one side slightly more convex. A cross section of the base indicates that transversely the point also was biconvex. The base is concave in outline with one broad flute, nearly ear to ear, removed from each side. Flute scars range from 27.56 mm long and 18.92 mm at its

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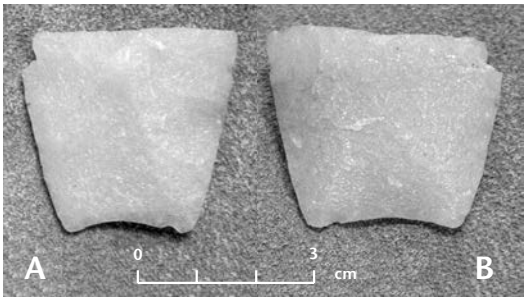

Figure 1. The Gainey point base from Boulder Lake Reservoir: **A,** obverse face; **B,** reverse face.

widest on the obverse (Figure 1A) to 27.82 mm long and 14.62 mm at its widest on the reverse (Figure 1B). The reverse exhibits one smaller retouch flake at the base which may have been part of platform preparation to flute the obverse or removal of a small ridge after the reverse was fluted. Morphologically the point fits the Gainey style, although the diverging lateral edges from the base are atypical (Stoltman 1991); a similar point was described earlier (Mulholland et al. 2007). This divergence of lateral edges from the base may be a regional stylistic variation, though a sample size of two is insufficient to define variations.

Hixton silicified sandstone (HSS) outcrops at Silver Mound in west central Wisconsin, 361 km south of Boulder Lake Reservoir (Boszhardt 1993). HSS is commonly found in the Reservoir Lakes collections, both as tools and debitage, and is most extensively used during the Paleoindian in northeastern Minnesota (Mulholland 2002:23) and the western Great Lakes in general (Carr et al. 2008:67). Another fluted point of HSS is reported from northwestern Wisconsin (Mires 1989). However, the other reported early-Paleoindan points in northeastern Minnesota are of regional lithic materials: Gunflint silica (Romano and Johnson 1990; Stoltman 1991), Knife Lake siltstone (Mulholland et al. 2007), and jasper taconite (Mulholland and Mulholland 2002).

The use of regionally available lithic materials suggests an indigenous population during the early-Paleoindian period; HSS is exotic but not rare. Geologic evidence indicates that parts of northeastern Minnesota were ice free relatively early with an open corridor between ice margins through which early peoples traveled (Hill 2007; Mulholland et al. 1997; Phillips and Hill 2004). Early-Paleoindian points are relatively rare in northeastern Minnesota, but additional examples are likely to be found as additional collections are examined.

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Reevaluating Folsom Mobility and Land Use in New Mexico

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➤ **Keywords**: Folsom, Toolstone Procurement, Albuquerque Basin

Amick (1994, 1996, 2000) argues for long-distance movements between the southern Plains and the Basin and Range region of New Mexico based in part on the presence of Edwards chert in the southern basins. He proposes that

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movement between the two regions was seasonally based. This paper addresses the applicability of Amick's Folsom mobility model to the Albuquerque basin based on recent excavations there and throughout New Mexico. We examine the lithic raw materials in assemblages from seven New Mexico Folsom sites. The Shifting Sands site from the southeastern New Mexico/Texas border is also included to balance the regional samples. If hunters regularly pursued wintering herds into the Albuquerque basin, Edwards chert or other raw-material sources from the southern Plains should appear with some frequency in the archaeological record of the Albuquerque basin.

The compiled data reveal two distinct lithic raw-material patterns between the Albuquerque basin and southern Plains (Table 1). Edwards chert does not appear in any of the assemblages from the Albuquerque basin sites. While the Rio Rancho Folsom site debitage assemblage contains three pieces of possible Alibates silicified dolomite debitage, Plains-derived materials are infrequent or absent in the Albuquerque basin Folsom sites. Furthermore, recent lithic sourcing suggests that Albuquerque basin Folsom groups obtained most of their raw materials from an area extending from the Chuska and Zuni moun-

Table 1. Breakdown of raw material percentages by sites: Boca Negra Loc. A (BNW), Deann's, La Vega, Rio Rancho, Elida, Folsom, Mitchell, and Shifting Sands. Analyzed portions are complete lithic assemblages (All), Diagnostics (Diag.), and projectile points (PP). All values in percent (%).

	North-Central New Mexico sites				Llano Estacado sites			
	BNW	Deann's	La Vega	Rio Rancho	Elida	Folsom	Mitchell	Sh. Sands
Raw Material	(All)	(All)	(Diag.)	(All)	(All)	(PP)	(All)	(All)
Eastern NM and CO Sources								
Alibates	0.00	0.00	0.00	0.05	0.00	35.71	11.30	0.00
Black Forest	0.00	0.00	0.00	0.00	0.00	7.14	0.00	0.00
Edwards	0.00	0.00	0.00	0.00	74.17	0.00	79.70	99.00
Flattop	0.00	0.00	0.00	0.00	0.00	7.14	0.00	0.00
Tecovas	0.00	0.00	0.00	0.00	15.88	28.57	5.70	0.00
Other	0.00	0.00	0.00	0.00	9.95	21.44	3.30	1.00
Western NM Sources								
Chuska chert	8.06	0.40	6.67	2.57	0.00	0.00	0.00	0.00
Cumbres chert	0.00	1.30	6.67	0.62	0.00	0.00	0.00	0.00
Pedernal chert	42.42	4.80	0.00	25.16	0.00	0.00	0.00	0.00
Red Jasper	0.00	1.70	0.00	0.81	0.00	0.00	0.00	0.00
San Andres chert	3.79	22.20	63.33	1.77	0.00	0.00	0.00	0.00
Santa Fe Formation	7.35	26.10	0.00	7.05	0.00	0.00	0.00	0.00
Valle Grande	25.59	0.00	3.33	4.49	0.00	0.00	0.00	0.00
Zuni Spotted chert	2.37	0.00	6.67	24.25	0.00	0.00	0.00	0.00
Other	10.43	35.20	13.33	33.28	0.00	0.00	0.00	0.00

Sources for data:

BNW	Data in possession of authors
Deann's	Huckell and Ruth 2004
La Vega	Amick 1996
Rio Rancho	Huckell and Kilby 2000
Elida	Hester 1962; Warnica 1961
Folsom	Meltzer 2006
Mitchell locality	Boldurian 1991
Shifting Sands	Amick and Rose 1990; Hofman et al. 1990

tains on the west, the Jemez mountains to the north, and the Rio Puerco/Rio Grande valleys (Huckell and Kilby 2002; Huckell and Ruth 2004). This evidence, coupled with the absence of Plains raw materials, indicates that group movement between the southern Plains and the Albuquerque basin is best described as rare.

It is possible that Folsom groups moved along the western margin of the southern Plains and only entered the southern basins of New Mexico (LeTourneau 2000:Fig. 5.6; LeTourneau and Cummings 2006). This hypothesis is supported by the decline in Plains-derived raw materials from south to north in New Mexico, implying that those materials were moving in a northerly direction (Amick 1996:Table 1). The data suggest the existence of at least two different patterns of raw material use within New Mexico, one in the east dominated by Plains sources and another west of the Rio Grande marked by use of materials available in the northwestern quarter of the state. It is clear that no single recurrent Folsom land-use pattern characterized this region.

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Recent Fluted-Point Finds in Eastern Oregon

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➤ **Keywords**: Fluted Points, Obsidian Hydration, Mazama O Tephra

Two sites on the Bureau of Land Management (BLM) Burns District, 35HA3220 and 35HA3667 (the Sheep Mountain site), were revisited in 2008 as part of a systematic effort to identify and monitor Paleoamerican sites on agency lands. Four fluted points recovered from the sites are the subject of this report. In the Alvord Desert, a pluvial lake basin on the east side of Steens Mountain, a number of fluted points have been found over the last 50 years. Site 35HA3220 is situated in an extensive area of eroded and coppice dunes, playettes, and abandoned stream channels near a present-day channel of Trout Creek. Two fluted points were surface collected at the site, one by Dugas in 1996 (Dugas et al. 1996) and the other by BLM personnel in 2008. Both were found in the north-central portion of the site.

Specimen 96-225 (Figure 1A) is a basal fragment that has a single flute scar on each side. It was surface collected on a low hummock adjacent to an abandoned stream channel. Edge grinding is present along the lateral edges but not on the base, and flute scratching was not observed. The point was broken by a bending fracture. It is 23.96 mm long, 24.96 mm maximum width, 5.00 mm thick, has a 4.66 mm basal depth, a basal width of 21.90 mm, and weighs 3.4 g (Rondeau 2007). The point was made of Beatys Butte obsidian (Skinner and Thatcher 2001) with a hydration-rind measurement of 7.9 μ (Skinner and Thatcher 2006). Beatys Butte is located approximately 48 km northwest of the site. For this obsidian source, a rind measurement of 7.9 μ suggests an early-Holocene age. Specimen 08-181 (Figure 1B) is a basal fragment that has two flute scars on one face and three on the other. Basal

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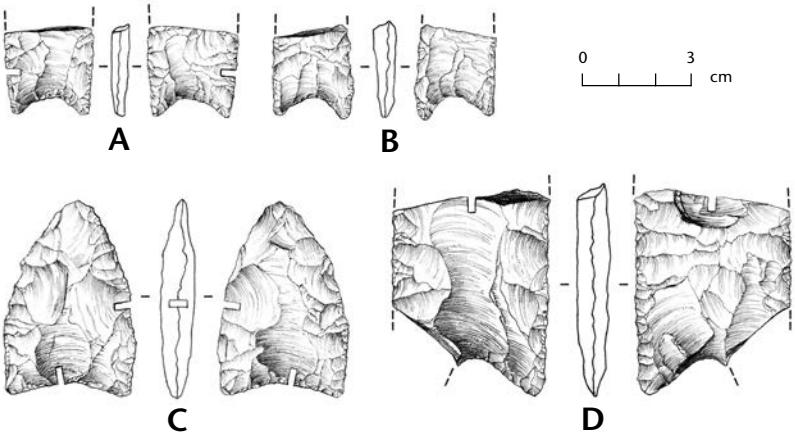

Figure 1. Fluted points. From 35HA3220: **A,** specimen 96-225; **B,** specimen 08-181. From 35HA3667, the Sheep Mountain site: **C,** specimen 3667-CL1; **D,** specimen 3667-CL2. Illustrations by Eric Carlson.

edge grinding is found on both lateral margins and primarily on the interior margins of the basal ears. Abrasion is noted on the edge of one flute scar but flute scratching is not present. The point was broken by a twisting fracture. It is 25.75 mm long, 22.06 mm wide, 5.33 mm thick, has a basal depth 7.16 mm, a basal width of 20.42 mm, and weighs 3.0 g (Rondeau 2008). Obsidian studies on this point are pending.

BLM personnel surface collected two fluted points at the Sheep Mountain site. A complete specimen was found during a 2005 fire rehabilitation survey and a second 75 m from the first during preliminary reconnaissance for 2008 University of Oregon field school excavations. The site occupies a small upland basin north of a large playa valley near Wagontire in southeastern Oregon. The locality has deep sediments (ca. 1.5–6.0 m), in part due to windborne sand and silt transport from the playa to the south. Two other fluted-point sites, Dietz (Willig 1989) and Sage Hen Gap (O'Grady et al. 2008), are both within 50 km of Sheep Mountain.

The 2005 point (3667-CL1) is missing an ear tip (Figure 1C). It is 53.95 mm long, 36.71 mm wide, 8.27 mm thick, has a basal depth of 3.72 mm, and weighs 15.7 g. The lateral margins and base are heavily edge-ground, and slight flute scratches are present on one face. The tip has been reflaked by percussion, and the maximum width of the point is well below the midline of the point length (Rondeau 2007). It is made of Buck Springs obsidian with a hydration measurement of 9.8 (Skinner and Thatcher 2008). The 2008 point (3667-CL2) is an unfinished base fragment missing one ear and the central basal margin (Figure 1D). The base has a maximum length of 55.93 mm, width of 43.0 mm, thickness of 8.28 mm, and weight of 21.1 g. It is made of obsidian from the Glass Buttes 1 source, with a hydration measurement of 8.0 μ (Skinner and Thatcher 2008). The transverse break probably resulted from end shock during the fluting process (Rondeau 2008). No edge grinding or flute scratches are present.

Over the past nine years, archaeologists from the Burns District BLM have been conducting systematic surveys and monitoring of agency holdings where Paleoamerican sites are known to be concentrated (e.g. Thomas and O'Grady 2006). This effort, in concert with test excavations by the University of Oregon, has resulted in the documentation of 46 fluted points and unfinished bifaces. The number of recorded sites and isolates is increasing annually; the sites here reported, 35HA3220 in the southeast portion of the district and 35HA3667 (Sheep Mountain) in northwestern portion, reflect the effort to target areas where old sites appear to be most abundant. One welcome byproduct is the identification of sites with deep sediments like Sheep Mountain, where Mazama O tephra (Foit 2008) covers high artifact concentrations, or those with good potential, as is the case with 35HA3220.

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Two Cody-Complex Projectile Points from the Valles Caldera National Preserve, Jemez Mountains, New Mexico

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➤ **Keywords:** Cody Complex, Paleoindian Period, American Southwest, X-ray Fluorescence Analysis

Two projectile points assignable to the Eden and Firstview types of the Cody complex (9500–8400 RCYBP (Frison 1991)) have been recovered from the Valles Caldera National Preserve in the Jemez Mountains of New Mexico. Cody-complex projectile points have not previously been reported from the Jemez Mountains and other high-altitude settings in New Mexico (Acklen 1993, 1997; Baker and Winter 1981; Vierra et al. 2006; Winter 1983), although a small number have been reported from high-elevation settings elsewhere in the southern Rocky Mountains (Pitblado 2003) and from adjacent regions of the Northern Rio Grande (Judge 1973; Schmader et al. 2006).

Four major toolstone sources occur in the Jemez Mountains. Cerro del Medio (a.k.a. Valles rhyolite) and Cerro Toledo (a.k.a. Obsidian Ridge) obsidian sources occur in the Caldera itself. The Polvadera Peak obsidian source (a.k.a. El Rechuelos rhyolite) is located approximately 17 km to the north of Cerro del Medio, and the Pedernal chert source is 13 km northwest of Polvadera Peak. Acquisition of this raw material drew people into the high Jemez Mountains beginning in Clovis times (see Hester 1988; Hester et al. 2006; Johnson et al. 1985).

The Eden point was recovered from a late-prehistoric midden at the La Jara Spring site (LA158200), a small rockshelter adjacent to a permanent seep. This base-and-midsection fragment of an unshouldered lanceolate point exhibits the parallel sides, square base, and diamond cross section typical of the type (Bamforth 1991; Bradley and Stanford 1987; Pitblado 2003). Light grinding of the base and haft margins is present, and the base is thinned. Collateral flaking typifies the finishing, with flakes that carry to the midline and were removed sequentially as described by Bradley and Stanford (1987). The point suffered impact damage that removed the tip and snapped off one lateral margin of the base. The width at the top of the haft is 13.1 mm, maximum width is 14.4 mm, and maximum thickness is 5.1 mm. Prior to breakage, the specimen exceeded 45 mm in length. X-ray fluorescence analysis determined that this point was manufactured from obsidian of the Polvadera Peak chemical type (Hughes 2008).

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The Firstview point was recovered during surface survey at LA82574, an open-air lithic scatter along the margin of a large open grassland in the caldera's northeastern quadrant, in an area where three other late-Paleoindian projectile points have recently been recorded (Decker 2008). This base-and-midsection fragment exhibits parallel sides, very weak shouldering, and a square base. Consistent with the Firstview type definition (Bamforth 1991; Wheat 1972), this point is stemmed by grinding rather than by flaking, with light grinding of the margins of both the base and the haft. Diagonal-parallel finishing flakes carry to the midline, giving the point a diamond shape in cross section. The base is thinned. The point suffered impact damage to the tip, and bears a semicircular notch to the blade representing modification of the point during reuse. Width at the top of the base is 19.2 mm, maximum width is 19.8 mm, and maximum thickness is 7.9 mm. Prior to breakage, the specimen exceeded 40.3 mm in length. Visual assessment indicates that this point is manufactured of Pedernal chert.

The Valles Caldera consists of flat grass-covered valley floors at 2,450 m a.s.l. ringed by relatively high mixed-conifer-forested mountains above 3,050 m a.s.l. Pollen records from high-altitude bogs in the southern Rocky Mountains (Anderson et al. 2008; Petersen 1988) indicate high-elevation vegetation in the region likely consisted of mixed spruce and pine parkland that gave way to pine forest over the course of the early Holocene. Within the caldera, grassy meadows likely dominated the valley floors, maintained as today by cold air drainage (Allen 1989).

Cody foragers are associated on the Plains with mass kills of bison (*Bison antiquus*). *B. antiquus* skeletons have been reported from the Pajarito Plateau area of the Jemez Mountains at 1,975 m a.s.l. (Drakos et al. 2007), at sites above 1,800 m from Navajo Lake, Abiquiu, Mesa Vibora, Folsom, and Snow Ranch (Morgan and Lucas 2005), and from sites in similar elevation parks of the Southern Rocky Mountains (Jodry 1999). Given the parkland environment of the Valles Caldera, it is likely that Cody foragers would have been drawn there to hunt *B. antiquus* and possibly other larger ungulates (e.g., elk and bighorn sheep) during the summer or early fall months. Use of local lithic raw material sources indicates these foragers were familiar with, and probably made regular use of, the Jemez Mountains.

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Establishing a Baseline Paleoamerican Record for Southeastern Idaho

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➤ **Keywords**: Paleoamerican Chronology, Site Documentation, Southeastern Idaho

In summer 2007 Utah State University (USU) archaeologists spent two weeks in southeastern Idaho evaluating its potential to yield Paleoamerican sites. Virtually no published literature attests to a Paleoamerican presence southeast of the Snake River Plain (SNP), although the SNP itself has an impressive record (e.g., Butler 1986, Green et al. 1998, Gruhn 2006, Lassen 2005, Marler 2004, Meatte et al. 1988, Miller 1989, Titmus and Woods 1991, Yohe and Woods 2002). Nonetheless, during our short stay we observed remarkable Paleoamerican artifact collections and left convinced that this little-studied region can enrich understanding of Paleoamerican lifeways in the American West.

During follow-up research in summer 2008, we recorded all Paleoamerican sites we could identify in the area bounded by the SNP to the northwest and the Utah and Wyoming borders to the south and east (Figure 1). Here, four major physiographic zones—the Great Basin, Columbia Plateau, Central Rocky Mountains, and Wyoming Basin—converge or nearly converge, creating a rich ecotone and offering easy access to each. Ubiquitous water; myriad obsidian, chert and quartzite sources; lava shelters; ice caves for storage (e.g., Henrikson 2003); and an extremely rich and diverse resource base surely provided powerful incentives for First Americans to colonize the region.

The 2008 work led to the documentation of 57 Paleoamerican sites, which yielded 5 Clovis or Clovis-era artifacts; 3 Folsom points; 15 Great Basin Stemmed points and crescents; 15 Haskett projectiles; 15 Cody-complex artifacts; 16 Angostura points; and 16 Concave Base Stemmed points (Pitblado 2003). These artifacts reveal occupation beginning by Clovis time (11,050 RCYBP) (Waters and Stafford 2007) and continuing through the early Holocene. They also reflect the distinct Paleoamerican sequences of the region's four physiographic zones. Of the 57 sites, 54 are located within just 500 m of a permanent water source (and 42 of those are less than 100 m from permanent water). Furthermore, half the sites are situated less than 1 km from a second permanent water source. Whether this reflects survey bias or reinforces just how well watered this particular landscape is remains to be determined.

With Paleoamerican sites now starting to populate a map of our study area (Figure 1) and a growing understanding of ecological characteristics that likely influenced Paleoamerican resource and land use, we are beginning to develop predictive models to lead us to more sites. We also plan to test sites

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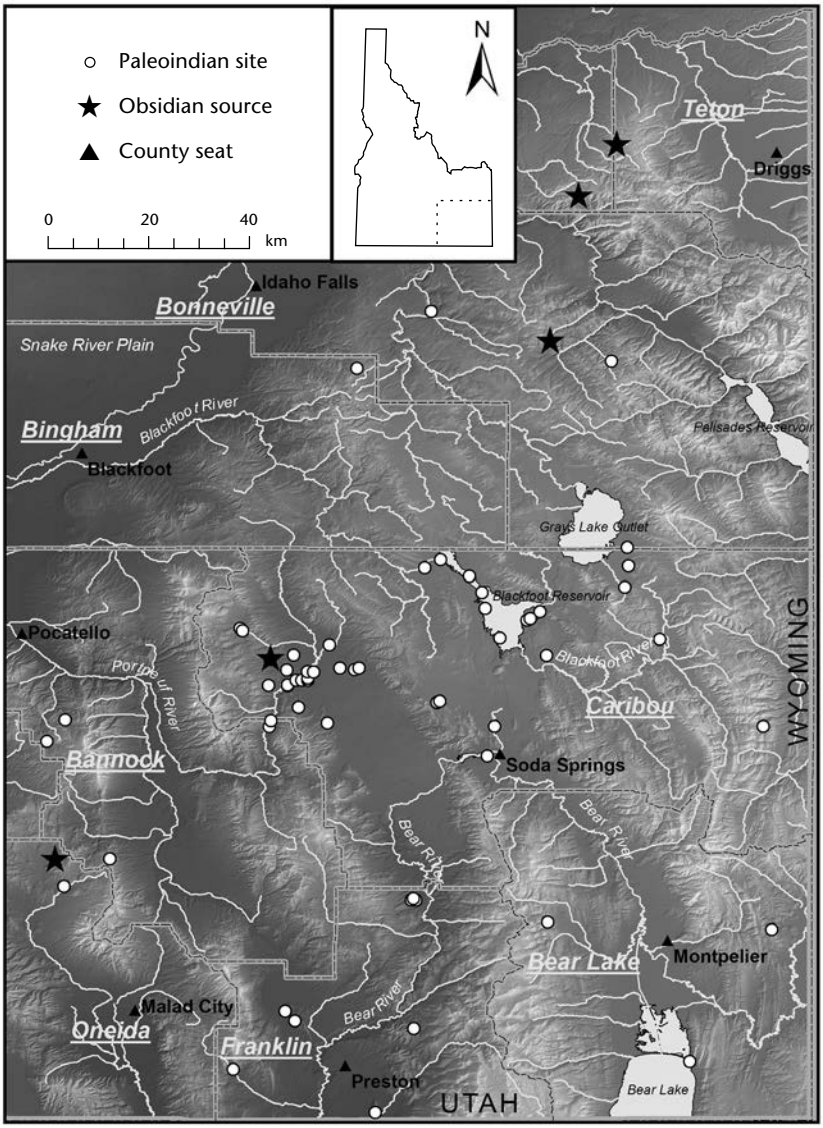

Figure 1. Southeastern Idaho study area, showing the locations of 57 Paleoamerican sites recorded in summer 2008 and select obsidian sources. Obsidian-source location data were graciously provided by Richard Holmer, Idaho State University, Pocatello.

with potential to harbor the in situ, stratified deposits that will facilitate reconstruction of the earliest human uses of a richly endowed Western landscape.

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CIEP and RIA Protein-Residue Analysis on Fluted Points from Northern Alaska

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➤ **Keywords**: Northern Alaska, Fluted Points, Protein Residues

Results are reported here on protein-residue analyses utilizing crossover-immunoelectrophoresis (CIEP) and radioimmunoassay (RIA) techniques conducted in 1999–2000 on seven fluted points from Alaska. In the early 1990s, Loy and Dixon (1998) analyzed protein residue on 36 fluted points recovered from eastern Beringian sites, including those analyzed here, to answer questions on the subsistence strategies of the people who made them, to determine the age of the artifacts, and to assess their potential relationships to materials from more southerly regions of the United States, in particular the Llano complex. Each of these artifacts was found either on the surface or in the subsurface of a site that lacks distinct stratigraphy. No faunal remains were reported in direct association with any of the artifacts.

Loy and Dixon (1998) utilized several analytic techniques to determine the origin of protein residues, including red blood cell (RBC) size, hemoglobin crystallization, isoelectric focusing (IEF), and the amplification of DNA by polymerase chain reaction (PCR). Bear, bison, caribou, mammoth, moose, musk ox, and sheep were among the mammalian taxa that they identified.

The 1999–2000 CIEP and RIA results reported here were part of a larger controlled comparative study of the two techniques involving both modern protein samples and archaeological residues, such as those reported here. The study was initiated to assess the reliability of taxonomic identifications made on protein residues adhering to stone tools recovered from northern Alaskan sites that are housed at the University of Alaska Museum (Gerlach et al. 1996; Loy and Dixon 1998; Reuther et al. 2006). Full descriptions of CIEP laboratory procedures are presented in Newman and Julig (1989) and Newman et al. (1993), while a description of RIA laboratory methods is found in Lowenstein (1981) and Reuther et al. (2006).

In 1999–2000, seven artifacts analyzed by Loy and Dixon (1998) were sent for analysis using CIEP to Margaret Newman at the Department of Biological Sciences at the University of Calgary and RIA to the third author at the Department of Nuclear Medicine, California Pacific Medical Center (Table 1). Antisera used during the CIEP analysis included bear, bovine, caribou, cat, chicken, deer, dog, duck, elephant, guinea pig, horse, moose, mouse, rabbit,

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Table 1. Results of protein-residue analyses on selected eastern Beringian fluted points.

Artifact no.	CIEP antiserum reaction	RIA antiserum reaction	Loy and Dixon (1998) taxon identification	Site (author reference)
UA74-027-0228	no test	human	mammoth, caribou	Girl's Hill (Gal 1976)
UA74-027-1256	no test	negative	caribou	Girl's Hill (Gal 1976)
UA74-027-6485	no test	human	mammoth, bison	Girl's Hill (Gal 1976)
UA76-203	negative	negative	musk ox	Hank's Hill (Cook 1977)
UA78-224-0001	negative	human	negative	TES-014 (Davis et al. 1981)
UA78-080-0633	negative	bovine, deer, bear	sheep, bear	Lisburne (Bowers 1982)
UA78-080-1105	deer, moose	bear	mammoth, sheep	Lisburne (Bowers 1982)

rat, and sheep. Antisera used during the RIA analysis included bear, bison, cat, chicken, elephant, elk, horse, human, rat and trout. The antiserum used during the 1999–2000 analyses had a reactive specificity with a precision no greater than the family taxonomic class, with the exception of CIEP moose and caribou antisera that targeted these specific species. Table 1 summarizes the results of the CIEP and RIA analyses.

CIEP and RIA analysis of two artifacts (UA78-080-1105 and UA78-080-0633) from the Lisburne site provided compatible results between the two immunologic techniques and methods utilized by Loy and Dixon (1998). Directly accordant results included residues identified as originating from bear and sheep by Loy and Dixon (1998: Tables 2 and 3, Figure 6) on one Lisburne point (UA78-080-0633) and bear and Bovine antisera reactions during the 1999–2000 RIA analysis on the same artifact. Less direct but equally compatible results included the identification of sheep residues by Loy and Dixon (1998) and RIA reactions to bear antiserum on a second fluted point from Lisburne (UA78-080-1105). In addition, residues on both Lisburne points produced reactions to deer (CIEP and RIA) antiserum indicating their potential use to procure Cervids, likely moose and/or caribou.

The remaining three results from the 1999–2000 study involved positive human antiserum reactions with residues during the RIA analysis: UA74-027-0228, UA74-027-6485 and UA78-224-0001. RIA reactions involving human antiserum likely occurred due to antiserum reactions with modern proteins derived from human saliva or sweat, as these artifacts have been handled repeatedly since their recovery (Reuther et al. 2006).

In this study, CIEP and RIA analyses could not associate northern Alaskan fluted points to their utilization on extinct species such as mammoth. Positive reactions of deer, bovine, and bear antisera to artifact residues could have been made to ancestral forms of modern species of Cervidae, Bovidae, and Ursidae; unfortunately, CIEP and RIA cannot distinguish between the extinct and modern forms. Therefore our study cannot indicate the relative age of northern Alaskan fluted points based on the association of protein residues of extinct or ancestral species to this artifact type, one of the primary research objectives in Loy and Dixon's (1998) study. Residues from species identified by Loy and Dixon (1998) may have been removed during their study, making replication of the identifications during the 1999–2000 CIEP and RIA impossible.

Identifications produced by CIEP and RIA analyses presented here are

deemed tentative at best and we are in agreement with Loy and Dixon (1998: 42) that independent verification of identifications by protein residues analyses are needed by several different lines of evidence before any firm conclusions can be established based on these analyses, especially in light of previous confusing and ambiguous results from controlled experiments designed to test the reliability and comparability of protein residue analytical techniques (Downs and Lowenstein 1995; Eisele et al. 1995; Leach and Maudlin 1995). The wide variety of identifications by Loy and Dixon (1998) and antisera reactions during the 1999–2000 analyses may indicate the use of fluted points to procure a wide variety of large mammals. Proteins from the two Lisburne points reacted with multiple antiserum, perhaps testifying to the long use life of these types of points.

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The Twain Harte Fluted Point, Tuolumne County, California

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➤ **Keywords**: Fluted Point, Mt. Hicks Obsidian, California

In 1978 a fluted point was recovered near Twain Harte in Tuolumne County, California. The Twain Harte specimen is the first fluted point identified of Mt. Hicks obsidian (Hughes 2008), a source located in the Great Basin roughly 75 air miles from the find spot, beyond the crest of the Sierra Nevada to the east. This point is also the largest of seven found to date in the Sierra Nevada Mountains (Figure 1) and the second from a buried context. It is 43.54 mm long, 37.65 mm wide, 11.29 mm thick, has a basal depth of 6.83 mm, and weighs 58.0 g. Pronounced flute scars are present on both faces, its base is concave, and edge grinding is present on both lateral margins and the basal edge. No flute scratching is present on either face. A small impact scar runs from the tip on one face, and one basal ear is missing. Obsidian hydration analyses produced average band-width readings of 6.4 μ (Origer 2008), 7.28 μ, 7.30 μ, and 7.34 μ (Carpenter 2009). However, these band widths appear to be too late in time, since Mt. Hicks artifacts have been found with readings of 10 μ band width (C. Skinner pers. comm. 2009). Specifically, some Great Basin Stemmed Series projectile points, generally thought to be later in time than fluted points, also show readings in the 10 μ range (J. Rosenthal pers. comm. 2009).

Found at an elevation of approximately 1,188 m, the fluted point was recovered from an approximate depth of 30 cm below ground surface during posthole excavation. It was broken in half at that time by a shovel strike. The find spot is located between an uphill spring and low bluffs that overlook a wetland. Ponderosa pine (*Pinus ponderosa*) is the dominant overstory. A visit to the find spot resulted in nothing that clearly signaled a prehistoric site in the area.

Maximum width, thickness, distal limits of edge grinding on both lateral margins, and the termination of the longer flute scar suggest a Clovis-like form (Rondeau 2009), although the relatively narrow obsidian-hydration band-width readings may suggest a later affiliation. The study of this specimen adds important information to a limited database on fluted points for the Sierra Nevada.

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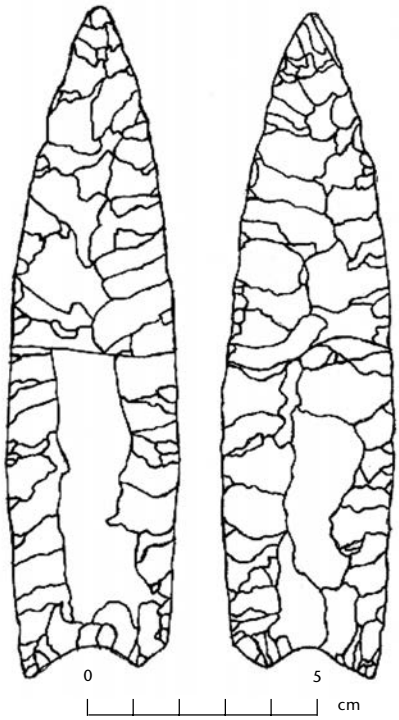

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Early Paleoamericans in Southern Idaho: The Buried Beach Site

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➤ **Keywoods:** Windust; Paleoamerican; Southern Idaho

In 2006 and 2007 Idaho State University archaeologists conducted excavations at the Buried Beach site (10CA986) in Cassia County, Idaho. The initial work

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was conducted primarily in connection with minor development of the site. The 2006 excavations were conducted to mitigate the impact of a backhoe trench inadvertently cut into the site. All excavation was conducted with very limited time and resources.

Between the two phases of excavation 21 m^2 was excavated. Most of the excavation was within two main excavation areas, a 4-by-3-m block unit and a 1-by-3-m 'L' trench. After establishing a stratigraphic profile, excavation preceded in natural stratigraphic units. Arbitrary subdivisions of large depositional units were used to maintain control of elevations within acceptable ranges. Archaeological deposits ranged in depth from 0 to more than 130 cm below the ground surface. A culturally sterile basal stratum was not encountered, and excavation was halted by the water table.

A combination of ^{14}C and OSL (optically stimulated luminescence) techniques has been used to date the cultural deposits at the Buried Beach site (Table 1). The results indicate that the site contains well-stratified deposits dating from the historic period to approximately 10,000–12,600 CALYBP. Since ^{14}C samples recovered from saturated deposits failed to produce reliable dates, OSL was used to date the lowest strata. Interpretation of the OSL results is complicated by the complex water history of the site and the luminescent properties of feldspar. Single-grain dating was used to produce the best estimate of deposit age. Currently the best estimate for the date of basal strata is 11,800 CALYBP.

Table 1. Radiometric dates from the Buried Beach site.

Stratum	Lab No.	Material	Technique	$^{13}C/^{12}C$ ratio (‰)	Date (RCYBP)	2σ age (CALYBP■)
5	Beta-225464	Charred wood	AMS	-25.5	260 ± 40	-4 – 458
3	Beta-225463	Charred wood	AMS	-25.2	5300 ± 40	5944 – 6201
2	UW-1806	Potassium feldspar	OSL▼			9500 – 10,700
1	UW-1805	Potassium feldspar	OSL▼			11,000 – 12,600

■^{14}C dates calibrated using Oxcal 4.1 software.
▼Single-grain dated. Date generated using the central-age model.

Temporally diagnostic projectile points are limited to the late-Paleoamerican and Archaic strata. One heavily reworked complete projectile point and three probable projectile-point fragments were recovered from the early-Paleoamerican-period strata. Results of typological classification using the Sigmoid-Archaeological Auto Classification System (SIGGI-AACS), an artificially intelligent classification agent (Lohse and Schou 2007), classified these artifacts to the Windust type series (Lohse 1985, 1995; Rice 1965, 1972), independently dated in a broad range from ca. 13,000 to 9000 CALYBP (Davis and Sisson 1998; Green et al. 1998; Pinson 2007).

The activity focus of the early-Paleoamerican component of the Buried Beach site appears to be the primary reduction of local quartzite through a blade-production strategy. The assemblage also contains examples of bifacial and bipolar reduction.

Taphonomic, geological, technological, and dating studies are ongoing, with the intent of verifying the antiquity and integrity of the site. Continued excavations are also being discussed.

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Obsidian Procurement and Use at the Dry Creek Site (HEA-005), Interior Alaska

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➤ **Keywords**: Alaska, Obsidian, Geochemical Sourcing

Geochemical analyses of obsidian artifacts play an important role in gaining behavioral insights into the earliest inhabitants of Alaska. In Alaska, few well-stratified, multicomponent sites exist with occupations that span the late-Pleistocene and Holocene periods. Even rarer are sites that have obsidian

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throughout most or all of the stratigraphic column. Here we report on geochemical analyses of obsidian artifacts recovered from one such site—Dry Creek (HEA-005)—located in the Nenana River valley of central Alaska.

The Dry Creek site is situated approximately 125 km southwest of Fairbanks on a glacial outwash terrace that overlooks Dry Creek. Nearly 2 m of stratified loess and eolian sand deposits with 5 interspersed paleosol complexes overlie glacial outwash (Hoffecker et al. 1996; Thorson and Hamilton 1977). Three components (C-I, C-II, and C-IV) that span over 7,000 years of intermittent use were identified at the site. C-I is dated to 11,120 ± 85 RCYBP and is assigned to the Nenana complex. C-II is associated with a paleosol dated to 10,690 ± 250 and 10,615 ± 100 RCYBP and is assigned to the Denali complex. C-IV dates between 4670 ± 95 and 3430 ± 75 RCYBP and is assigned to the Northern Archaic tradition.

A total of 60 obsidian artifacts from the site were analyzed by neutron activation analysis (NAA), X-ray fluorescence (XRF), or laser ablation inductively coupled plasma mass spectroscopy (LA-ICP-MS). Although no obsidian was recovered from C-I, obsidian from several sources was encountered in C-II. Thus far, 10 samples from Batza Téna (335 km northwest) have been identified including two biface fragments. In addition to Batza Téna, obsidian with no known geological location, referred to as Group K (Cook 1995), was first encountered at this site. Group K obsidian has no distinct visual characteristics and looks similar to Batza Téna obsidian in quality. Thirty-seven artifacts from Group K were identified including three medial microblade fragments, a microblade core tablet, and burin spall. Cook (1995) mistakenly reported artifacts of Group A (Wiki Peak source) obsidian in C-II, but provenience information for those samples indicates they were recovered from C-IV.

Multiple activity areas were identified for 14 artifact clusters (A–N) in C-II, including microblade-inset weaponry manufacture and maintenance, bifacial projectile-point production, hide working, and butchering (Powers and Hoffecker 1989; Powers et al. 1983). Obsidian artifacts are associated with 5 of the 14 artifact clusters (clusters B, C, D, G, I). Batza Téna obsidian is associated with clusters that are interpreted as related to microblade manufacturing (cluster C), and bifacial-tool production and maintenance and butchering (cluster D). Group K obsidian is associated with activity areas that include microblade manufacturing and spear maintenance (clusters B and G), bifacial-tool production and maintenance, and butchering (clusters D and I). Both varieties of obsidian are associated with clusters that reflect multiple activities. A limited analysis of formal artifact types from C-II indicated that Batza Téna obsidian was used predominantly for bifacial-tool manufacture, whereas Group K obsidian was used for microblade production.

In general, the relatively small size of artifacts attributed to Group K (average maximum dimension of 21 samples is 15 mm, and the largest maximum dimension is 45 mm) indicates that package size and shape of available raw materials from this group likely constrained the use of this source to a microlithic technology (Reuther et al. 2008). Group K obsidian has been found at HEA-232, HEA-391, LIV-054, XMH-277, and XMH-284, with at least two of these sites associated with microblade technology. Geographic distribu-

tion of Group K is restricted to interior Alaska, with the majority of the sites located in the northern Alaska Range.

During the subsequent Dry Creek occupation(s) represented by C-IV, only obsidian from the Wiki Peak area (Group A), located approximately 455 km to the southeast, was used. Thirteen Wiki Peak samples were identified in this component, including six scrapers and a side-notched point. While the earliest occupations (ca. 11,000 RCYBP) in the Nenana Valley, such as the Nenana component at Walker Road, utilized Wiki Peak obsidian (Speakman et al. 2008), the C-II occupants at Dry Creek did not. This is surprising, since obsidian seems to be a highly utilized raw material at this site compared with other sites in the region (Powers et al. 1983). It also is of interest that the C-IV occupants focused solely on procuring Wiki Peak obsidian. Although the sample size is small, our data indicate that emphasis shifted to acquiring materials from the east, rather than from the north (i.e., Batza Téna). Future research will hopefully address whether differential preference of obsidian sources/groups is a real phenomenon or just related to sampling. Further research also should focus on how obsidian raw materials influenced typological and technological variability in the Dry Creek and other interior Alaskan lithic assemblages.

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Reworked Clovis Biface Distal Fragments from the Topper Site, 38AL23: Implications for Clovis Technological Organization in the Central Savannah River Region

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➤ **Keywords**: Clovis Technology, Bifacial Point Resharpening, American Southeast

The Topper site, a Clovis quarry-related site in Allendale County, South Carolina, continues to reveal insights into Clovis lithic technology based on annual excavations in the area of the site known as the Hillside (Miller and Goodyear 2008). Excavations totaling 210 m^2 on the Hillside have produced an interesting pattern of reworked bifaces presumably originally intended as point preforms.

The analysis of Clovis bifaces from Topper is part of a comprehensive study intended to characterize biface production at this site and relate it to the broader regional Clovis systems operating in the Southeast (Smallwood and Miller 2009). During analysis of the Hillside units, we observed more failed biface bases than tips. Specifically, of 38 fragments, 13 are tips and 25 are bases. Based on a one-tailed binomial test, predicting the proportion of tips should be 0.5, a probability value of .036 suggests there is a significant difference or nonrandom pattern of salvaging and reworking preform tips.

Some distals show clear evidence of this reworking. In Figure 1A, the piece is thicker toward the base (13.1 mm) with several short flakes originating on the present basal margin. Figure 1B shows a preform tip that is thicker (8.5 mm) toward the base with bifacial retouch on the shoulders and base originating from the present margin, and what appears to be a surviving remnant of the break face. In Figure 1C, a distal fragment has been reworked with short bifacial flakes from the present margin. This piece is a thin late-stage preform with a maximum thickness of 7.6 mm; based on the clear overshot scars, it appears to be the upper blade portion of the original preform.

Salvaged preform tips were likely reused to produce Clovis points. In examining collections from the central Savannah River region, we observed two examples of points made on recovered preform tips. Figure 1D represents a whole Clovis point with early-stage fluting on the obverse face (D) but no flutes on the reverse (D′). Instead, short pressure flakes were used to create a concavity for hafting. The maximum thickness of this point is 14 mm, much thicker than an average Clovis point found in the area (the average Clovis point made on the

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local Coastal Plain chert is 7.23 mm in thickness). A second point (Figure 1E) was found in the Georgia Southern University Museum, having been collected in Burke County, GA, immediately west of Allendale County, SC. This is a prime example of a preform distal fragment converted to a point. It thickens toward the base (10.5 mm), has overshot flaking scars on both faces, and short pressure flakes originating from the present basal margin. On the obverse face high up on the mid plane of the biface is one (Figure 1E1), and possibly a second (Figure 1E2), flute termination from a removal earlier in the production process (cf. Morrow 1995). This piece has been sharpened on the tip and margins and ground on the base consistent with projectile use.

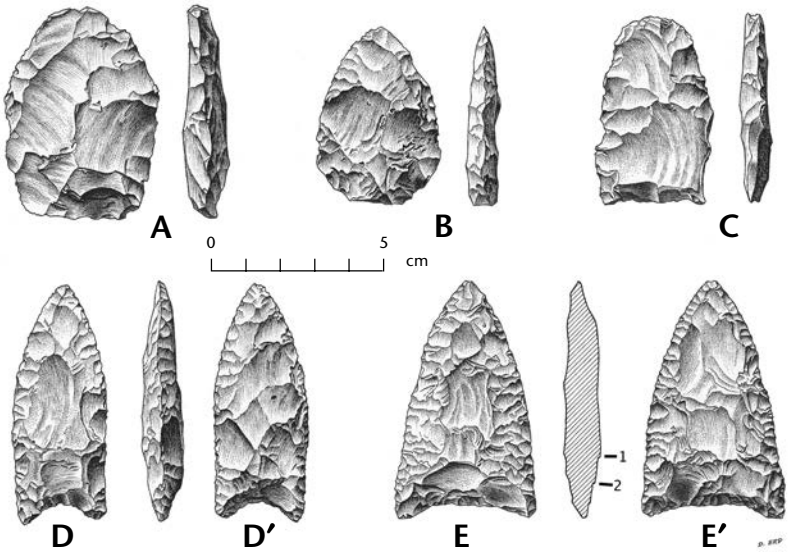

Figure 1. Reworked Clovis preform distals from the Topper site, South Carolina (**A**, **B**, and **C**) and the surrounding central Savannah River region (**D,** SC 487; **E,** SGA 1625).

Retipped and rebased Clovis points occur at kill sites, such as Colby and Murray Springs, where Clovis points were used in areas distant from quarries (Frison 1986; Haynes and Huckell 2007). The pattern at Topper suggests that modifying broken preforms into projectile points and other bifacial tools was planned at the quarry location and was not just an ad hoc strategy used in situations removed from raw-material sources. As such, it adds another clue to the organization of Clovis technology in the Southeast.

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Additional Results from the XRF Analysis of Pre-Archaic Artifacts from Last Supper Cave, Northwest Nevada.

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➤ **Keywords**: Paleoindian, XRF Analysis, Great Basin

Over the past few decades, source-provenance studies of lithic artifacts (e.g., X-ray fluorescence [XRF] spectrometry) manufactured on volcanic toolstone (e.g., obsidian) have become commonplace in archaeological research in the Great Basin. Through extensive on-the-ground sampling of raw materials (e.g., Hughes 1986; Page 2008) and geochemical analyses, we now possess a good understanding of the lithic landscape in the region. This approach has enabled researchers to consider the distances and directions that prehistoric foragers transported toolstone. In turn, these data are commonly used to reconstruct mobility strategies or exchange networks (e.g., Eerkens et al. 2008; Jones et al. 2003; Smith 2007).

In a recent study, Eerkens et al. (2007) compared the XRF results for samples of both projectile points and unmodified debitage from archaeological sites in western North America. Their comparison showed that projectile points often exhibit different source profiles than unmodified flakes, with points generally exhibiting far greater source diversity than debitage. A primary point of Eerkens et al. (2007) is that researchers should source diverse artifact types to complete the picture of prehistoric lithic procurement and transport.

Here I follow such an approach and compare the recent results of the XRF analysis of 30 unmodified and modified obsidian flakes (i.e., scrapers and retouched flakes) with results I obtained for 35 projectile points (Smith 2008)

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from Last Supper Cave (LSC), a site in northwest Nevada that was excavated in the late 1960s and early 1970s (Layton and Davis 1978). The projectile-point sample comprises Great Basin Stemmed Series points (Tuohy and Layton 1977) representative of terminal-Pleistocene/early-Holocene occupations in the Great Basin (Beck and Jones 1997). The sample of flakes was selected from the deepest strata at LSC, which contained evidence of human occupation dated to between ca. 10,300 and 8200 RCYBP (Layton and Davis 1978; Smith 2008).

Table 1 shows the results of the XRF analysis of flakes from LSC along with the previous XRF results for the sample of stemmed points (Smith 2008). Clearly, and in line with the findings of Eerkens et al. (2007), there are substantial differences in the source profiles exhibited by the two samples of obsidian artifacts. Specifically, nine geochemical types are represented in the stemmed-point sample whereas only two geochemical types are represented in the sample of modified and unmodified flakes. Additionally, there is a major difference in how far the toolstone on which the artifacts were manufactured was transported. Stemmed points were transported 1–91 km to the site with a mean distance of 20.9 km, while modified and unmodified flakes were transported 1–26 km to the site with a mean distance of 6.0 km.

Table 1. Geochemical types represented in the samples of obsidian stemmed projectile points and modified/unmodified flakes from Last Supper Cave.

		Projectile points		Flakes	
Geochemical type	**Distance to nearest source (km)**	**n**	**%**	**n**	**%**
Badger Creek (NV)	26	1	2.9	6	20.0
Beatys Butte (OR)	76	4	11.4	-	-
BHS■ Unknown 1	unknown	1	2.9	-	-
BS/PP/FM▲ (NV)	56	2	5.7	-	-
Buck Mountain (CA)	90	1	2.9	-	-
Coyote Spring (NV)	22	1	2.9	-	-
DH/WH▼	91	1	2.9	-	-
Hawks Valley	21	2	5.7	-	-
ML/GV◆	1	22	62.7	24	80.0
Total		35	100.0	30	100.0

■ Bog Hot Springs
▲ Bordwell Spring/Pinto Peak/Fox Mountain
▼ Double H/Whitehorse
◆ Massacre Lake/Guano Valley

Foremost, the results of this study support the assertion of Eerkens et al. (2007) that when sourcing lithic artifacts from archaeological sites, it is important to include a range of artifact types to provide a comprehensive picture of prehistoric technological organization. Additionally, these findings illustrate the potential complexity involved in reconstructing foragers' lithic economies. For example, what aspects of hunter-gatherer behavior do the differences in the source profiles of points and modified/unmodified flakes reflect? Several possible answers exist. First, such differences could be a function of varying use lives of lithic tools (i.e., curated vs. expedient artifacts) (*sensu* Binford 1980). Second,

they could reflect gender-based divisions in mobility strategies where men ranged far from residentially stable locations occupied by women, children, and the elderly (Elston and Zeanah 2002; Leach 2007). Finally, the differences in the source profiles could reflect retooling activities where groups arrived at sites with depleted lithic artifacts and reprovisioned their toolkits using locally available raw materials (Graf 2001; Smith 2007). These possibilities are not mutually exclusive, and addressing each in detail lies beyond the scope of this paper. However, based on the results presented here and elsewhere, it has become clear that we must include other artifacts in addition to projectile points if we are to better understand prehistoric mobility strategies and exchange networks in the Great Basin.

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Old Points in a New Place: Paleoindian Projectile Points of the Valles Caldera, Jemez Mountains, New Mexico

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➤ **Keywords**: Valles Caldera, Paleoindian Projectile Points, Obsidian Sourcing

The high-quality obsidian in the Jemez volcanic field in north-central New Mexico would have been a powerful attraction for early mobile populations in the Southwest and Great Plains. The scanty knowledge of Paleoindian use of the Jemez Mountains comes from surface finds of diagnostic artifact types and a single excavated Clovis site (LA66891) (Anschuetz et al. 1997; Huber et al. 1993). Sourcing artifacts in Paleoindian assemblages elsewhere can provide indirect evidence of Paleoindian use of the mountains (Hester et al. 2006; LeTourneau and Steffen 2002; Steffen and LeTourneau 2007), although the presence of some Jemez obsidians outside the Jemez Mountains in secondary deposits must be considered before assuming direct acquisition (Hughes 1998; LeTourneau 2000; LeTourneau et al. 1998). At the center of the Jemez Mountains is the Valles caldera, a large volcanic crater managed as the Valles Caldera National Preserve (VCNP) since 2000. Central research objectives of the VCNP cultural resources program are to understand the earliest human uses of the caldera, maximize information gained from surface assemblages, enhance the utility of obsidian analyses for regional chronometrics, and understand prehistoric raw-material transport and economy. One ongoing research project uniting all these goals is a diagnostic projectile-point study that includes type identification, obsidian hydration, and raw-material sourcing (Decker 2008; Steffen and Decker 2008).

This study of projectile points includes all 121 temporally diagnostic specimens collected from the VCNP during the 2001–07 field seasons (37 additional

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points from 2008 are currently undergoing analysis). Point types range from late Paleoindian through Puebloan. X-ray fluorescence analysis conducted by Hughes on the 90 obsidian points has established that all are from Jemez Mountains geochemical sources (Hughes 2008a, 2008b). Obsidian hydration analysis was conducted by Tom Origer to document relative indicators of hydration age across the wide temporal span represented. These data provide a baseline for chronometric study of the three main Jemez obsidian sources. The oldest obsidian points will inform on late-Pleistocene/early-Holocene human use of the caldera, and also provide examples of older hydration rims critical for developing source-specific hydration rates.

To date, seven Paleoindian projectile points have been documented within the VCNP. Six were recovered from surface contexts, and one was excavated from an Ancestral Puebloan subsurface context. The types represented include Midland, Plainview, Agate Basin, Cody, and Jimmy Allen/Angostura.

The oldest specimen is a Midland point proximal fragment of fine quartzite (probably Morrison or Dakota Formation). While no fluted points have yet been discovered within the VCNP, the Midland point indicates a Folsom-era presence in the caldera. Points immediately postdating the Folsom era include the basal portion of a Plainview type made of chert/chalcedony from Cerro Pedernal geological deposits in the northern Jemez Mountains, and an Agate Basin basal fragment of the same material. The Agate Basin point is a basal fragment measuring 25 mm from base to break, biconvex in cross section, with parallel flaking carrying to the midline. The lateral margins are lightly ground and expand from a basally thinned, straight unground base. The vertical removals from the base may represent reworking. Two Cody-complex point fragments of Pedernal chert and El Rechuelos rhyolite (Polvadera Peak) obsidian have also been recovered (see Pinson et al. this volume).

Two points date to the late-Paleoindian/early-Archaic period. This transitional period includes a number of poorly understood projectile point types, but the distinctive parallel-oblique flaking patterns of the two VCNP points suggest Jimmy Allen or Angostura types. One point is a distal fragment made from El Rechuelos obsidian, and the other is a basal fragment made of dark red silicified rhyolite (see Dello-Russo 2004) from Socorro County.

While this group of seven Paleoindian points is a small sample, it is interesting to note that most specimens were found in the northern half of the caldera and that all but two were made from local materials from the area directly north of the caldera. The dominance of non-obsidian points probably reflects a preference for chert over obsidian characteristic of Paleoindian point assemblages throughout New Mexico. Given the extraordinary abundance of obsidian in and around the VCNP, the low proportion of obsidian among Paleoindian points in the VCNP (29 percent) bears a surprising similarity to the 15–31 percent range documented in assemblages in central New Mexico (LeTourneau and Baker 2002; LeTourneau et al. 1998). This pattern also may indicate the importance of the intra-caldera high elevation grasslands for hunting: All seven points are fragments of finished points and reflect hunting losses (the tip and base/midsection) and retooling of points damaged during hunting (bases).

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Late-Pleistocene Occupations in the Lake Koshkonong Region, Southeastern Wisconsin

Daniel M. Winkler and Robert J. Jeske

➤ **Keywords**: Great Lakes, Clovis, Museum Collections

As part of an ongoing study of the late-Pleistocene/early-Holocene settlement in southeastern Wisconsin, Paleoamerican hafted bifaces (a.k.a. projectile points) from local collections at the Hoard Museum in Fort Atkinson were examined and compared with previously reported data from the Schmeling site, located on the northwest shore of Lake Koshkonong (Jeske and Winkler 2008). The collections at the Hoard Museum often lack precise provenience information, but the collections are still useful since most of the collectors focused on the local area, including Lake Koshkonong.

Early-Paleoamerican occupation of the region is represented by 14 Clovis bifaces or fragments in the Hoard collections (Figure 1). Late-Paleoamerican material is more diverse and is represented by 11 bifaces or fragments including 7 Agate Basin, 2 Dalton, an Eden, and a Scottsbluff. Similar types were recovered in situ at the stratified Kelly North Tract at Carcajou Point in 2002 (Jeske et al. 2003; Winkler 2004).

The Clovis bifaces were manufactured from local Galena, Platteville, and Silurian cherts, with one unknown chert. Six were thermally altered or burned. Three were broken. Five showed signs of reworking or reuse, including bipolar recycling. The complete bifaces had an average length of 60.1 mm, width of 26.3 mm, thickness of 8.1 mm, and weight of 13.0 g. Thirteen of the hafted bifaces were recovered by one individual, suggesting they may have all been collected from the same site, similar to the Clovis points recovered at the Schmeling Site.

However, the complete Schmeling Clovis bifaces are significantly smaller than those from the Hoard (mean length 44.7 mm, width 24.2 mm, thickness 6.6 mm, and weight 7.6 g). More of the Schmeling bifaces were broken and showed signs of reuse. Five of the Schmeling bifaces were made from non-local Hixton silicified sandstone, which is not found in the Hoard Clovis material (cf. Jeske and Winkler 2008:100). The differences may be the result of collector bias in the Hoard assemblage, or the differences may be related to the Schmeling site's inferred long-term occupation. But the overall use of local materials, recycling, and heat-altered materials suggests that a similar resource-use strategy is represented by both collections. Although the provenience of the Hoard collection bifaces is not precise, the possibility of a second locality near Lake Koshkonong that yielded more than a dozen Clovis points is especially interesting.

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Figure 1. Selected Clovis hafted bifaces from the Hoard Museum collection (top row) and the Schmeling site (bottom row).

The limited data from the Hoard Museum support our previous inferences that the early-Paleoamerican occupants of the Lake Koshkonong region were relatively sedentary, with a smaller geographic range than later groups. The local availability of multiple, relatively high quality lithic resources also militated against high mobility and large territories. The raw-material types from the combined collections suggest the use of locally available raw materials, with occasional logistical forays into western and west-central Wisconsin (Jeske and Winkler 2008:101).

Our proposed model is also supported by pollen samples that indicate that late-Pleistocene/early-Holocene southern Wisconsin had a relatively warm and open environment dominated by a spruce parkland landscape and wetlands (Johnson 1997). This environment would have provided an energy base capable of supporting long-term or repeated occupation of sites and a subsistence strategy involving the use of local resource zones to take aquatic species, small terrestrial mammals, and birds.

The proposed low mobility of early-Paleoamerican groups required tight management of material, as groups juggled the energy requirements for

technology with energy requirements for food acquisition. The reworked tools, heat treatment, and bipolar recycling techniques seen in the Lake Koshkonong collections were effective ways to balance these competing needs. Continued research around Lake Koshkonong will provide new insights into the Paleoamerican entry and occupation of the region.

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Taphonomy

Taphonomic Effects of Burning on Ivory: Preliminary Results

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➤ **Keywords**: Burned Ivory, Forensics, Taphonomy

Much has been written on the taphonomy of burned animal and human bones and teeth (Beach et al. 2008; Correia 1997; David 1990; Gilchrist and Mytum 1986; McCutcheon 1992; Nicholson 1993; Schmidt and Symes 2008; Shipman et al. 1984; Sillen and Hoering 1993; Spennemann and Colley 1989; Ubelaker 2009). The subject is of interest to paleontologists, archaeologists, and forensic anthropologists engaged in such diverse research as understanding the origin of fire use by humans, interpreting archaeological and paleontological site-formation processes, and investigating modern crimes involving human remains in forensic contexts. In contrast, comparatively little has been written on studies of burned ivory (Baer et al. 1971a, 1971b, 1978; Low et al. 1980; Sakae et al. 2005). While less commonly noted than burned bones, burned ivory may be encountered in paleontological and archaeological contexts and is of particular interest to wildlife forensic scientists seeking to identify and understand processes that modify ivory and ivory artifacts in the wildlife trade.

To investigate this issue, we initiated taphonomic studies on the effects of burning on tusks of modern African elephant (*Loxodonta africana*) and walrus (*Odobenus rosmarus*). Open-flame experiments were conducted at a fire research laboratory (Chilworth Pacific Fire Laboratories, Inc.; Kelso, Washington USA). Data were collected on the following variables: temperature range (200–1100 C), differing fuel sources (propane, gasoline, diesel fuel, wood, and straw), time of combustion (10 min to 1 hr), and changes to the ivory material itself (including color, fragmentation, and weight).

While details of the experiments will be presented in a subsequent paper,

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some preliminary results are presented here. Overall, we found that short duration exposure to gasoline-fueled flames did not destroy the ivory; rather, it only discolored the outer layers. Like previous studies of bone and ivory (Baer et al. 1971a, 1971b, 1978; Beach et al. 2008; Low et al. 1980; Nicholson 1993; Sakae et al. 2005; Shipman et al. 1984), we noted a range of color changes that occurred as burning time and temperature increased. Colors observed included black, tan, blue, gray, and white. Spalling was common, with both small and large spalls ejecting up to 10–15 feet away. This typically occurred as the ivory began to burn, presumably related to moisture being driven out of the ivory. All specimens underwent weight loss as a result of burning. To our knowledge, no researchers have reported spalling similar to that we observed on burned ivory (Baer et al. 1971a, 1971b, 1978; Low et al. 1980; Sakae et al. 2005). This may be related to the fact that we used open-flame tests and liquid fuels, while previous tests used furnace/oven experiments.

Following even short-duration burning (10 min), exterior surfaces of the elephant ivory exhibited extensive fine-line cracking and delamination. After more prolonged burning (30 min), some exterior surfaces were calcined blue and white, while inner layers were charred black. The primary difference we observed between walrus ivory and elephant ivory of similar size is that walrus ivory was much more fragmented and fragile following burning.

Among our most significant observations was the fact that it is possible to extensively burn the outer layers of elephant ivory (including the cementum) while leaving the central core of the ivory (the dentine) visually unchanged. In other cases, the inner dentine was discolored a tan/caramel color resembling some hues we have observed on fossil mammoth ivory. These open-flame results are consistent with oven experiments reported by Baer et al. (1971a).

Overall, our experiments showed that extensive and prolonged burning would be required to completely consume a large piece of elephant ivory in a fire. Our results are consistent with Baer et al. (1971a) in documenting that caramel-colored hues seen on some ivory can be produced by burning. This suggests that modern elephant ivory can be made to look old and discolored by exposure to fire. Our results also show that it is possible to extensively burn the outer layers of elephant ivory, yet retain an inner core that can later be carved into artifacts. This is also consistent with Baer et al. (1971a), who speculated that it might be possible to carve ivory after it was burned and discolored. This has implications for understanding the taphonomic pathways that produce modifications to ivory artifacts in the archaeological record and the modern wildlife trade.

Our plans for future research include 1) more fully reporting these experiments, 2) comparing these open-flame experiments with furnace experiments (where the focus is on heat rather than flame), and 3) investigating structural changes to burned ivory using analytical instrumentation such as infrared spectroscopy (Sakae et al. 2005). Given the fact that we used propane and liquid fuels in several of our experiments, more extensive tests using fuel sources available to early hunter-gatherers are also needed. We hope that this note will stimulate further interest and research regarding burned ivory.

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Microwear on a Probable Burnishing Tool of Pre-Clovis Age from SV-2 (44SM37), Saltville, Virginia

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➤ **Keywords**: Pre-Clovis/Paleoamerican Tools, Microwear, Saltville

Field research into the late-Quaternary history of the Middle Appalachian region was carried out from 1980 through 1997. An important result was the recognition of human presence in the region from at least ca. 14,500 RCYBP. Three horizons of pre-Clovis age are known from site SV-2 in Saltville Valley, southwestern Virginia (McDonald 2000). Publication of results of this work includes information on the environmental and archaeological context in which the probable burnishing tool described in this paper appeared (Delcourt and Delcourt 1986; McDonald 1984, 1985a, 1985b, 1989, 2000, 2003, 2008; McDonald and Bartlett 1983; McDonald and Freeman 2009; McDonald and Kay 1999; McDonald et al. 2008).

The oldest of three pre-Clovis horizons at SV-2 (44SM37) is dated to 14,510 ± 80 RCYBP (Beta-117541). This horizon, which was unified stratigraphically and functionally, contained evidence of extensive utilization of a mastodon (*Mammut americanum*) carcass, including the butchering of the animal, possible working of its hide, shattering of much or most of the skeleton, extraction of grease from the shattered bone, and sectioning and husking of the tusks (McDonald 2000). Several tools and probable tools were recovered from this horizon, one of which was a small piece of dense bone (Virginia Museum of Natural History VMNH 2262; Figure 1A), a fragment of a larger bone incised with a highly polished hemicylindrical groove resulting from extensive but low-pressured patterned abrasion of cylindrical objects. This piece was most closely associated spatially with the sectioned and husked fragments of tusk. The diameter of the groove in VMNH 2262 corresponds with those of several ivory rods in the collections of the Florida Museum of Natural History with which it has been compared, and it is considered probable that VMNH 2262 is a burnishing tool that was employed in the finishing of ivory—as well as, possibly, bone, antler, horn, or wood—rods.

Microwear on VMNH 2262 was examined and imaged in 2008 at magnifications of 100x, 200x, and 500x, using a Z-stage confocal microscope operated by J. Wiederhold at the Center for the Study of the First Americans, Texas A&M University (Wiederhold and McDonald 2008). All regions of the surface of VMNH 2262 were viewed under magnification. Random unpatterned striae, ranging from abrasion visible without magnification to diverse microscopic incisions, occur irregularly across much of the examined surface, including

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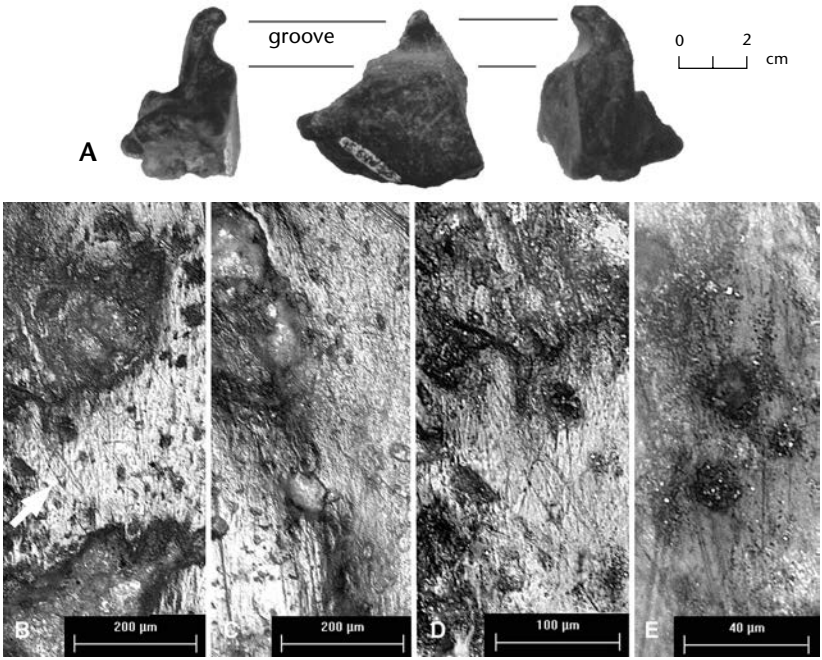

Figure 1. VMNH 2262, a probable pre-Clovis burnishing tool, in three perspectives (**A**) and three levels of magnification (**B–E**). The longitudinal axis of the groove is oriented top-to-bottom in images **B–E.** In all three views, the striae are numerous but weak, thereby exhibiting one important quality that contributes to the interpretation of the function and use of this tool. (**B**) At 100x, topographic extremes of higher (dark shiny areas at top and bottom) and lower (lighter area in middle) relief surfaces are shown, with the lower surface showing numerous short, shallow, and straight striae at this level of magnification. Note the few diagonal striae near the middle left part of the light area, marked here with an arrow. (**C**) At 100x, juxtaposed areas of high polish (upper left), moderate polish (right half), and no polish (lower left) can be seen. Note the generally longitudinal orientation of the striae and the exceptional diagonal set of parallel striae near the upper right corner. (**D**) At 200x, the striae in the softer degraded surfaces are more apparent. The area centered here corresponds with the area marked by the arrow in view B. (**E**) At 500x, striae on one of the highly polished surfaces are visible. Collectively, these images show the dominance of short, shallow, straight, longitudinally oriented striae; the difference in visibility of striae between the harder and softer surfaces; and the preferential bias of diagonal striae being oriented from lower right to upper left (apparent in B, C, and D).

the flat fracture surface along which the piece separated from the larger bone of which it was a part. Directionally and morphologically patterned microwear, however, is confined to, and occurs across the entirety of, the surface of the groove. The patterned wear on the surface of the groove consists predominantly of two distinct signature classes, each corresponding to the topographic extremes of the microscopic surface: a) the topographically higher surfaces, considered to be micromasses of harder bone more resistant to abrasion, exhibit high polish and relatively shallow striae; b) the topographically lower surfaces, presumably associated with softer bone and more easily removed by abrasion, contain numerous and relatively deeper striae.

The softer, topographically lower surfaces that were more susceptible to

abrasive degradation contain myriad striae. These are typically short, shallow, and straight incisions, primarily solitary but occasionally as multiple parallel features, and oriented parallel or nearly parallel to the longitudinal axis of the groove. In addition, solitary or multiple parallel striae sometimes occur at angles, typically < 30°, distinctly oblique to the longitudinal axis and showing a biased orientation. Rarely, and presumably randomly, nearly transverse striae occur across the surface of the softer bone. The presumed relative hardness of the topographically higher parts of the bone structure combined with the inferred light abrasion used in the burnishing process have resulted in a continuous wearing away of the harder surface, resulting in polish but an absence of numerous distinct striae. The relatively few and shallow striae present on the highly polished surfaces are not visible except under higher magnification (Figure 1B–E).

The numerous striae on the softer, lower surfaces and the strong polish on the harder, higher surfaces suggest that the abrasive wear on this tool was created by the repeated application of possibly short, more certainly low-pressure, strokes onto or against relatively soft or fine-grained substances. The biased directional pattern of diagonal striae further suggests that the object being abraded was occasionally rotated during the burnishing process in a consistent direction, and at a consistent rate, relative to the movement of the burnishing tool. The patterns of microwear on this object, combined with its size, form, and the context of its discovery, converge to support the supposition that it was a specialized tool used in the later or final phases of production of polished rods, including the ivory rods that apparently were being produced at SV-2.

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Paleoenvironments: Plants

A Nonsiliceous Algae Sequence from Rocky Run Road Channel Lake, Portage County, Wisconsin

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➤ **Keywords**: Nonsiliceous Algae, Paleoenvironments, Wisconsin

A nonsiliceous algae investigation was undertaken on a sediment core from an unnamed lake referred to as Rocky Run Road Channel Lake (RRRCL) located in the city of Stevens Point, Portage County, Wisconsin (89° 34′ 24″ N, 44° 30′ 41″ W, Whiting 7.5′ Quadrangle). The 221-cm-long core retrieved from RRRCL consists of two major lithological units (Figure 1). The base of the core can be dated to approximately 11,000 RCYBP by pollen correlation to other dated cores (Huber 1998).

In Zone RRRCL-1, *Gloeotrichia*-type is the most abundant algae (1–15 percent). *Scenedesmus* reaches a maximum of 40 percent in the lowermost level, then falls to less than 4 percent (Figure 1). Other prominent algae are *Botryococcus*, *Zygnema*-type, *Spirogyra*-type, *Tetraedron*, and *Pediastrum Boryanum*. Algae are well established at the beginning of this zone indicating that initial colonization had taken place prior to the deposition of the oldest sediments. The maximum in *Scenedesmus* in the lowermost sample indicates elevated nutrient levels (Cronberg 1982) at the bottom of this zone. The decline in *Scenedesmus* and increase in *Gloeotrichia*-type indicate a decline in nutrient influx to the lake. *Gloeotrichia* is a nitrogen-fixing blue-green algae (Van Geel et al. 1989) that can absorb nitrogen gas directly from the air (Lee 1980) and often indicates nutrient-poor conditions. *Zygnema*, *Spirogyra*, and *Mougeotia* are indicators of stagnant, shallow, and more or less mesotrophic habitats (Van Geel 1978).

In Zone RRRCL-2, *Gloeotrichia*-type is the dominant algae, *Scenedesmus* falls to trace amounts, and *Botryococcus* is absent. The decline in algae diversity and abundance in this zone may be a result of lowering of the water level. The *Gloeotrichia*-type peak in the upper portion of Zone RRRCL-2 may be the result of reworking and redeposition of lake bottom sediments as suggested by the pollen stratigraphy and core lithology (Huber 1998).

The increase in algae abundance and diversity in Zone RRRCL-3 indicates a return to moister conditions. The small *Scenedesmus* peak at the top of this

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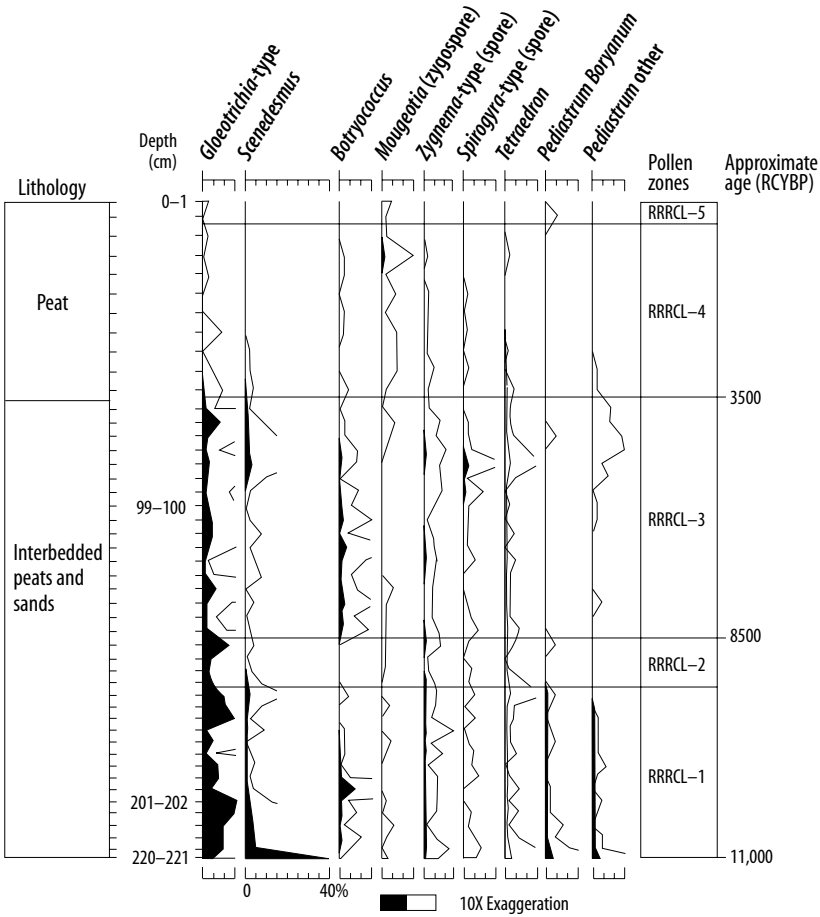

Figure 1. Percentage diagram of nonsiliceous algae, Rocky Run Road Channel Lake, Portage County, Wisconsin. Approximate RCYBP dates are based on pollen correlation to dated sites. *Pediastrum* undifferentiated includes *P. Boryanum* var. *longicorne*, *P. integrum*, *P. integrum* fa. *glabra*, *P. araneosum*, *P. araneosum* var. *rugulosum*, *P. duplex*, *P. muticum*, *P. obtusum*, and *P. Kawraiskyi*. Algae percentages are based on the pollen sum plus the algae sum.

zone may indicate a short period of slightly enriched nutrient conditions. Zone RRRCL-4 is characterized by a decline in both algae diversity and abundance (Figure 1). The reduction in algae abundance and diversity in Zone RRRCL-4 may be the result of changing water chemistry and nutrient availability as the lake became filled with sediment. Zone RRRCL-5 is even more impoverished than Zone RRRCL-4. The impoverished algae spectra indicate that nutrient-poor conditions currently prevail in RRRCL.

Few nonsiliceous algae investigations have been undertaken in Wisconsin. The algae sequence from RRRCL provides comparative data for future late-Pleistocene and Holocene paleoecological studies. The nonsiliceous algae

indicate that stagnant mesotrophic conditions to nutrient-poor conditions have prevailed throughout most of the lake's history.

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Evidence of Late-Pleistocene Monte Formation in Central West Argentina

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➤ **Keywords**: Coprolites, Paleoenvironment, Mendoza Province

The present knowledge on late-Quaternary environmental change in subtropical central-western Argentina is fragmentary, particularly because dates and organic records are scarce (Martínez Carretero et al. 2004), pollen analyses are mostly restricted to the Holocene, and a general model of Pleistocene glacial advances is not yet available. Within this context, a paleoecological record obtained from recent stratigraphic excavations at the Gruta del Indio site (34° 45′ S, 68° 22′ W, 660 m a.s.l.) provides important evidence of paleoenvironments of the area, particularly for the late Pleistocene (García 2003; García and Lagiglia 1999). This record, unique for this part of South America, is composed of coprolites from small rodents (medium-sized *Lagidium viscacia*) and large mammals (*Hippidion* sp.) (García et al. 2006, 2008). Two xeric phytogeographical regions are currently present in the area: the Monte, on flatlands and foothills, dominated by shrubs and scarce trees, and the Cardonal, on sunny slopes, dominated by cactaceae and small shrubs.

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Microhistological and phytosociological analyses were performed on this record. Results point to the presence of Monte conditions in the area as early as ca. 31,000 RCYBP.

Considering both the current and the paleobotanical local flora, and analyzing macrobotanical remains, 42 plant taxa were identified, 35 to the species level (Table 1). In the current local flora, 77 percent of the 35 species recorded belonged to the Monte and 4 percent to the Cardonal, whereas in the fossil record, dated between 24,140 ± 510 (LP 1075) and 30,800 ± 700 (LP 918) RCYBP, 17 plants were found, 10 of them (58.8 percent) identified to the species level and all belonging to the Monte formation. In agreement with plant taxa distribution, chorological types were defined as Monte, Cardonal or other. Taking the chorological spectrum into account, Monte plant species are present in all samples, and those from Cardonal (the warm region closely related to the Monte) are less abundant.

From this analysis, *Prosopis flexuosa* var. *depressa*, *Pappophorum caespitosum*, *Capparis atamisquea*, *Cercidium praecox* ssp. *glaucum*, among others, emerge as indicative species of a warm and dry environment, typical of the Monte.

Midden floras contain perennial C3 shrubs (*S. aphylla*, *P. flexuosa* var. *depressa*, *L. divaricata*), C4 summer-flowering perennial grasses (*P. caespitosum*, *Boutelowa* sp., *D. californica*), and C4 annual grasses (*A. adscensionis*). *Pappophorum* is common in Argentina and southern Peru, and scarce in Chile, whereas *P. caespitosum* is a common grass in the Monte (Argentina). On the whole, megathermal species and the C4 photosynthetic path indicate that plant species adapted to environments of high temperature, high solar radiation, and low water availability dominated both records.

According to these results, vegetation in Gruta del Indio and the surrounding area for the period of 31,000 to 24,000 RCYBP provides evidence of arid conditions similar to the current ones. This does not mean that the plant community structure was the same, since aspects like distribution, density and quantity of each species could be different. Nevertheless, as a whole, the presence of a group of megathermal species characterizing current Monte formation indicates that this type of vegetation prevailed over the area in the analyzed period, in relation to a climatic trend dominated by warm and dry conditions.

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Table 1. Current and fossil flora (24–31 kybp) from Gruta del Indio area. M= Monte; C = Cardonal; N= Nanophanerophytes; Ch= Chamaephytes; H= Hemicryptophytes; T= Terophytes; E = Epiphytes; ft= climb phanerophytes; S= Succulents

	Current flora	Paleo flora	Chorological type	Life form
*Ephedra triandra**			M	N
*Lycium chilense ovalifolium**				N
*Condalia microphylla**			M	N
Glandularia crythmifolia			M	Ch
*Aloysia gratissima**			M	N
*Zuccagnia punctata**			M	N
*Larrea divaricata**			M	N
*Lecanophora heterophylla**			M	Ch
*Tephrocactus aoracanthus**			M	S
*Bulnesia retama**			M	N
*Trichocereus candicans**			M	S
*Lycium tenuispinosum**			M	N
*Larrea cuneifolia**			M	N
*Senna aphylla**			M	Ch
*Prosopis flexuosa depr.**			M	N
*Pappophorum caespitosum**			M	H
Acantholippia seriphioides			M	Ch
*Boutelowa af. curtipendula**			M	H
*Capparis atamisquea**			M	N
*Stipa sanluisensis**			C	H
Clematis denticulata				ft
Bowlesia tropaeolifolia			C	T
*Schinus fasciculata**			M	N
Senecio gilliesianus			M	N
Baccharis salicifolia			M	N
*Salvia gilliesii**			C	N
*Geoffroea decorticans**			M	N
*Digitaria californica**			M	H
*Aristida adscencionis ?**			M	H
*Budleja mendocensis**			C	N
*Cercidium praecox**			M	N
Eupatorium patens			M	N
*Hyalis argentea**			M	Ch
Caesalpinia gilliesii				N
Ligaria cuneifolia				E
Chenopodiaceae				
Chloridea				H
Poa ?				H
Fabiana sp.				
Lycium sp.				
Setaria sp.				H
Hordeum sp.				H

* Megathermal species
Presence

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Paleoenvironments: Vertebrates and Invertebrates

Fossil Birds of the Crowfield Local Fauna, Late Pleistocene (Rancholabrean), South Carolina

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➤ **Keywords**: Rancholabrean, Birds, South Carolina

This report on the Crowfield local fauna paleo-avifauna is the second on late-Pleistocene local fauna (Rancholabrean) to be recorded for South Carolina. The first record is from the Ardis local fauna (Chandler and Bentley 2007).

During 1988–90 fossils were collected from the Crowfield Lake excavation site between Summerville and Goose Creek, South Carolina, along the Dorchester-Berkeley county line. Among the more than 7,000 vertebrate fossils collected were 38 bird bones, 29 identifiable. Associated with the bird remains were over 40 mammalian taxa and a substantial herpetofauna. Materials were surface collected, particularly after heavy rains, and at least 3 tons of fossiliferous matrix was screen washed using #20 soil sieves.

The Wando Formation, the source of the fossils, is composed of late-Pleistocene sands, clays, and silts, dated at approximately 130,000 to 75,000 years ago. Fossil wood and vertebrates suggest deposition in estuarine to fluvial environments (Weems and Lemon 1988).

The Crowfield bird fauna comprises five orders, eight families, and eleven species. Included are four species of ducks including the mallard (cf. *Anas platyrhynchos)*, American black duck (cf. *A. rubripes)*, green-winged teal (cf. *A. crecca),* and wood duck (cf. *Aix sponsa*); wild turkey (*Meleagris gallopavo*); Northern bobwhite (*Colinus virginianus*); a grebe (*Podiceps* aff. *P. auritus*); a hawk (*Buteo* aff. *B. lineatus*); and three passerines—a jay (aff. *Cyanositta* sp.), meadowlark (aff. *Sturnella magna*), and wood warbler (cf. *Icteria virens*).

The fossil material includes, for the mallard, right coracoid humeral end (SC 2009.1.1), and left coracoid humeral end (SC 2009.1.2); for the American black duck, right coracoid humeral end (SC 2009.1.3); for the green-winged teal, left humerus proximal end (SC 2009.1.4), left humerus shaft (SC 2009.1.5), right humerus distal one half (SC 2009.1.6), and right tibiotarsus

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distal one half (SC 2009.1.7); for the wood duck, right humerus distal one half (SC 2009.1.8); for the wild turkey, left carpometacarpus distal end (SC 2009.1.9), left tibiotarsus distal end (SC 2009.1.10), left tibiotarsus distal end (SC 2009.1.11), left tarsometatarsus proximal end (SC 2009.1.12), and left tarsometatarsus distal end (SC 2009.1.13); for the Northern bobwhite, right coracoid humeral end (SC 2009.1.14), left coracoid humeral end (SC 2009.1.15), left coracoid humeral end (SC 2009.1.16), left coracoid humeral end (SC 2009.1.17), left humerus missing internal tuberosity (SC 2009.1.18), right humerus proximal end (SC 2009.1.19), right humerus missing head (SC 2009.1.20), left ulna proximal end (SC 2009.1.21), and left carpometacarpus distal end (SC 2009.1.22); for the grebe, left humerus missing head (SC 2009.1.23); for the hawk, talon (SC 2009.1.24); for the jay, right humerus missing proximal end (SC 2009.1.25) and left ulna distal end (SC 2009.1.26); for the meadowlark, left tarsometatarsus distal end (SC 2009.1. 27); for the wood warbler, right coracoid humeral end (SC 2009.1.28) and left tarsometatarsus distal end (SC 2009.1.29).

The species recorded from the Crowfield local fauna are typical members of the modern Atlantic coastal plain biota. The ducks and grebe indicate the presence of ponded water or riparian meandering streams. The turkey and quail require well-drained soils for nesting. A medium-sized hawk is a typical aerial predator here today. The passerines may represent resident or migratory species. All fossils are completely ossified precluding any juvenile or immature individuals. The Crowfield paleo-avifauna is similar to the Ardis local fauna (Chandler and Bentley 2007) and Clark Quarry near Brunswick, Georgia (Mead et al. 2006), with fossil species representing water birds, gallinaceous birds, an aerial predator, and several species of perching birds. However, Bentley et al. (1994) considered the mammals from the Ardis local fauna to represent an edge community ("disharmonious fauna"), i.e., species not represented in the region today. The Crowfield fossil birds are all modern species that support the paleo-environmental interpretation of Weems and Lemon (1988).

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Opal Phytoliths from Teeth Calculus in the Mammoths of the Hot Springs Site, South Dakota

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➤ **Keywords:** Columbian Mammoth, Paleodiets, Hot Springs Site

Understanding paleohabitats and paleodiets of Pleistocene megafauna may help us comprehend the causes of their extinction or survival. Some experimental studies of opal phytoliths from teeth calculus have been carried out on North American herbivore megafauna (Armitage 1975; Gobbetz and Bozarth 2001). This approach complements analysis of plant remains found in preserved dung (Mead et al. 1986) and supplements studies of isotopes of carbon, oxygen, and strontium for reconstructing diets and geographic range (Bombin and Muhlenbachs 1985; Connin et al. 1998; Hoppe 2004). In this paper we present the first results of our study, the analysis of mammoth teeth calculus from the Hot Springs site, South Dakota.

Samples of dental calculus from six mammoth at the Hot Springs site were collected for opal-phytolith analysis. The samples were processed using a modified version of the method proposed by Bozarth and Hofman (1998). The specimens included four Columbian mammoths (*Mammuthus columbi*) and two woolly mammoths (*Mammuthus primigenius*). Specimens HSM-1, HSM-2 and HSM-4 are different individuals. HSM-3 and HSM-5 belong to the upper and lower teeth, respectively, in one individual. The two woolly mammoth samples (HSM-6 and HSM-7) were obtained from the upper teeth. Samples of sinkhole sediments surrounding the mammoth remains were collected from four stratigraphic locations (HSS-1 to HSS-4), processed, and analyzed for opal phytoliths. The results were plotted in sets of graphs for the two mammoth species and the sediment samples (Figure 1).

Short cells diagnostic of Pooideae (C_3 cool season) grasses dominate in dental calculus of both mammoth species and in all sediment samples. The percent of total grass phytoliths in teeth varies from 16 to 30 percent in the Columbian mammoths and 13 to 20 percent in the woolly mammoths. Cyperaceae hats and polygonal papillae appear in very low percentages in the two species; the highest frequency is 3.6 percent in a woolly-mammoth sample. The sinkhole sediments present highly variable amounts of grass phytoliths, from 5 to 45 percent, suggesting an environment poor in grasses. The Cyperaceae are totally absent in the sediments, but present in dental samples. Dicot-plat phytoliths dominate both the teeth and sediment samples. Conifer phytoliths are virtually absent in the sediments, but they are found in variable percentages in the teeth of both species.

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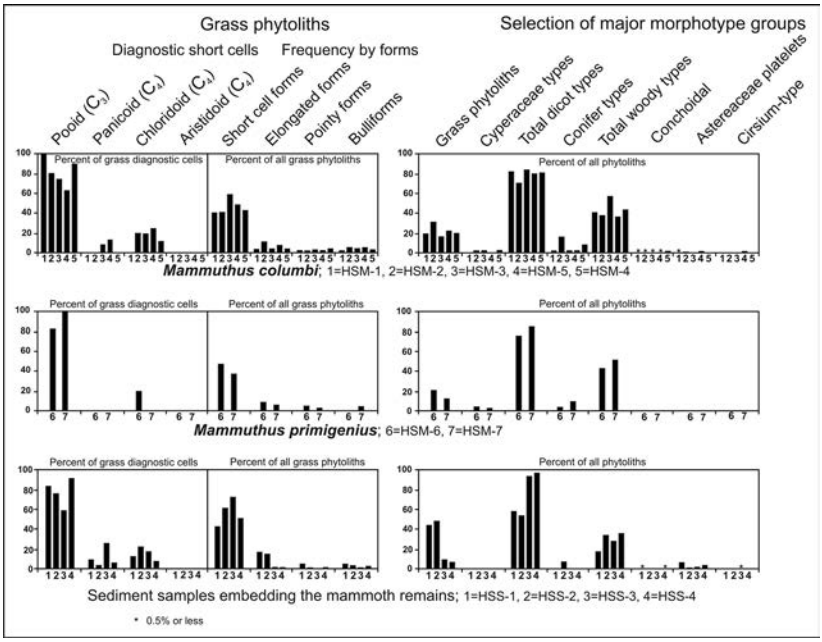

Figure 1. Frequencies of phytoliths in the sampled Hot Springs mammoth specimens and sediments of the sinkhole.

The Columbian-mammoth samples have frequencies of all warm-season (C_4) grasses combined (Panicoideae and Chloridoideae). The woolly-mammoth samples have only 18 percent of Chloridoideae in one sample and no Panicoideae. The Columbian-mammoth samples have a higher diversity of dicot-phytolith types, for example, conchoidal phytoliths, Asteraceae platelets (see Bozarth 1992), and *Cirsium*-types (see Blinnikov 2005). From this preliminary study we conclude that Columbian mammoths trapped at the site had a more diverse diet, which may be related to different seasonal-migration patterns. The larger amounts of Panicoidae in Columbian-mammoth samples suggest grazing in southern areas.

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Rodents and Lagomorphs (Mammalia) from the Late-Pleistocene Deposits at Valsequillo, Puebla, México

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➤ **Keywords**: Valsequillo, Pleistocene, Micromammals

Micromammal studies provide important information about habitats and environment. Contrary to most macromammals, many micromammals need specific conditions of temperature and humidity. Because many Pleistocene micromammals survive to the present, changes in their morphological variation and abundance can be statistically analyzed and used as paleoenvironmental indicators (Graham et al. 1987).

In México, few studies are available about fossil micromammals. This current research focuses on rodent and lagomorph species that lived in central México during the late Pleistocene. Valsequillo is located 15 km south of Puebla, State of Puebla, at 2,040–2,056 m s.n.m. This important fauna has been assigned to the Rancholabrean owing to the presence of *Bison* spp. (Graham 1978; Pichardo 1997). Geologic and stratigraphic studies are controversial, with purported evidence of human presence as old as 200,000 CALYBP (Gonzalez et al. 2006; Ochoa-Castillo et al. 2003). The studied fossil material for the most part lacks provenience and specific chronological data, and was collected between 1962 and 1973 (Irwin-Williams 1967).

Most of the studied materials are molars. Of the 15 species identified, four

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are new fossil records for México: *Cynomys mexicanus* (Mexican prairie dog), *Baiomys musculus* (pygmy mouse), *Lepus callotis* (white-sided jackrabbit), and *Romerolagus diazi* (volcano rabbit). One specimen probably is a new species of *Microtus* (vole). Another is that of an extinct deermouse, *Peromyscus maldonadoi.* Other identified species are *Cratogeomys castanops* (yellow-faced pocket gopher), *C. merriami* (Merriami's pocket gopher), *Thomomys umbrinus* (southern pocket gopher), *M. mexicanus* (Mexican vole), *Neotoma mexicana* (Mexican woodrat), *Hodomys alleni* (Allen's woodrat), *Reithrodontomys megalotis* (western harvest mouse), *Sigmodon hispidus* (hispid cotton rat), and *Sylvilagus audubonii* (desert cottontail).

Although some of the identified species could have been sympatric during the late Pleistocene, at present they are allopatric. Such is the case for *Cynomys mexicanus* and *Romerolagus diazi. Cynomys* currently is an inhabitant of prairies limited to a small area between San Luis Potosí, Nuevo León, Zacatecas, and Coahuila in northeastern México (Ceballos and Wilson 1985). Restricted to the central Mexican Transvolcanic Belt (Cervantes et al. 1990), *Romerolagus* inhabits areas of volcanic origin with pine forest and is associated with bunch grasses.

The term "disharmonious" has been used for assemblages of species that were sympatric in the past and at present are allopatric (Lundelius 1989). The current allopatry of *Cynomys* and *Romerolagus* could indicate that the Valsequillo fauna is disharmonious, but only if coexistence could be demonstrated during the late Pleistocene. On the other hand, if these species did not coexist, then the faunal assemblage is likely time-averaged. At present, *C. mexicanus* and *R. diazi* live under quite different specific environmental conditions, and they may have inhabited the same kinds of environments in the past. The probability of these species having coexisted is considered minimal until C-14 dates on individual specimens confirm their coexistence (e.g., Stafford et al., 1999).

Consequently, the presence at Valsequillo of two or more communities is suggested, with two possible arrangements. First, two contemporaneous communities were mixed; fossils from the two communities were found together because materials were transported from their places of origin and buried in the same deposit. Second, two or more communities existed at different times, each with different environmental conditions. Because of the lack of stratigraphic control, further research is warranted to confirm either of these possibilities.

Even without stratigraphic control, the paleoenvironmental conditions suggested by this species assemblage can be assessed using the method of Area of Sympatry (Martin 2004). The geographical distributions of the micromammals from a late-Pleistocene fossil deposit are examined, and the area where those overlap today is likely representative of the general environmental conditions during the time of deposition. The area of sympatry for the fossil assemblage from Valsequillo is located in the same state, Puebla, about 100 km north of the present site location between Acatzingo, Tepeaca, Tecamachalco, Palmar del Bravo, Quecholac, and San Pablo de las Tunas. The climate indicated is warm and semi-humid with summer rains. The original vegetation is shrub associated with pine forest (INEGI 1987). At Valsequillo during the late Pleistocene (Rancholabrean), the predominant vegetation therefore was most likely shrub and pine forest that extended or decreased

with climatic change, providing habitat for different species in each period.

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Bison cf. *B. latifrons* from the Late-Pleistocene Broach Locality, Fresno, California

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➤ **Keywords**: *Bison*, Broach, California

In December 2006, Thomas C. Broach discovered a bone eroding from an outcrop (36° 52′ 51″ N, 119° 46′ 51″ W) along the San Joaquin River Parkway

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trail near Friant and Rice roads in Fresno, California. Broach brought the specimen to the attention of the San Joaquin River Parkway and Conservation Trust, who contacted California State University, Fresno for assistance. The University excavated the remains in May 2007.

The specimen is a large *Bison* radius. *Bison* are common in late-Quaternary strata throughout California, with over 160 reported localities (Jefferson 1991). The Broach bison is notable because of its large size and associated ^{14}C date. Specimen measurements, following Miller (1971), are: 401 mm greatest length, 126.6 mm greatest proximal transverse diameter, 45.5 mm least anteroposterior width of shaft, 73 mm least transverse width of shaft, 122.5 mm greatest distal transverse diameter. In order of decreasing body size, *Bison latifrons*, *Bison antiquus,* and *Bison bison* occur in California's fossil record. The Broach bison exceeds the size of *Bison latifrons* from the Los Angeles basin (Miller 1971) and is in the mid to upper end of the size range of *Bison latifrons* reported by McDonald (1981). The Broach specimen compares well with the size of articulated male *Bison latifrons* from American Falls, Idaho (Stevens 1978), albeit long and slender in transverse dimensions relative to the Idaho specimens. While radius measurements appear to indicate distinct size differences between *Bison latifrons* and *Bison antiquus* (Miller 1971; McDonald 1981), Robertson (1974) noted the potential for overlap in postcranial dimensions between the two taxa based on Florida specimens. Because definitive species assignment for *Bison* is based on horn-core characteristics, caution should be exercised in identifying postcranial elements to species. The Broach specimen compares best with large *Bison latifrons* radii and is therefore referred to *Bison* cf. *B. latifrons.*

The Broach bison was deposited in the upper unit of the Modesto Formation (Lettis and Unruh 1991; Marchand 1976; Marchand and Allwardt 1981) on the San Joaquin River alluvial fan, one of several large fans formed by channelized fluvial and sheet flow along the eastern margin of the San Joaquin Basin. The Modesto Formation represents rapid aggradation of predominantly arkosic sediments within an incised valley during the Wisconsin glacial period (Weissmann et al. 2002).

At the bison site, the Modesto Formation consists of a complex of channel-fill deposits comprising cross-stratified sand and minor gravel, overbank sediments consisting of interbedded laminated-massive fine sand, silt and clay, and mature paleosols attributed to extended periods of landscape stability on the alluvial-fan surface (Lettis 1988). The bone was located within a massive light gray clay-rich horizon, with common charcoal, 35–55 cm thick and laterally continuous over at least 2 km. The charcoal often appears as elongate strands with a relict cellular grain parallel to the long axis, as might be expected with grass or reeds. The fine grain size, massive character, and presence of charcoal indicate this facies was deposited on the floodplain distal to the channel.

Two ca. 0.5-cm^2 pieces of charcoal from sediment surrounding the bison specimen were submitted as a single sample for ^{14}C dating. The radius, treated with polyvinyl acetate in the field, was unsuitable for ^{14}C analysis. The charcoal yielded an AMS date of 19,230 ± 80 RCYBP (Beta-244983). The date corre-

sponds well with the inferred late-Wisconsinan age of the upper unit of the Modesto Formation, which is bracketed by a minimum age of the lower unit at about 27,000 RCYBP and the final phase of the Tioga Glaciation, which concluded around 9000 RCYBP (Marchand and Allwardt 1981). Two ^{14}C dates on wood from the upper member, 14,100 ± 200 RCYBP at 12 m below the surface of the Kern River alluvial fan at Bakersfield, California, and 14,060 ± 450 RCYBP from the subsurface 40 km to the west, led Marchand and Allwardt (1981) to propose a narrower age range for the upper unit at between 14,000 and 9000 years RCYBP. The Broach locality ^{14}C date supports the broader age range for the upper unit of the Modesto Formation.

While *Bison latifrons* is reported from at least 28 localities in California (Jefferson 1991), only Rancho La Brea (40,000 to 12,000 RCYBP) and Costeau Pit (> 40,000 RCYBP) have been ^{14}C dated (McDonald 1981). The Broach locality therefore provides an important numerical age record for giant bison in California. The age also adds to the dataset (Mead et al. 2006) suggesting that *Bison latifrons* persisted beyond the 21,000 to 30,000 RCYBP terminal-age range for the taxon reported by Kurtén and Anderson (1980).

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A New Pleistocene Faunal Assemblage from Morrill Cave, Sullivan County, Tennessee: A Preliminary Discussion of the Arvicoline Rodents

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➤ **Keywords**: Arvicolinae, Appalachians, Paleoenvironment

Morrill Cave (also known as Morrell or Worley's Cave), located in Sullivan County, Tennessee (current entrance at 36° 27′ 30″ N; 82° 13′ 41″ W; Keenburg quadrangle, 445 m a.s.l. [Barr 1961]), was reported to contain vertebrate fossils such as *Platygonus* and an unidentified deer-like animal (Corgan 1976); however, there had been no systematic sampling or excavations until now. Upon locating purported peccary tracks near a former opening in a remote portion of the cave, we collected and screen washed two sediment samples from one large room. Though this ancient entrance is now collapsed and currently too small for large vertebrates to utilize, it remains open enough for snakes and rodents (several live individuals were observed). Macrovertebrate fossils visible on the surface dictated where samples were taken. Osteoderms from the extinct armadillo *Dasypus bellus* were found in the sediment, indicating that at least portions of the deposit are Pleistocene in age (Kurtén and Anderson 1980). Many taxa were recovered; however, this note is not intended to be a complete list of the fauna, but rather an attempt to use arvicoline rodents to provide a preliminary reconstruction of the environment at the time of deposition.

Where possible, identifications were taken to the species level, but only complete teeth representing multiple individuals of a species were considered in this analysis. Though many characters formerly used for identification are unreliable at the species level within this group (Bell and Repenning 1999), useful information about the paleoenvironment can still be inferred at the generic level (e.g., Schubert 2003). Genera and species present were primarily identified following Semken and Wallace (2002), who provided a key mostly based on lower first molar (m1) morphology, which identified many taxa, even though some were digested or broken.

Though samples were taken at two different areas (separated by roughly 10 m), there was a similar representation of arvicoline genera within each. Consequently, all samples were combined for this analysis. After identification, the number of individual specimens (NISP) was calculated to give a rough estimate of the relative abundance of each taxon. The total number of teeth observed was 757. A substantial number of the teeth were only identifiable as *Microtus* sp.

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(n = 435). *Microtus pennsylvanicus* (n = 33) and *M. ochrogaster* (n = 26) are common, while *M. chrotorrhinus* (n = 1) and *M. pinetorum* (n = 2) are more rare. The small numbers of these *Microtus* species, along with their tendency to morphologically overlap, warranted their exclusion from the paleoenvironmental reconstruction. *Clethrionomys* (n = 125) and *Synaptomys* (n = 180) are more abundant in Morrill than most caves containing Pleistocene deposits, whereas *Phenacomys* (n = 17) is more typical (FAUNMAP 1994).

Digested teeth and bones show that rodents were brought into the cave by predators (likely mammalian carnivores), probably hunting in a variety of habitats. Consequently, the rodents recovered from Morrill Cave show preferences to grasslands (*M. ochrogaster*), boreal or mixed conifer forests (*Phenacomys* and *Clethrionomys*), and even more moist environments (*Synaptomys*). All *Synaptomys* are *S. cooperi*, known as the southern bog lemming. It has a wide range of habitats, but prefers wetter environments, which is why it is less common in the area today. *Phenacomys* is extralimital, currently living throughout Canada and in portions of the Rocky Mountains (Hall 1981). Perhaps the conditions responsible for the higher abundance of *Synaptomys* during the Pleistocene also account for the range of *Phenacomys* extending south into much of the Appalachians. The abundance of certain taxa in Morrill Cave is very similar to nearby Baker Bluff Cave, which has a more complete faunal analysis, hypothesized to contain taxa typical of deciduous forest with nearby grasslands (Guilday et al. 1978). Specifically, Guilday et al. (1978) point out that unusually high numbers of *Synaptomys*, such as the 24 percent mentioned here, occur in four other late-Wisconsinan caves in eastern Tennessee, perhaps suggesting the presence of a fauna unique to the southern Appalachians at that time. The distinct biogeography of this area could be considered an influence on early human settlement. Ongoing excavations at Morrill, as well as other caves in the southern Appalachians, should shed more light on this potential regional fauna.

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New Late-Pleistocene Dates for the Extinct Megafauna of Lagoa Santa, Brazil

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➤ **Keywords**: AMS Dates, Extinction, and Central Brazil

The chronological dispersion of the Brazilian megafauna is now known to be much broader than previous recognized (Auler et al. 2006). In this context, defining the precise time of its extinction is especially relevant for those taxa that eventually survived until the Pleistocene/Holocene transition due to the potential role that the first South Americans may have played in this process (Barnosky et al. 2004; Hubbe et al. 2007; Steadman et al. 2007 and references therein).

Although there is an electron spin resonance (ESR) middle-Holocene date for a *Toxodon platensis* from southern Brazil (around 6500 CALYBP; Baffa et al. 2001), Neves et al. (2007) have questioned this date. Two ^{14}C AMS dates for the same specimen resulted in minimum ages of 11,380 ± 40 RCYBP (Beta-215330) and 11,090 ± 40 RCYBP (Beta-218193; ca. 13,000 CALYBP). Therefore, the youngest ages for the Brazilian megafauna are most probably close to the Pleistocene/Holocene boundary (Czaplewski and Cartelle 1998; Neves and Piló 2003; Rosseti et al. 2004), similar to what is observed in other regions of the New World. Most dates obtained so far for the Brazilian megafauna are based on fossils derived from excavations lacking stratigraphic control. Thus, despite the existence of some late-Pleistocene/early-Holocene dates for this megafauna (Czaplewski and Cartelle 1998; Neves and Piló 2003; Rosseti et al. 2004), it is hard to evaluate their reliability.

Here we present two recently obtained ^{14}C AMS dates for megafauna remains from central Brazil (Table 1), one for a *Smilodon populator* (metacarpal bone) and one for a *Valgipes bucklandi* (dermal ossicle)[1] recovered from

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[1] *Valgipes bucklandi* has been recently described by Cartelle et al. (2009) as a new species of Scelidotheriinae.

Table 1. ^{14}C AMS dates obtained at Locus 2 of Cuvieri Cave.

	Sample■		
	CV-L2-13122	**CV-L2 14310**	**CV-L2 15266**
Lab number	Beta-234519	Beta-248057	Beta-248059
Taxa	*Smilodon populator*	*Valgipes bucklandi*	Tayassuidae
Common name	Sabertooth cat	Ground sloth	Peccary
Skeletal element dated	Metacarpal bone	Dermal ossicle	Rib
Material dated	Collagen▲	Collagen▲	Collagen▲
$\delta^{13}C$ ‰ (PDB)	-15.0	-15.3	-20.4
Conventional ^{14}C AMS date (RCYBP)	10,790 ± 60	11,020 ± 40	10,470 ± 40
2σ calibration date (CALYBP)◆	12,880–12,720	13,060–12,870	12,670–12,140

■ Samples dated at Beta Analytic Radicarbon Dating Laboratory, USA.
◆ Calibration database used: IntCal04 Radiocarbon Age Calibration (Reimer et al. 2004). Mathematics according to Talma and Vogel (1993).
▲ Treated with multiple alkali extractions and ultra-purified prior to dating.

one of the vertical pits (Locus 2) of Cuvieri Cave, a paleontological site located in Lagoa Santa, Minas Gerais, Brazil (Auler et al. 2006). The site has been excavated since 2002 with techniques adapted from archaeology to provide precise stratigraphic control of the fossiliferous deposits and of the exact position of the bones found therein. From another vertical pit (Locus 1) of the same cave, Neves and Piló (2003) reported one of the latest direct dates for the Brazilian megafauna obtained from a specimen of *Catonyx cuvieri* (9990 ± 40 RCYBP; Beta-165398). Although isolated, this date lies well within the range of late dates found for megafauna in South America (Hubbe et al. 2007).

The two specimens reported here were found in a sedimentary layer still under excavation. Only a small fraction of the skeletons has been found by us so far. The remains already recovered are scattered material ranging from well-preserved bones to fragments. The date obtained for the *V. bucklandi* is only slightly older (11,020 ± 40 RCYBP; Beta-248057) than that of the *S. populator* (10,790 ± 60 RCYBP; Beta-234519). Both specimens were found at a similar depth and close to the well-articulated skeleton of a slightly younger subadult wild pig (Tayassuidae; 10,470 ± 40 RCYBP; Beta-248059). The presence of the Tayassuidae in the same stratigraphic level suggests that the megafauna bones have not migrated significantly along the stratigraphy, despite the fact that these animals are represented only by scattered material. The high degree of articulation of the Tayassuidae specimen strongly supports the idea that vertical dislocation of fossil remains in the level where they were found was not significant, and contextualizes this level as close to the Pleistocene/Holocene boundary.

The dates presented here are the first megafauna ages for Brazil at the Pleistocene/Holocene transition derived from excavations with rigid stratigraphic control, thus rendering them more reliable. Also, the reported age of the *S. populator* found at the Cuvieri Cave (Locus 2) is similar to a young age obtained for another *S. populator* specimen found in the same region by P. W. Lund in the 19th century (9260 ± 150 RCYBP; Beta-174722) (Neves and

Piló 2003), which is at this moment the youngest direct date for a megafauna fossil in Brazil. Massive dating of the Brazilian megafauna is still necessary to substantiate the chronology of these animals, but the data available in the literature and the new data presented here support the hypothesis that at least part of this fauna survived until the early Holocene.

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A Preliminary Report on a *Bison bison occidentalis* Cranium from Sauk County, Wisconsin

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➤ **Keywords:** Bison, Holocene, Wisconsin

In November 2005, seven-year-old Joshua Bradford and Bob Weiss discovered a large bovid skull partially buried along the Wisconsin River shoreline in Sauk County, Wisconsin. They contacted the State Archaeologist's Office at the Wisconsin Historical Society, and it was determined that the partial cranium belonged to the extinct Holocene bison, *Bison bison occidentalis*. The location was designated the Bradford Bison site (47SK607); future investigations are pending to determine if additional paleontological or archaeological materials are present. The specimen is currently undergoing cleaning and preservation treatment at the Wisconsin Historical Society in Madison.

The specimen consists of a partial cranium, represented by both horn cores, the occipital, a portion of the basioccipital, and the posterior portion of the frontal bone (behind the eye orbits). The posterior portion of the left orbit is intact. The exterior surface has been damaged by insect boring, obliterating any possible butchering marks. Some exfoliation of the outer surfaces has occurred, especially on the frontal. The horn cores are essentially intact; no splinters, cracks, or angular breaks were observed. Lacking teeth, it was not possible to determine a specific age. An adult male is suggested by the robustness of the skull and horn cores, overall size, and the degree of fusion of the sagittal suture.

Species level identification of bison focuses on absolute body size and the size, curvature, and orientation of the horn cores (McDonald 1981; Skinner and Kaisen 1947; although see Guthrie 1966 for a contrary opinion). The following measurements were obtained, following Skinner and Kaisen (1947). The Bradford bison cranium results are first, followed by the *Bison bison occidentalis* minimum-maximum range noted by Skinner and Kaisen in parentheses (all in mm): spread of horn cores, 776 (670–875); greatest spread of cores on outside curve, 790 (735–892); core length upper curve, 291 (222–330); core length lower curve, 368 (275–405); length core tip to upper base, 257 (210–290); vertical diameter of core at right angle to longitudinal axis, 85.3 (76–100); core circumference at right angle to longitudinal axis, 281 (253–336); transverse diameter of core at right angle to longitudinal axis, 87 (85–114); greatest width at auditory openings, 237 (259–307); occipital condyle width, 119.7 (124–147); occipital crest to top of foramen magnum, 119 (78–99, from McDonald 1981:87); occipital crest to lower border of foramen magnum, 170 (136–177); and cranial width between cores and orbits, 285 (277–340). The angle of posterior divergence of the horn core is 70 degrees; the angle of proximal horn core depression is approximately 20 degrees.

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Skinner and Kaisen (1947:142–3) calculated indices of curvature, compression, proportion, and length as a means of further quantifying the shape and form of bison horn cores. Comparing these indices distinguishes between the different *Bison* species in the same manner as the direct measurements. The index of curvature reflects the relative amount of horn core curvature, reducing all curved horn cores to a relative proportion regardless of other aspects of shape. The horn core compression or roundness index indicates the relative degree of dorsoventral compression. The slenderness or stubbiness of the horn core relative to its basal circumference is indicated by the index of compression. Finally, the index of horn core length examines the length of the horn core relative to the frontal width of the skull. The Bradford bison skull has indices of curvature, compression, proportion, and length of 143.2, 98.0, 103.6, and 102.1 mm, respectively. All four indices are consistent with, and slightly above, the averages determined by Skinner and Kaisen (1947) for *B. bison occidentalis*: 140, 93, 97, and 95 mm, respectively. The Bradford bison cranial measurements are remarkably similar to those obtained from other Holocene bison in the upper Midwest (Kuehn 2006).

Relatively few early-Holocene or late-Pleistocene-age bison remains have been recovered in Wisconsin. Reported sites include Interstate Park, Rud I and II, and Nye (Boszhardt et al. 1993; Eddy and Jenks 1935; Hawley et al. 2007; Hill 1993; McDonald 1981; McMillan 2006:103; Palmer 1954; Pond 1937; Theler 1993; West and Dallman 1980). Historically, the natural range for bison extended only into the western and southern edges of the state (Jackson 1961; Lott 2002; Schorger 1937). To date, the Bradford bison is the most easterly example of *B. bison occidentalis* reported for the state. The specimen has not yet been ^{14}C dated, but likely is 5,000 to 7,000 years old, based on shared characteristics with dated bison remains from the upper Midwest. Further study of the Bradford bison and other Holocene and Pleistocene bison remains from Wisconsin should provide useful information on the antiquity of this species in the region and their potential dietary role for the earliest inhabitants of the Midwest.

My thanks to Josh Bradford and Bob and Joan Weiss for bringing their find to the attention of the Wisconsin Historical Society, and to State Archaeologist John Broihahn for his assistance. Drs. John Dallman, Matt Hill, Bruce McMillan, and Terry Martin provided helpful insight on bison remains in the upper Midwest.

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Did Female Mastodons Have Mandibular Tusks? Some Additional Data

Richard S. Laub

➤ **Keywords**: Mastodon, Mandibular Tusk, North America

Whether female mastodons (*Mammut americanum*) had mandibular ("chin") tusks remains an unresolved issue. In earlier contributions, Laub (1999, 2002) reported results of mandible C-T (Computer-Aided Tomography) scans of male and female mastodons and a female Asian elephant. He noted that 1) while the female mastodon mandible lacked tusks, it possessed alveoli where the tusks would have been, and these alveoli communicated with the mandibular canal as they do in males bearing tusks; and 2) in the female elephant mandible, known to lack tusks, the symphysis had no connection to the mandibular canal.

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C-T scanning was done on a second female mastodon mandible belonging to the Hartley mastodon from near Salem, Ohio, reposited at the Cleveland Museum of Natural History (catalogue no. CMNH 11909). The animal was approximately 39 African elephant years old (Laws 1966). Identification of its sex as female was determined using Lister's (1996) study of dimorphism in the mammoth pelvis, which the author has found applicable to mastodons as well. The animal's small physical features relative to its age also indicate it was female, yet it has well-developed symphyseal alveoli (Figure 1G).

More than 200 transaxial images were taken during the scan at 1-mm intervals, from the midst of the front tooth to the symphysis alveoli. At around the 200-mm longitude three canals, 4, 2 and 2 mm in diameter, arise from the lingual side of the right mandibular canal, which is approximately 3 cm in diameter here (Figure 1E, F). (The left side of the mandible was broken and unavailable for examination at this point.) As they extend anteriorly, these canal branches anastomose, some combining while others divide. Occasionally, as at the 130-mm longitude, a branch exits the side of the mandible. The tubes generally widen anteriorly. At 160 mm the anterior mental foramen opens, and the medial channels resolve into a distinct left and right canal, 4–5 mm wide (Figure 1D). From here they narrow slightly, and there is some splitting, but by 115–110 mm they form distinct dental alveoli which approach 1 cm wide and more than 1.5 cm high (Figure 1B, C).

This system of slender canals thus connects the symphyseal alveoli to the mandibular canal as it did in an adult female mastodon studied earlier (Laub 1999). Where there are no dental structures in the symphysis (as in the Asian elephant), that region is not connected to the mandibular canal. Hall (2005:340) states that "alveolar bone will not form unless dental follicle mesenchyme is present." The retention of this connection in female mastodons suggests the presence of some sort of unmineralized dental tissue in the alveoli that required a blood and nerve supply.

The author thanks Dr. Jeffrey Schwersenski (The Cleveland Clinic, Cleveland, Ohio), and Dr. John Hagga and Elizabeth Russell (The University Hospitals of Cleveland, Cleveland, Ohio) for arranging and providing C-T scanning services, Drs. Brian Redmond (Department of Archaeology) and Michael Ryan (Department of Vertebrate Paleontology) of the Cleveland Museum of Natural History for making the mastodon mandible and its data available for study; and Michael Grenier (Buffalo Museum of Science) for producing the graphics for this article.

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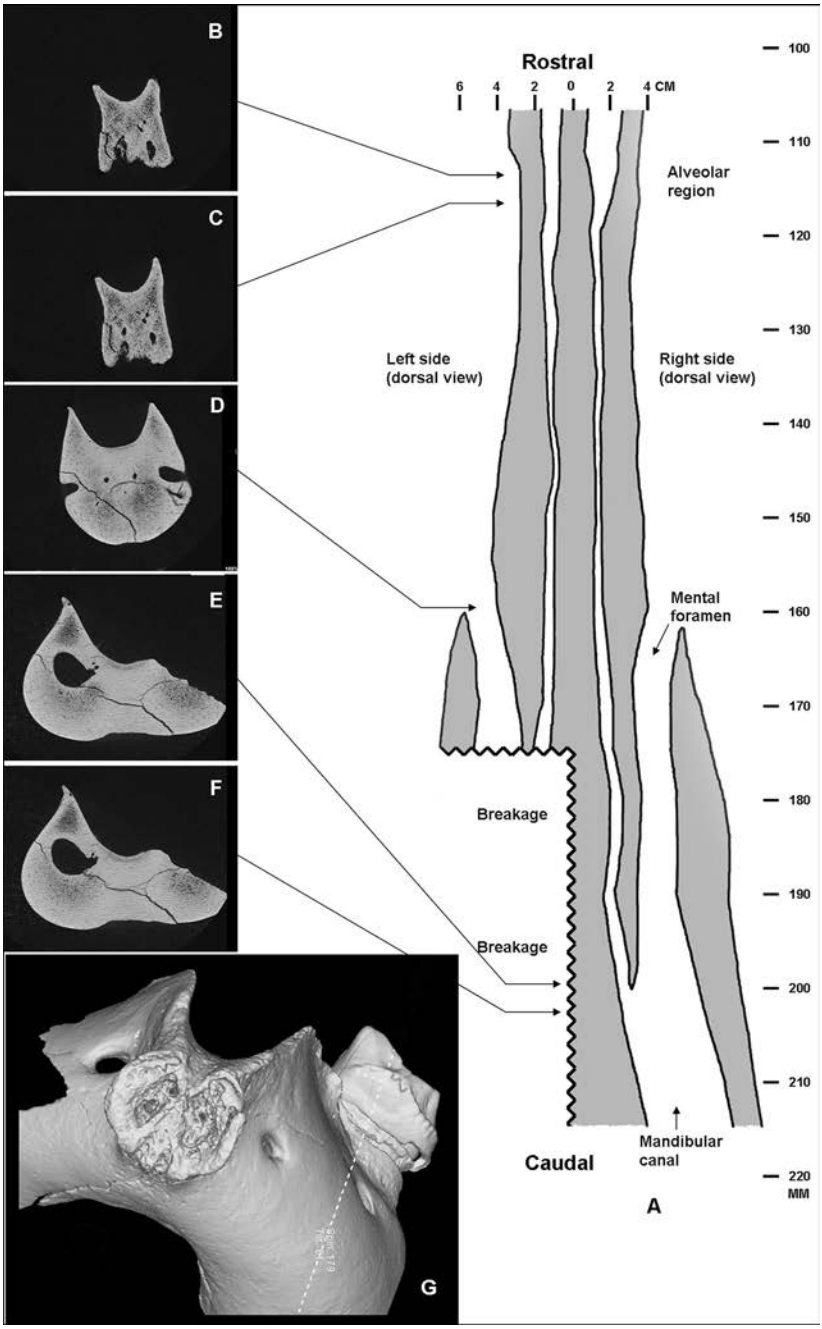
Figure 1 (opposite). Mandible of the Hartley mastodon. **A,** simplified diagram showing internal structure in the symphyseal region. Millimeter scale on right represents the longitudinal positions on the C-T scan read-out. **B–F,** transaxial C-T scan images from selected parts of the sequence. In E and F the small lingual canals begin to branch from the mandibular canal; in D the anterior mental foramina appear, and the lingual branches appear as two discrete tubes; in B and C the lingual canals have expanded and coalesce into the alveolar openings. Note the exaggeration of length relative to width in this diagram. **G,** rostral view of the mandible, generated by stacking the transaxial images, and showing the large symphyseal alveoli, the anterior and posterior mental foramina, and the anterior molar.


B
C
D
E
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Rostral
6 4 2 0 2 4 CM
Alveolar region
Left side (dorsal view)
Right side (dorsal view)
Mental foramen
Breakage
Breakage
Caudal
Mandibular canal
A
100
110
120
130
140
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First Record of Late-Pleistocene Turtles from Chiapas, Mexico

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➤ **Keywords**: Turtles, Rancholabrean, Chiapas

The record of fossil turtles in Mexico is scarce. Taxonomic and biogeographic data are difficult to obtain because of scarce and badly preserved material. In this paper, fossil remains of turtles from the late Pleistocene of Chiapas are reported for the first time, and their biogeographic importance is discussed. Fossils were collected from the La Simpatía locality, municipality of Villa Corzo, and include carapace scutes of three different species, *Kinosternon scorpioides*, *Trachemys scripta,* and cf. *Staurotypus* sp. In addition, *Bison* sp., *Mammuthus columbi* and *Equus conversidens* were also collected from this locality; based on these species a Rancholabrean age is assigned to the fauna (Carbot-Chanona and Vázquez-Bautista 2006).

K. scorpioides is represented by five peripheral plates of two individuals of different sizes (Figure 1). *Trachemys scripta* is represented by two well-preserved peripheral plates and one modestly preserved coracoid; these remains belong also to two individuals of different sizes, probably a juvenile and adult. One peripheral plate is tentatively assigned to *Staurotypus* sp. based on a plate morphology that corresponds to this genus, but it is too incomplete to make a trustworthy determination.

The only fossil record of *Kinosternon scorpioides* in Mexico is from the Fauna Cedazo (late Pleistocene) in Aguascalientes (Mooser 1980). Material from other late-Pleistocene localities in north and central Mexico has been reported only at the generic level as *Kinosternon* sp. (Barrios-Rivera 1985; Castillo-Cerón et al. 1997; Guzmán and Polaco 2000; Tovar et al. 2007).

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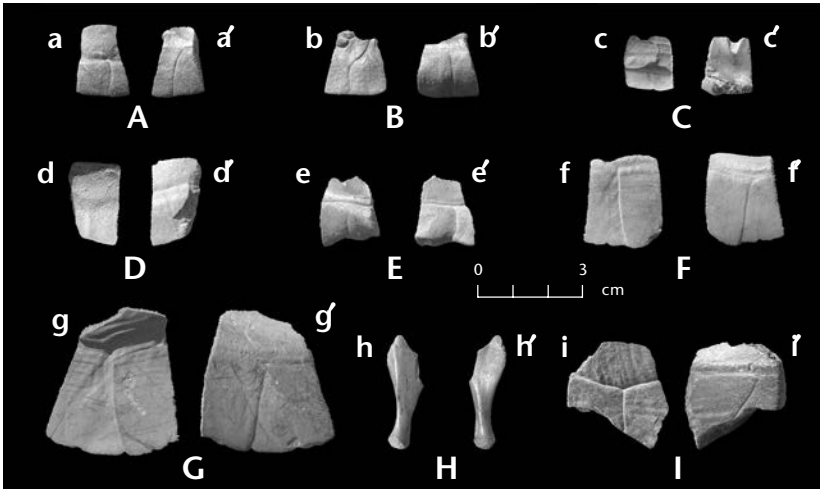

Figure 1. A–E, *Kinosternon scorpioides*: **A,** IHNFG-0508, second right peripheral plate; **B,** IHNFG-0507, ninth left peripheral plate; **C,** IHNFG-0510, sixth right peripheral plate; **D,** IHNFG-0520, quarter right peripheral plate; **E,** IHNFG-0509, second left peripheral plate. **F–H,** *Trachemys scripta*: **F,** IHNFG-0505, ninth right peripheral plate; **G,** IHNFG-0504, eleventh right peripheral plate; **H,** IHNFG-0506, right coracoid. **I,** cf. *Staurotypus*: IHNFG-0511, eighth right peripheral plate. (**A–I,** dorsal view; **A′–I′,** ventral view.)

Trachemys scripta has been reported in late-Pleistocene localities of Jalisco, Tabasco and Veracruz (Barrios-Rivera 1985; Peña-Serrano 2006), and *Trachemys* sp. is also reported from the same age in Zacatecas (Guzmán and Polaco 2000). *Staurotypus* is a genus with no fossil records from Mexico. The present distribution of this genus includes most of the area of Tehuantepec Isthmus, Gulf of Mexico, and Yucatan Peninsula to the west of Honduras (Ernest and Barbour 1989).

In Chiapas, extant *K. scorpioides* and *T. scripta* are present in the central part of the state. The presence of cf. *Staurotypus* would represent a different paleodistribution for the genus during the late Pleistocene in southern Mexico, since the genus is living today in wetlands in the north and Pacific Coast of Chiapas, suggesting that environmental conditions in the central part of the state during the late Pleistocene were similar to those currently shown in these regions. These records allow us to extend the historic biogeographic range of the taxa mentioned and define their more southern records for Mexico as well.

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Presence of Late-Pleistocene Rheidae in the Oasis of Calama (Second Region, Chile)

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➤ **Keywords:** Rheidae, Late Pleistocene, Northern Chile

Members of the Rheidae Family are endemic to the Neotropic zone of South America. Among their main features are big sizes, exclusively terrestrial habits owing to an inability to fly, and habitual running (Handford y Mares 1982; Folch 1992; De la Peña and Rumboll 1998; Tambussi 1995a; Tambussi and Acosta 2002). Currently this family is represented by two species, *Rhea americana* and *Pterocnemia pennata*, both of which inhabit grazing lands and to lesser degrees small and isolated wooded areas (Tambussi 1995a).

The recent evaluation of paleontological remains from the site of Kamac Mayu (Second Region, Chile, 68° 54′ 40″ W, 22° 26′ 22″ S), Chile, has revealed the presence of two bone fragments of the Rheidae Family. These correspond to two distal fragments of a femur and the body of the cervicothoracic vertebra, all these bones attributable to an adult. These bone fragments are associated with remains of *Macrauchenia* sp. (Litopterna), *Hippidion saldiasi* (Equidae), Xenarthra, and cf. *Lama gracilis* (Camelidae) (Alberdi et al. 2007; López et al. 2007). The deposits from which the remains were recovered are characterized by sand and stone sediments over an extensive karst forma-

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tion located inside a fluvial event (Chong Díaz and Jensen 2004). These deposits are correlated to those of the Betecsa 1 site, located 100 m from the current channel of the Loa River. In this site the fluvial event has been dated by AMS ^{14}C on *Hippidion saldiasi* remains to 21,070 ± 100 RCYBP (GrA-29389) and 21,380 ± 100 RCYBP (GrA-29388).

Morphologic comparison of the Kamac Mayu remains with known *Pterocnemia pennata* remains reveals a similarity with this species. However, bones are too fragmented for morphometric analysis. For this reason we classified the Kamac Mayu fossil record as Rheidae gen. *et* sp. indet. According to Tambussi (1995a, 1995b) the fossil record of Rheidae for South America is composed of four extinct species: *Heterorchea dabbenei* from sediments of the Monte Hermoso Formation (Pliocene), *Hinasuri nehuensis* and *Rhea anchorenensis* from the Ensenada Formation (middle Pleistocene), and *Rhea fossilis* (late Pleistocene). Also *Pterocnemia pennata* and *Rhea americana* have been found in several Paleoindian sites (late Pleistocene) of the southern cone, especially in the Pampas and Patagonia on both slopes of the Andes (Tambussi 1995b). In the contiguous area, the first remains were found in the highland site of Aguas Calientes I (4,205 m) dated to 8720 ± 100 RCYBP (Cartajena 2002).

This is the first record for Rheidae in deposits corresponding to the last glacial maximum (22,000—18,000 RCYBP) in northern Chile; together with the other species described, it suggests a predominance of grazing lands. Results of a δ^{13}C analysis on *Hippidion saldiasi* from Betecsa 1 were -15.45 on bone and -16.68 on tooth enamel, suggesting a diet of C3 pastures. However, these values could also be associated with the intake of aquatic plants related to a humid phase in the study area between 16,000 RCYBP and 10,000 RCYBP (Latorre et al. 2002). In the case of Kamac Mayu, the presence of a fluvial deposit with freshwater molluscs from the families Planorbidae, Hidrobiidaee, and Sphaeriidae, Typhaceae fossils, and evidence of diverse faunal groups suggest an environment of wetlands in the middle course of the Loa basin, related directly to the ancient basin Chiu Chiu-Calama (May et al. 2005).

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New Records for the Pleistocene Mammal Fauna from Loltún Cave, Yucatán, México

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➤ **Keywords**: México, Carnivores, Distribution

Paleontological studies in the Yucatán Peninsula are very important because it is a unique region with abundant tropical mammal remains from the late Pleistocene, one of the few such areas in México. Studies undertaken by personnel of the Instituto Nacional de Antropología e Historia (INAH), both on dry caves and inundated caves, have demonstrated large amounts of bone in excellent condition at multiple sites. Mercer (1896) and Hatt et al. (1953), who studied dry caves, recorded remains of extinct sloth (*Paramylodon* sp.) and Pleistocene horse (*Equus conversidens*). In sinkholes, remains have been found of horse, extinct llama (*Hemiauchenia* sp.), giant glyptodont (*Glyptotherium* cf. *G. floridanum*), tapir (*Tapirus bairdii*), and gomphotherid (*Cuvieronius* sp.) (González-González et al. 2006).

Loltún Cave is one of the most important localities in the Yucatán Peninsula.

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This cave is located in the southwestern portion of the State of Yucatán, about 110 km south of Mérida and 7 km southeast of Oxkutzcab (Velázquez 1981). The cave preserves a long cultural chronology and a large, quite diverse faunal record. Excavations in the 1970s by INAH Yucatán personnel in the southeast portion of the cave investigated a chamber named Huechil (Álvarez 1982), with two trenches known as El Toro and El Túnel. The stratigraphy of El Túnel includes 7 strata extending to a depth of 4.8 m, while El Toro exhibits 16 strata down to 9.5 m. The first six strata at El Túnel contain Maya ceramics, and the last one has a large concentration of fossil bones. At El Toro, Maya ceramics are in strata I to VII; from IX down, only fossil bones occur. Overall, ceramics were recovered from two excavation field seasons (1977 and 1980), but also a faunal succession through time, from the late Pleistocene to the Holocene (from approximately 25,000 RCYBP to recent times).

The only published ^{14}C date for the cave is at 3800 ± 150 RCYBP from a charcoal sample taken from strata VII and VIII in El Toro (Schmidtt 1988). Volcanic ash in stratum XI (El Toro) is correlated with Rosseau's Tephra, known from several sediment cores from the Caribbean and Gulf of México and dated at 28,400 RCYBP (Álvarez 1982; Rampino et al. 1979). More recently, a horse bone from stratum VII at El Túnel was dated by AMS at 12,720 ± 40 RCYBP (BETA-157084) (W. Miller and S. E. Jones, pers. comm. 2008).

Álvarez (1982) and Arroyo-Cabrales and Álvarez (2003) studied the fossil and recent mammal remains from Loltún Cave and identified a diverse and abundant Pleistocene fauna with marsupials, insectivores, edentates, rodents, bats, lagomorphs, proboscideans, artiodactyls, perissodactyls, and carnivores. The remains collectively represent 10 orders, 26 families, 52 genera, and 68 species. Most recently, detailed study was undertaken of the carnivore remains, this order represented by at least 15 species. Outstanding distributional records were those pertaining to dire wolf (*Canis dirus*), saber-tooth cat (*Smilodon fatalis*), and bobcat (*Lynx rufus*). These species of Nearctic affinity were living together along with tropical species; further details of these three species are presented below.

Remains were identified both anatomically and taxonomically using the available literature and comparing with reference collection specimens at INAH. Further information follows.

Canis dirus. Twelve remains pertained to dire wolf, including five dental fragments and seven postcranial elements. Dire wolf previously was reported by Álvarez (1982). All the remains were larger than any other Mexican canid, either fossil or recent, including gray wolf and large dogs. Among some diagnostic characters, molars are wider than any other North American canid, and muscle scars are quite deep in comparison to other canids.

Smilodon fatalis. Five bones are assigned to saber-tooth cat: three cranial elements, including three upper incisors, and two postcranial elements. This species is reported for the first time in the Yucatán Peninsula and southeastern México. Some diagnostic characters included larger size than *S. gracilis*, but much smaller than *S. populator* from South America (Martin, 1989; Turner, 1997). Also, metapodials are wider in *fatalis* than in *gracilis*, which could be its geographic overlap, although they seem not to be contemporaneous (Kurtén and Werdelin, 1988).

Lynx rufus. Bobcat is represented by eight postcranial elements. This species also is reported for the first time from the Yucatán Peninsula, greatly increasing its current known distribution. Although Ceballos and Oliva (2005) documented the distribution of the species south to the State of Chiapas, there have previously been no records from the tropical regions of the Pacific coast from Colima south and southeast. The lynx bones were larger than any bone pertaining to ocelot, margay or jaguarundi.

The presence of these three Nearctic species, along with abundant remains of Pleistocene horse and the presence of bison (*Bison* sp.), llama, and cotton rat (*Sigmodon* sp.), as well as pollen analysis (Xelhuantzi-López 1986), points to a complex paleoenvironment at the end of the Pleistocene with tropical forests intermixed with grasslands. Further excavations and studies are needed to test this hypothesis.

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Late-Pleistocene Peccaries from Guy Wilson Cave, Sullivan County, Tennessee

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➤ **Keywords**: *Platygonus, Mylohyus,* Guy Wilson Cave

Guy Wilson Cave (GWC), in Sullivan County, Tennessee, produced a late-Pleistocene faunal assemblage that is known for its high diversity of extinct large mammals (Nye et al. 2007; Schubert 2005; Schubert and Wallace 2007). Collections from the cave are housed at the Carnegie Museum of Natural History (CMNH); Frank H. McClung Museum, University of Tennessee; and East Tennessee Museum of Natural History collections at East Tennessee State University (ETMNH) (Schubert and Wallace 2007). The most abundant taxa from the site are deer (*Odocoileus* sp.) and flat-headed peccary (*Platygonus compressus*), with many of these remains exhibiting evidence of carnivore damage (Schubert and Wallace 2007). Here we summarize a thesis (Nye 2007) on the peccaries from two of the three collections (ETMNH and McClung), and report the first AMS ^{14}C date for the site.

Of the Tayassuidae present at GWC, *Platygonus compressus* is the most abundant and therefore was studied in greater detail. Material from the ETMNH and McClung collections produced a minimum number of individuals (MNI) of 16 based on left femora. Guilday et al. (1978) also report an MNI of 16 for the CMNH specimens; however, this sample cannot be combined with our MNI because the element used was not reported. Following Wright's (1993) example and contradictory to Hawksley, Reynolds, and Foley (1973), *P. compressus* upper canines in the ETMNH collection suggest sexual dimorphism. Overall, long-bone number of identified specimen (NISP) counts and age profiles of the ETMNH and McClung material show a predominance of *P. compressus* adults in the latter, suggesting a collection bias in the McClung sample with an under-representation of juveniles and fragments. Of the 133 long bones analyzed for carnivore damage and utilization (following Haynes 1980, 1981, 1982, 1983), 49.6 percent have gnaw damage consistent with light utilization by wolves. Evidence of weathering (Behrensmeyer 1978) on the long bones is essentially lacking, indicating limited exposure outside of the cave. In combination, the above suggest that the cave was used as a carnivore den (e.g., Emslie and Morgan 1995). We hypothesize that the most likely candidate was dire wolf (*Canis dirus*), elements of which are also known from the cave.

The long-nosed peccary (*Mylohyus* sp.) is also known from the deposit based

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on a handful of specimens (MNI of two based on teeth). There has been disagreement over whether or not two *Mylohyus* species (*M. nasutus* and *M. fossilis*) existed during the Pleistocene (Lundelius 1960; Ray 1967; Westgate and Messick 1985; Wright 1995). We compared the GWC P3, P4, M1, and M2 with specimens identified as *M. fossilis* and *M. nasutus* in the literature. Based on linear dimensions of these teeth, we found a possible association between tooth dimensions and "species" identification through scatter-plot diagrams, with all the GWC specimens grouping with *M. nasutus*. Clustering is most clear in P3, P4, and M2, and barely discernible in M1. Despite measurements falling into two groups, we contend that there are too many variables to support two species of *Mylohyus* in the late Pleistocene, and propose that sexual, temporal, and geographic variation in one species could account for the observed differences. Because this issue has not been fully resolved, we classify the GWC material as *Mylohyus* sp.

A previous ^{14}C date was reported from GWC, 19,700 ± 600 RCYBP (I-4163), based on *P. compressus* bone from the Carnegie collection (Buckley and Willis 1972). However, according to Stafford et al. (1987, 1991), ^{14}C dates that were performed at this time are not very accurate or reliable compared with current techniques. Therefore, we sampled root dentine from a *Mylohyus* right M^1 (ETMNH 1583), and sent it to Rafter Radiocarbon Laboratory in New Zealand for an AMS ^{14}C date. This sample had well-preserved collagen and produced a date of 11,727 ± 60 RCYBP (NZA-27736). The value represents the only known AMS ^{14}C date reported for this taxon, and further indicates that at least a portion of the GWC deposit dates to the terminal Pleistocene.

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A Gomphothere from Lake Pátzcuaro, Michoacán, México

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➤ **Keywords**: Gomphothere, Pollen, Volcanoclastic Sediments

On 23 June 2008, a gomphothere mandible and other fossil remains were recovered from Barranca Rancho Viejo (BRV), located 3.5 km southwest of the town of Tzintzuntzan, Michoacán, Mexico, near Lake Pátzcuaro. Pliocene and Pleistocene mammal fossils are known from other central lake basins of the Transmexican Volcanic Belt (lakes Zacapu, Cuitzeo, Chapala, Zumpango and Mexico), but the present is the first known report for Lake Pátzcuaro. The finding provides key information about the Quaternary mammalian fauna in the area and the paleoenvironment it inhabited.

Lake Pátzcuaro shows a continuous lacustrine stratigraphy older than 38,000 CALYBP (Bradbury 2000). The area, known as the Michoacán-Guanajuato Volcanic field, is characterized by paroxysmal changing paleoenvironments, from lakes to fluvial basins, and temperate forests associated with monogenetic volcanoes, showing a variant geometry, distribution and geochemical composition in time and space since at least before 540,000 CALYBP (Banno 1992).

Geomorphological and sedimentological descriptions, geological mapping, and petrographic and palynological analyses on the stratigraphic column at BRV were examined. The fossils were included in a lahar deposit intercalated with basaltic lava, pyroclastic flows and ash fall deposits related to the Catio

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monogenetic volcano activity (Figure 1). The ^{14}C dating on a correlative organic burned log, located in the same volcano stratigraphic level of gomphothere mandible, indicates a late-Pleistocene age of 26,000 CALYBP.

The gomphothere remains consist of rib bones and a relatively well preserved mandible with signs of weathering and modern anthropogenic alteration.

The mandible is almost released from the matrix and shows the features of a brevirostrine proboscidean. It has well-worn left and right trilophodont M2, and a slender right tetralophodont M3 with a simple trefoil pattern; these teeth also indicate that the animal was an adult, close to its old age. Molar measurements (length x maximum width, in mm) are: left M2, 121.1 x 74.8; right M2, 123.2 x 73.8; left M3, 180.4 x 78.7. Compared with other molars from México (Alberdi and Corona-M. 2005), the Pátzcuaro specimen is intermediate size. The mandible and M3 morphologies indicate that the remains belong to *Cuvieronius*, a genus with a wide distribution in Mexico (Arroyo-Cabrales et al. 2007), but in the nearby basins other gomphothere genera are known (Pliocene *Rhynchoterium* from Lake Cuitzeo basin: Carranza C. 1976; García-

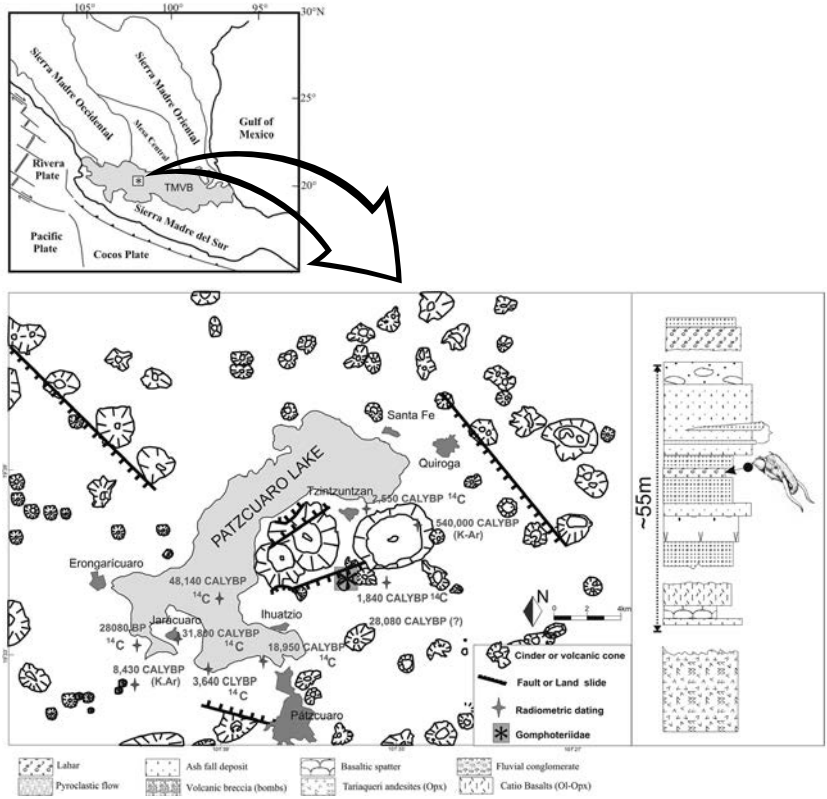

Figure 1. Regional geology and lithostratigraphic setting at Barranca Rancho Viejo. The placement of the fossil remains is indicated in the stratigraphic column.

Zepeda 2004; López García 2008; and Pleistocene *Stegomastodon* from Lake Chapala basin: Alberdi et al. 2009).

Results of pollen analysis suggest a landscape formed by a mixture of closed forest and secondary stands, dominated by Pinaceae (aff. *Picea*), Betulaceae (*Betula*), Fagaceae (*Quercus*) in the arboreal stratum, and by Amaranthaceae-Chenopodiaceae, Compositae, and Gramineae in the herbaceous stratum. This complex volcanic-sedimentary landscape could represent a paleoenvironment that was cooler than at present, with temperate forests and grasslands.

This finding indicates that megafauna already inhabited the area around Paleolake Pátzcuaro before explosive eruptions related to the Catio Volcano took place. Future explorations in this region could broaden the information about late-Pleistocene mammal history, including early man.

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Early-Pleistocene Glaciations in Argentina (South America) and the Response of Mammals: The Case of the Pampean Region

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➤ **Keywords**: Mammalian Biocenoses, Paleoclimate, Pampean Region, South America

The Pampean region of Argentina (approximately between 33° 22′ and 38° 22′ S, and 65° 45′ and 56° 45′ W) at present has a temperate-humid climate with predominant subtropical faunal elements. Some authors have pointed out that most of the present-day mammal biocenoses and climatic conditions in this region seem to have been recently established (Deschamps et al. 2003; Tonni et al. 1999). Climate during most of the Pleistocene was more arid than at present, and fauna of the Pampean region was adapted to these conditions, with an abundance of megaherbivores (body mass more than 1 ton; see Cione et al. 2008; Tonni et al. 1999).

In the Pleistocene sequences of Argentina, loesses and paleosols show fluctuations between glacial and interglacial cycles that occurred during the Pleistocene. Loess (or loessoid) levels were deposited during glacial periods, and paleosols developed during interglacial periods (Bidegain et al. 2007; Nabel et al. 2000; Pecsi 1990). These climatic changes affected the biota, modifying speciation and extinction rates, mainly as a result of habitat fragmentation (Barnosky 2005; Cione et al. 2008; Réale et al. 2003).

More than 15 glacial cycles have been detected in the Pleistocene sequences of Patagonia (Argentina); among these, a major one occurred around 1 million years ago (Ma) and is known as the "Great Patagonian Glaciation" (GPG) (Fig. 6 in Rabassa et al. 2005; Singer et al. 2004; Fig. 3 in Soibelzon et al. 2006). After the GPG another important glacial event is recorded in Patagonia around the Matuyama/Brunhes boundary (0.78 Mya) (Rabassa et al. 2005). These glacial events produced significant environmental changes in the Pampean region, affecting not only the distribution and composition of its fauna, but also increasing continentality as a consequence of the drop in sea level that occurred during the Last Glacial Maximum (Tonni et al. 1999). In the Pampean region the GPG and post-GPG events are correlated with the arid events registered around the Matuyama/Brunhes polarity change (Bidegain et al. 2005; Nabel et al. 2000), based on the characteristics of glass shards recorded in the loess. The base of the Brunhes polarity zone shows a peak of glass shards that suggests that the Matuyama/Brunhes turnover coincided with intense volcanic activity in the Cordillera de Los Andes. Nabel et al. (2000) have

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suggested that the fresh condition of the glass shards in the Pampean loess around the Matuyama/Brunhes boundary indicates a colder and more arid climate.

The mammalian assemblages found in the sediments of the Pampean Region between about 0.99 and 0.78 Ma are adapted to open areas with dry and cold climate (Nabel et al. 2000; Soibelzon et al. 2006, 2008; Tonni et al. 1999a, 1999b; Verzi et al. 2002). Several extant species found in the early Pleistocene of the Pampean region indicate these climatic conditions. These include the marsupial *Lestodelphis halli,* the armadillos *Zaedyus pichiy, Tolypeutes matacos*, and *Chaetophractus vellerosus*, the rodents *Dolichotis*, *Tympanoctomys*, *Eligmodontia, Microcavia,* and *Graomys*, the peccary *Catagonus*, and the Patagonian weasel *Lyncodon* (Soibelzon 2008). In addition, some extinct species of Xenarthra (*Eutatus* sp. and the Glyptodontidae and Mylodontidae), also recorded in the Pampean region, were adapted to arid and relatively cold conditions (Carlini and Scillato-Yané 1995).

During this lapse were recorded changes in the biocenosis of other places in the Southern Hemisphere (i.e., Africa) (deMenocal 2004), consistent with greater adaptation to arid conditions. These turnovers also coincided with the intensification of high-latitude glacial cycles (deMenocal 2004).

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Last Glacial Maximum Fauna from Great Saltpeter Cave, Kentucky

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➤ **Keywords**: Flat-headed Peccary, Paleoenvironment, Ohio Valley

Great Saltpeter Cave is located on a sharp meander of Crooked Creek in Rockcastle County, Kentucky. It is developed in the Mississippian-age Newman Formation, Ste. Genevieve Limestone Member, which is capped by the Pennsylvanian age, Lee Formation, Livingston Conglomerate Member. Cave passages are voluminous, extensive, and include sediment-filled canyons, tubes, and vertical shafts.

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The Cave has been explored and used by people for thousands of years as evidenced by numerous torch fragments and smudge marks found throughout the cave, indigenous petroglyphs on the western wall near the south entrance, and petroglyphs and pictographs in the passage known as Fat Man's Misery. The cave was explored during the 18th century by Virginian colonists such as Daniel Boone, as evidenced by his 1769 signature near the south entrance.

A 1799 signature of Samuel Brown occurs on the west wall of Fat Man's Misery near its intersection with a passage known as the Ballroom (formerly known as the Big Room). In April 1805, Brown discovered a large long bone during his saltpeter-mining operations. Recognizing its similarity to a specimen illustrated by Thomas Jefferson (1799), Brown contacted John Vaughan of the American Philosophical Society (Brown 1805a). Six months later, Brown (1805b) reported to Jefferson the discovery of a "skull and lower jaw of an animal whose species is unknown." The specimen was sent to Congressional Representative John Fowler and later presented to Jefferson (Barton 1806).

Although they were not recognized at the time, the remains discovered by Brown were of two distinct species of megamammals, *Megalonyx jeffersonii* (Jefferson's ground sloth) and *Platygonus compressus* (flat-headed peccary). More importantly, the flat-headed peccary discovered by Brown in the nitrate-rich sediment of Great Saltpeter Cave was the first specimen ever reported. The species was not formally described until a half-century later (Leidy 1853). Today the Great Saltpeter Cave specimens are curated by the American Philosophical Society. Unfortunately, the exact location of their discovery was never recorded.

On 14 October 1973, Tankersley found an isolated phalanx of an immature *Platygonus compressus* in a passage known as "Scots Hole" (sic) (DuFour 1805; George 2001:58–59). Since then, additional elements have been found at this location including cranial and innominate fragments, a second phalanx, an upper right canine (i.e., tusk), a femur with an unfused distal epiphysis, and a humerus with a well-marked proximal epiphyseal line. Badger (*Taxidea taxus*), long-tailed weasel (*Mustela frenata*), woodchuck (*Marmota monax*), and abundant unidentified bones of birds, bats, and microtines have also been found at the site (McDonald 2002:78).

Vertebrate fossils occur at a depth of 17 m in an unconsolidated coarse gravel (sandstone, quartzite, siderite), fine sand (goethite, hematite, ilmenite, pyroxene, quartz, spinel), and clay (berthierine, illite, kaolinite, smectite, vermiculite) deposit, which extends almost to the ceiling of the cave. The deposit displays a complex grouping of channelization and flow features such as cut-and-fill structures, and northwest to southeast beds with aligned clast imbrications. The episodic nature and large volume of the cave sediments suggest climatically controlled variations in surface runoff and stream levels during the Pleistocene (Engel and Engel 1998:7–10). Engel and Engel (1998) estimated the age of the deposits at more than 2,000,000 years. More conservatively, McDonald (2002) proposed a late-Pleistocene age for the fossil-bearing sediments.

In January 2009, an attempt was made to directly date the flat-headed

peccary and evaluate the age of the overlying cave sediments. A portion of an immature humerus was selected for AMS dating because it was found in stratigraphic context. The bone collagen yielded an age of 21,700 ± 130 RCYBP (Beta-254473), which overlaps at 1σ the current age range of the Last Glacial Maximum.

The $\delta^{13}C$ value of bone collagen from the Great Saltpeter Cave specimen was -20.7 ‰ (VPDB), which is comparable to the $\delta^{13}C$ value (-20.9 ‰ VPDB) obtained from a flat-headed peccary excavated from Clovis-age deposits at Sheriden Cave, Ohio, dated 11,060 ± 60 RCYBP. (CAMS-10349) and 11,130 ± 60 RCYBP (CAMS-33970) (Tankersley 1999; Tankersley and Redmond 2005; Waters et al. 2009). While the carbon isotope ratio for collagen speaks more about diet than environment, they are closely related and much the same. During the Last Glacial Maximum, Great Saltpeter Cave was approximately 250 km linear distance south of the glacial ice margin, which is comparable to the distance of Sheriden Cave to the glacial ice margin during the Allerød. Despite the dramatic climatic differences between the Last Glacial Maximum and Allerød, similar $\delta^{13}C$ values obtained on flat-headed peccary bone collagen from Great Saltpeter and Sheriden caves and similar linear distances from the ice margins suggest that flat-headed peccaries inhabited similar environments throughout the late Pleistocene.

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First Data on Late-Pleistocene Rodents from Central Arid Patagonia as Paleoenvironmental Indicators

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➤ **Keywords**: Chubut Province, Small Mammals, Sigmodontinae

Late-Pleistocene rodent faunas from Patagonia are poorly known. Pardiñas and Teta (2008) studied seven micromammal fossil assemblages with chronologies between 13,000 and 7000 RCYBP mostly from western Andean areas or near the Atlantic coast. For the remainder of the vast Patagonian territory (> 700,000 km^2) no late-Pleistocene/early-Holocene fossil micromammal assemblages have been reported (Pardiñas 1999). Here we briefly discuss the environmental significance of the paleontological site Torito Fissure (TF) (43° 16′ 46″ S, 69° 08′ 40″ W; 340 m a.s.l.), a rock crevice filled with organic material (feces, vegetation debris) and bones, found in the middle valley of the Chubut River (Figure 1). A ^{14}C age of 12,010 ± 160 RCYBP (LP-1995) was obtained from a fragment of the organic matrix. The scarcity of other traditional paleoclimatic archives in dryland areas of Patagonia (> 80 percent of its territory) enhances the importance of this sample, the first coming from north-central Patagonia.

Much of the study area is located in an ecotone between the dwarf shrub steppes of *Nassauvia* spp. and *Chuquiraga aurea* (locally known as *eriales*) and the shrubby steppes of *Junellia tridens* of the Central District of the Patagonian Phytogeoghapic Province (León et al. 1998). Paleoenvironmental reconstruction was based on comparisons between the fossil sample and two (pooled) modern micromammal assemblages (produced by owl predation) collected in the vicinity (< 10 km) of TF.

The fossil assemblage was exclusively composed of sigmodontine and caviomorph rodents. The dominance of sigmodontines that typically inhabit

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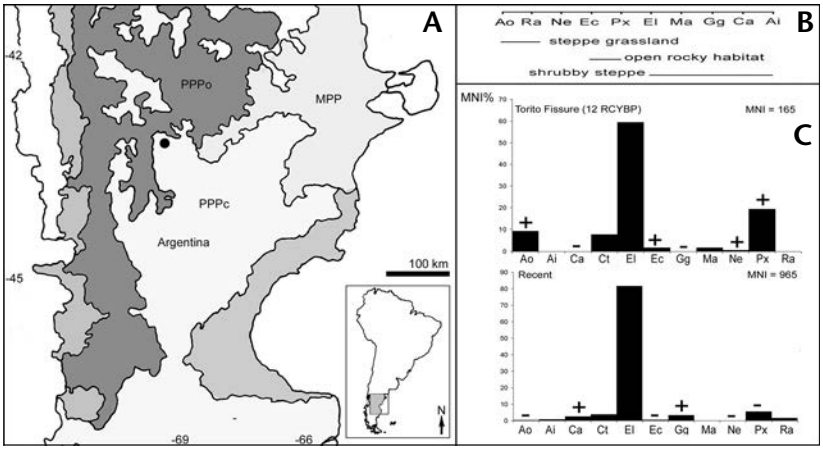

Figure 1. **A,** Central Patagonia, showing the location of Torito Fissure (black circle); **B,** approximated habitat requirements of rodent species reported in the studied samples (taken from Pearson, 1995); **C,** pair-comparisons between the fossil assemblage of Torito Fissure and recent samples (+ and – symbols on histogram columns highlight the main paired differences). Abbreviations: *Abrothrix olivaceus* (Ao); coney rat, *Reithrodon auritus* (Ra); *Notiomys edwardsii* (Ne); *Euneomys chinchilloides* (Ec); *Phyllotis xanthopygus* (Px); *Eligmodontia* spp. (El); southern mountain cavy, *Microcavia australis* (Ma); *Graomys griseoflavus* (Gg); *Calomys musculinus* (Ca); *Akodon iniscatus* (Ai); tuco-tuco, *Ctenomys* sp. (Ct); Monte Phytogeographic Province (MPP); Central District of the Patagonian Phytogeographic Province (PPPc); Oriental District of the Patagonian Phytogeographic Province (PPPo).

open shrubby and grassy areas such as the silky desert mice *Eligmodontia* spp. and the olive grass mouse *Abrothrix olivaceus* and a dweller of rocky outcrops such as the yellow-rumped leaf-eared mouse *Phyllotis xanthopygus* (see Pearson 1995) are indicators of a local landscape dominated by sparse shrubby vegetation mixed with bunchgrass patches and large rocky exposures. In addition, both the chinchilla mouse *Euneomys chinchilloides* and the Edwards's long-clawed mouse *Notiomys edwardsii*, two species numerically dominant in recent samples from the central basaltic plateaus of northern Patagonia (e.g., Somuncurá), suggest well-developed open, bare, windswept, rocky scree areas. The presence in modern samples of sigmodontines typically adapted to the Monte Desert, such as the grass mouse *Akodon iniscatus*, the vesper mouse *Calomys musculinus,* or the gray leaf-eared mouse *Graomys griseoflavus,* is partially linked with recent human activities, such as overgrazing and the expansion of cultivated areas along the Chubut River (see Udrizar Sauthier 2009). Thus, the absence of these species in TF indicates that by the late Pleistocene the boundary between the Monte and Patagonia phytogeographic units was located further eastward.

Inhospitable and cooler conditions, with scarce vegetal cover and extensive open bare areas (like those suggested by TF), may have been widespread across Patagonia during the late Pleistocene (see Pardiñas and Teta 2008). The first humans arrived at this time, and this regional landscape confronted them.

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A Middle-Pleistocene Interglacial Faunal Assemblage in Southeastern Buenos Aires Province, Argentina

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➤ **Keywords**: Middle Pleistocene, Climate, Argentina

The *Megatherium americanum* biozone is the biostratigraphical basis for the Bonaerian Stage in the Pampean region of Buenos Aires Province, Argentina (Cione and Tonni 1999). A biozone based on micromammals, the *Ctenomys kraglievichi* biozone has been described for the lower section of the Bonaerian Stage (Deschamps 2005). At the marine cliffs of southeastern Buenos Aires Province (Necochea County, 38° 37′ S, 58° 49′ W; Figure 1) remains of the bat *Noctilio* and caviomorph rodents such as an echimyid closely related to the living *Clyomys*, the dasyproctid *Plesiaguti totoi*, and the ctenomyid *Ctenomys kraglievichi* (Merino et al. 2007) were recorded in the lower section of the Bonaerian. In addition, in a profile located somewhat north of Necochea (Mar del Sur, 38° 21′ 00.0″ S; 57° 59′ 35.6″ W), the lower section of the Bonaerian includes a paleosol with abundant termite nests (Laza and Tonni 2004), similar to those of *Cornitermes cumulans* (Isoptera, Termitidae).

Noctilio represents the southernmost record for the genus; *Plesiaguti* is the only dasyproctid recorded in the Pleistocene of Argentina, whereas the echimyid related to *Clyomys* is the only post-Pliocene record of an echimyid at this latitude. All these species and the Termitidae are located at least 6° south of the present

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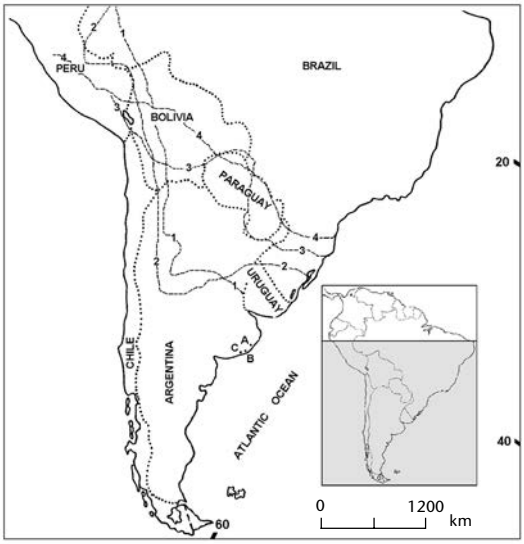

Figure 1. Map of southern South America depicting the southernmost distribution of: **1,** Termitidae (from Laza 2006); **2**, *Noctilio* (from Merino et al. 2007); **3**, Dasyproctidae; **4**, Echimyidae (from Mares and Ojeda 1982). **A**, **B,** and **C** indicate the localities Santa Clara del Mar, Mar del Sur and Necochea, respectively, in southeastern Buenos Aires Province.

continuous distribution, and they were clearly immigrants to the southeastern Buenos Aires Province. These taxa are linked to environmental conditions such as those currently occurring in the "Provincia Chaqueña" (Cabrera and Willink 1980) and indicate that they were associated with an important warm pulse that took place within the interval represented by the *C. kraglievichi* biozone. However, as stated by Merino et al. (2007), although the caviomorph species recorded in this biozone suggest warmer environments, they do not clearly indicate more humid conditions than those currently found at this latitude.

According to paleomagnetic and biochronological evidence, the *Ctenomys kraglievichi* biozone corresponds to OIS 11 (Shackleton 1995) verified at ca 0.4 Ma (see Bidegain et al. 2005; Verzi et al. 2004). In addition, this age is supported by Ar-Ar dates of 0.43 ± 0.03 Ma from an impact glass found within Bonaerian sediments at Centinela del Mar, between Mar del Sur and Necochea localities (Heill et al. 2002; Schultz et al. 2004).

This interglacial episode was very strong and the longest one in the past 0.5 Ma (Droxler et al. 2003). The marine transgression described by Cione et al. (2002) at Santa Clara del Mar marine cliffs (37° 50′ 56″ S, 57° 30′ 18″ W) also corresponds to this interglacial episode.

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American Mastodon (*Mammut americanum*) in the Rancho La Brea Collection of the University of California Museum of Paleontology

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➤ **Keywords:** Mammut, Mastodon, Rancho La Brea

While *Mammut americanum* occurs at over 100 Rancholabrean localities in California (Jefferson 1991), most sites record single individuals. Even Rancho

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La Brea preserves few specimens, Stock and Harris (1992) reporting a minimum of 14 individuals in the Page Museum collection. Miller (1987) and Harris (2001) remarked that Rancho La Brea mastodons are smaller than those found elsewhere in the United States, although neither author provided measurements. To increase sample size for comparison and further evaluate the tar seep versus other North American specimens, we examined mastodons in the Rancho La Brea collection of the University of California Museum of Paleontology (UCMP).

Like the Page Museum, mastodon material in the UCMP collection has not been published. Previously, only four UCMP Rancho La Brea mastodon specimens were catalogued, all from locality 3874 (Rancho La Brea general): UCMP 22995 (tooth fragment), UCMP 27114 (femur), UCMP 27115 (tibia), and UCMP 158258 (molar). These specimens are missing from the UCMP. However, we identified and catalogued 10 other locality 3874 specimens, which are reported here.

Two partial right dentaries are UCMP 198852 and UCMP 198861. UCMP 198852 has a single tooth, an M_3 with four lophids and a posterior turbercle. M_3 maximum width is 83.0 mm at the tritolophid, and length is 199.7 mm. UCMP 198861 has an M_1 and M_2. M_1 maximum width at the metalophid is 66.5 mm, and maximum length is 108.5 mm. M_2 maximum width at the metalophid is 79.1 mm, and maximum length is 110.5 mm. Stage of tooth wear indicates that these individuals were approximately 34–39 years and 20 years in age respectively, based on Saunders's (1977) use of African elephant years.

Two partial left dentaries are UCMP 198853 and UCMP 198858. UCMP 198853 has an M_3 with five lophids, although the pentalophid is not fully developed. M_3 maximum width is 83.1 mm at the tritolophid, and maximum length is 190.0 mm. UCMP 198858 has a broken M_2 that prevents taking standard measurements. Tooth wear suggests UCMP 198853 was about 34 years old, while the presence of the M_2 and an M_1 alveolus in UCMP 198858 indicates an individual greater than 18 years in age, based on Saunders's (1977) age model.

UCMP 198859 is a partial cranium, including the left maxilla with M^1 and M^2 and the left and right tusk alveoli. The M^1 and M^2 are broken, precluding useful measurements. The tusk alveoli are subrounded to oval; the left alveolus has a dorsoventral diameter of 86.5 mm and a mediolateral diameter of 78.2 mm, and the right alveolus has a dorsoventral diameter of 85.6 mm and a mediolateral diameter of 79.4 mm.

UCMP 198860 is a partial cranium, consisting mostly of the palate. The left M^1 and M^2 are broken but present. The right M^1 and M^2 are intact. The right M^1 has a maximum width at the metaloph of 69.9 mm and a maximum length of 97.1 mm. M^2 has a maximum width at the metaloph of 74.9 mm and a maximum length of 97.2 mm. An unerupted M^3 occurs on the right side. The right M^1 protoloph and metaloph are worn. The M^2 is unworn. This individual is estimated to be a young adult, about 20 years in age based on Saunders's (1977) model.

Three isolated premolars (UCMP 198854, 198855, 198856) and a right femur (UCMP 198857) were also identified. Femur length is 845.1 mm, minus the proximal epiphysis, which is missing.

In relation to Trolinger Spring and Boney Spring mastodons of Missouri (Saunders 1977) and specimens from Utah (Miller 1987), the UCMP Rancho La Brea specimens have long, narrow teeth, particularly the M_3 of UCMP 198852 and UCMP 198853. The M_1 and M_2 of UCMP 198861 are small compared with Trolinger Spring and Boney Spring specimens, as are the M^1 and M^2 of UCMP 198860. While the M_3 of UCMP 198853 and UCMP 198852 are approximately the same width as the Utah mastodons, they are 22 to 32 mm longer, respectively. The M_2 of UCMP 198861 is larger than Brigham Young University specimen BYUVP 4379, while the M^2 of UCMP 198860 is about the same length but 5 mm narrower than the aforementioned male specimen from Utah. While Miller (1987) stated that Page Museum specimens are smaller than Utah mastodons, which are smaller than Missouri and Michigan mastodons, UCMP specimens overlap in size with those from Utah. Sexual dimorphism may account for some Page Museum and Utah specimen size differences. Further study of Rancho La Brea mastodons and comparison with other North American populations is warranted.

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Southernmost Records of the Brown Lemming (*Lemmus* sp.) during the Late Pleistocene: Implications for Re-colonization after Glacial Retreats

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➤ **Keywords**: *Lemmus*, Deglaciation, North America

Of the hundreds, if not thousands, of Pleistocene fossil sites described in North America containing micromammals (e.g., FAUNMAP 1994), only about

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seven (counting this report) have included the brown lemming, *Lemmus trimucronatus* (currently the only recognized species in North America [Jarrell and Fredga 1993]). Moreover, several are within, or fairly close to, its current geographic range (e.g., Inland pit 48 of central Alberta [Burns 2004] and January Cave of southwestern Alberta [Burns 1980]). Here I highlight the significance of the three records of *Lemmus* from Iowa: the Wapsipinicon (Wallace 2000, 2001, 2008) and Honey Dipper Den (Slaughter and Jones 2000) assemblages, both in Jones County; and the Prairieburg local fauna (l.f.) in Lynn County (Foley and Raue 1987).

Wapsipinicon has four dates on mandibles of *Microtus xanthognathus* that range from 13,460 ± 120 to 25,470 ± 350 RCYBP (NZA-10446, NZA-10444, NZA-10443, and NZA-10445) (Wallace 2000), Honey Dipper Den has a date of 15,490 ± 100 RCYBP from a *Dicrostonyx* mandible (NZA-10693) (Slaughter and Jones 2000), and Prairieburg was interpreted to be full glacial (Foley and Raue 1987), c. 18,000 RCYBP. The three sites contain the southernmost records of *Lemmus* in North America, which seems surprising considering that *Dicrostonyx*, a genus with a very similar distribution today, is significantly more common (though still rare compared to other arvicoline rodents) in Pleistocene deposits (Burns 2004; Driver 1998; FAUNMAP 1994; Mead and Mead 1989). Oddly, all three Iowa sites are within roughly 24 km of each other, with the Wapsipinicon assemblage occurring roughly 24 km southeast of the Prairieburg l.f. and roughly 8 km southeast of Honey Dipper Den.

Lemmings are unique among rodents in that their population cycles are not directly related to those of carnivores, but are instead tied to the plant communities in which they live (Oksanen et al. 2008). Specifically, lemmings evolved with the tundra, developing the ability to successfully forage during even the harshest of conditions at the expense of agility (Oksanen et al. 2008); a trait no longer necessary because the low lemming populations supported by the tundra are inadequate to sustain warmblooded carnivores (Oksanen and Oksanen 2000). This unique relationship could explain the rarity of fossil lemmings south of the Pleistocene ice sheets, because vast expanses of tundra-like environments were likely uncommon owing to the patchwork nature of the glacial landscape (Graham 1985; Graham and Mead 1987; Lundelius 1989). Moreover, if only small segments of "tundra" existed in these southern regions, mammalian carnivores (as well as owls) would have been more common because of the adjacent resources, meaning that lack of agility would have been very costly.

Clearly *Lemmus* did find at least some tundra-like environments south of the Pleistocene glaciers as shown by the Iowa records, but were these populations significant? Burns (1980) suggested the possibility of northern dispersals from "relict" southern populations based mostly on the proximity of January Cave to the current distribution of *Lemmus*. However, recent genetic studies support this idea stating that there were likely no refugia for many arctic taxa (i.e., *Dicrostonyx* [Ehrich et al. 2000; Fedorov and Stenseth 2002], *Lemmus*, [Fedorov et al. 2003], and *Microtus oeconomus* [Brunhoff et al. 2003]) in Beringia during Pleistocene displacement. Within *Lemmus* specifically, significant genetic divergence between eastern Canadian and Beringian populations seems to

suggest that much of the diversity was attained prior to the last glacial maximum (Fedorov et al. 2003), with a separation well over 100,000 CALYBP. To maintain this difference, eastern populations displaced by the ice sheets would have needed populations to survive in small, isolated refugia. Therefore, though these southern fossil records of *Lemmus* are rare, undoubtedly the populations they record played an important role in the re-colonization of at least the eastern portions of the current range of the genus.

The southern records reported here are significant because: 1) the occurrence of *Lemmus* shows that there may have been extensive tundra-like conditions in Iowa during at least the full glacial as suggested by Baker et al. (1986), as well as Foley and Raue (1987); 2) the rarity of *Lemmus* at other fossil sites suggests that most of these tundra-like regions (outside of the Midwest) were small, or at least intermixed with different habitats creating an environment unable to sustain large numbers of lemmings; 3) it seems that *Lemmus* will remain a rare taxon in Pleistocene faunas; and 4) southern populations of *Lemmus* during the Pleistocene prove the existence of the refugia necessary to sustain the genetic diversity observed in the living eastern populations of the genus.

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Paleoenvironments: Geosciences

Developing a Geospatial Database of Playas within the High Plains of Kansas

Mark W. Bowen, William C. Johnson, Scott T. Klopfenstein, and John W. Dunham

➤ **Keywords**: Playa Lakes, Mapping, Kansas High Plains

Playas (a.k.a. buffalo wallows, potholes, rainwater basins, lagoons, salinas) are widely distributed across the southern and central High Plains (Holliday et al. 1996; Johnson and Campbell 2005; Smith 2003). Besides being an important source of groundwater recharge and wetland habitat, playas were widely utilized by Paleoindian peoples. To better understand the number and spatial distribution of these essential High Plains features, a playa inventory was conducted in a GIS-environment and a comprehensive geospatial playa database was created for Kansas.

Many playas have functioned as perennial or ephemeral sources of water for thousands of years, and, as a consequence, playas were clearly a major resource for Paleoindian peoples in the region and a focus for much of their activity. Paleoindian associations have been documented, however, at only a limited number of playas within the central and southern High Plains (Campbell et al. 2007; Hill et al. 1995; Holliday 1997; Holliday et al. 1994; LaBelle et al. 2003; Mandel and Hofman 2003). Given the nature of these finds and the ubiquity of playas, identifying and mapping these widely exploited resources is essential to improve our understanding of the peopling of the Americas.

We have made an effort to assemble a geospatial database that accurately portrays playa distribution on the High Plains of Kansas. Our first approximation of playa mapping was derived solely from the distribution of hydric soil series in the SSURGO (Soil Survey Geographic) database (Johnson and Campbell 2005), and, as a consequence of using this single data source, approximately 10,000 playas were documented. Our new playa database was extracted from multiple years of high-resolution imagery from NAIP (Na-

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tional Agriculture Imagery Program), with augmentation by depression contour data from DRGs (digital raster graphics) and the SSURGO database. The distribution is clearly nonrandom, with clusters occurring on broad expanses of the loess-mantled uplands (Figure 1). For example, the elongate clusters in the northwestern part of the state coincide with the broad upland divides between northeast-flowing tributaries to the Republican River. Simple statis-

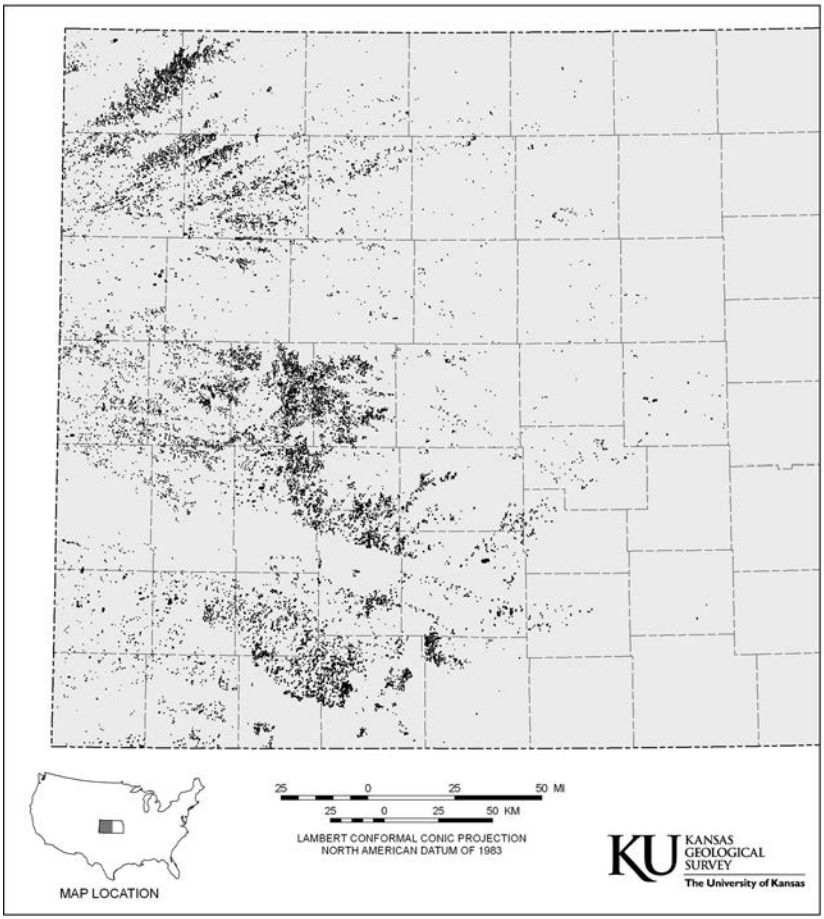

Figure 1. Distribution of playas on the High Plains of western Kansas. Data were derived from NAIP imagery, augmented with SSURGO distribution of hydric soil series and DRG depression contour data. Playas are plotted as polygons, rather than point data.

tics for the database include a sum of about 23,200 playas, with a minimum playa area of 325 m^2, maximum area of 3,354,300 m^2, mean area of 16,400 m^2, modal area of 1400 m^2, and median area of 6200 m^2. Shape files of these data may be downloaded from DASC (Data Access & Support Center) at the Kansas Geological Survey (http://www.kansasgis.org/). Playa distribution data are

also available for Colorado, Nebraska, New Mexico, Oklahoma and Texas from the PLJV (Playa Lakes Joint Venture) (http://www.pljv.org/).

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Late-Pleistocene/Early-Holocene Boundary, Buried Soils, Loess, and Alluvium throughout the Bull Creek Drainage, Oklahoma Panhandle

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➤ **Keywords**: Soil Formation, Radiocarbon Age, Southern Great Plains

The Bull Creek drainage system located in the Oklahoma panhandle (Figure 1) provides evidence for a late-Pleistocene/early-Holocene transition and lies on the cusp between the southern and central Great Plains. The most recent site described, Bull Creek III (BCIII), is a continuation of previous paleoenvironmental work along the Bull Creek drainage (Bull Creek I (BCI) and Bull Creek II (BCII)) (Bement et al. 2007a; Bement et al. 2007b; Carter and Bement 2004). The drainage system empties into the Beaver then North

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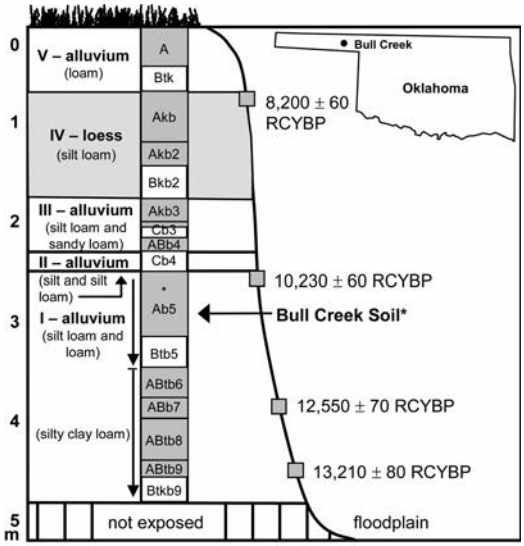

Figure 1. Schematic profile of Bull Creek III site, located in Beaver County, Oklahoma. The valley-wall exposure provides evidence of a stacked sequence of buried soils formed in alluvium and loess, dating from the late Pleistocene to early Holocene.

Canadian River and provides additional evidence for periodic grassland soil formation within alluvium, colluvium, and loess. The BCIII soil profile was described and sampled by horizon for particle-size analysis to determine soil formation and depositional environments. Radiocarbon dates (total soil organic matter) were obtained from the upper 10 cm of selected buried horizons (Akb, Ab5, ABb7, and ABtb9) to identify the time of soil burial.

Soil profiles for these three sites broadly contain the same litho-, pedo-, and chronostratigraphic units (loess over alluvium, multiple buried grassland and carbonate-rich soils, and a late-Pleistocene-to-middle-Holocene age). The BCI and BCII profiles contain loess units starting from the ground surface to depths of 144 cm and 186 cm, respectively. The BCIII profile however, contains alluvium (mean percent: sand 32.3; silt 47.6; clay 32.3) from the surface to a depth of 70 cm, and then contains a loess (mean percent: sand 9.2; silt 69.5; clay 21.3) interval 70–167 cm below ground surface. These loess units are marked by calcic soils that were buried during the early and middle Holocene for BCI and BCII (Bement et al. 2007a) and before 8200 ± 60 RCYBP (Beta-249842) for BCIII. The BCI and BCII soil profiles contain evidence of a drier climate of the middle-Holocene period (Baker et al. 2000; Holliday 1989), during which there was increased eolian activity (Olson and Porter 2002) with calcic soils and loess indicating relatively dry conditions during soil formation. The BCIII soil profile indicates an early-Holocene period of calcic soil formation and eolian deposition.

Underlying the loess at BCIII is alluvium. Prominent mollic (Ab5, ABtb6, and ABtb8) and dark ochric (Akb3, ABb4, ABb7, and ABtb9) buried surface soil zones punctuate this alluvium and correspond to periods of stability immediately above and below the late-Pleistocene/early-Holocene boundary (Figure 1), supporting findings by Mandel (2008) and Olson and Porter

(2002). Clay translocation as evidenced by buried Bt subsurface horizons indicates moist soil-forming conditions extending back to 13,210 ± 80 RCYBP (Beta-249845). The prominent mollic soil (Bull Creek Soil) at BCIII was buried 10,230 ± 60 RCYBP (Beta-249843) and is traced down-valley to BCII (Bull Creek Soil at 10,280 ± 60 RCYBP; Beta-205624). Additional BCIII buried soils extend the chronology from 12,550 ± 70 RCYBP (Beta-249844) to 13,210 ± 80 RCYBP (Beta-249845).

A soil-profile description, four new radiocarbon ages, and particle-size analyses were obtained from a new Bull Creek site (BCIII). The preliminary comparison with other soil sites from the Bull Creek valley identified loess and alluvial units, and multiple late-Pleistocene and early-Holocene buried grassland soils. Continued investigation of stacked soils in the Bull Creek and adjacent drainages could provide vital data for understanding past climates, floral and faunal communities, and human inhabitants of the region.

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Geology of Mammoth (*Mammuthus*) Fossils on the Western Snake River Plain, Idaho

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➤ **Keywords**: Mammoths, Geology, Idaho

In North America, mammoth (*Mammuthus*) fossils are key biostratigraphic indicators for the Irvingtonian and Rancholabrean land mammal ages that

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can provide information regarding Pleistocene environmental patterns and processes. They occur in a variety of geologic contexts in the western Snake River Plain (WSRP), southwestern Idaho. This paper provides a review of previously known localities and a preliminary assessment of the geology of mammoth fossils recently recovered northeast of Nyssa, Oregon.

The oldest mammoth remains known in this region are from the eastern WSRP within the Bruneau Formation, near Glenns Ferry (Elmore County). The locality is an outcrop of lake beds on the south side of the Snake River containing tooth fragments of *Mammuthus* (Malde and Powers 1962; Malde 1991). Based on K-Ar measurements of stratigraphically related basalts they may date to about 1.36–1.4 Ma (Everenden et al. 1964; Armstrong et al. 1975) or possibly 2.06-0.78 Ma (Bell et al. 2004) and can be attributed to the Irvingtonian. There are two Rancholabrean localities with *Mammuthus* in Elmore County, north of the Snake River (Jefferson et al. 2002). Mammoth remains have been recorded from the Rabbit Springs locality (IMNH 85031) and in the Bonneville flood gravels (Melon Gravels) at Sugar Bowl (IMNH 83014, Jefferson et al. 2002). Floodwaters of the Bonneville flood date to about 14,500 RCYBP (Hill 2006: Table 2).

At least two proboscidean fossils have been previously reported from the WSRP near the Idaho-Oregon boundary. Mastodon (*Mammut americanum)* fossils are known from a small bluff from probable lake deposits about 3 km northeast of Nyssa, and remains of *Mammuthus columbi* were found about 3 km north of Payette (Hay 1927). Additionally, in August 2008 mammoth remains were discovered at a gravel pit northeast of Nyssa, Oregon, and south of Fruitland, Idaho. The assemblage includes fragments of a mandible, molars, vertebrae, ribs, and limb bones. The bones seem to have originally been deposited at the locality in articulated position and were overlain by about 2 m of sand and gravel. Sediments adhering to the bones are very pale brown (~10YR 8/2-3) silts and very fine to medium sands.

The pit is situated in the Nyssa 7.5-minute quadrangle at an elevation of about 725 m a.s.l., in an upland area between Ashlock Gulch (also called Big Whitney Gulch) to the south and Hurd Gulch to the north. The locality is east of the Snake River in a wide depression within the upland. The exposure where the fossils were discovered is an 8-m-thick sequence of fluvial sands and gravels. The sediments enclosing the bones are unindurated and consist mostly of cross-bedded medium sands with coarse sand and gravel, and low amounts of finer clastics. These fossils overlie a 0.4- to 1.0-m-thick unit of gravel, which is the top part of a ~5-m sequence of sands and gravels (base unexposed).

The gravel pit deposits can be correlated to the regional geologic sequence, providing an opportunity to estimate the age of the mammoth fossils. Immediately to the south of this area, slackwater deposits from the Bonneville flood reach an elevation of 747 m (O'Connor 1993). These silts overlie the Whitney and Wilder terraces. Immediately south of the gravel pit mammoth locality the Wilder terrace it is at an elevation of ~720 m or higher. Thus, it may correlate with the sands and gravels containing the mammoth remains.

The ages of terraces, estimated based on the presence of basalts that overlie

them, have been correlated to glacial and interglacial episodes (Othberg 1994). The Whitney terrace has been correlated with the regional Bull Lake glaciations; based on the age of the younger Mores Creek basalt (107 ka) (Othberg et al. 1995) that overlies the lower Boise terrace, the Whitney terrace is late middle Pleistocene (OIS 6, ca. 198-132 ka) (Othberg et al. 1996). If the mammoth-bearing sequence at the gravel pit is associated with the Wilder terrace, it would be older than the Whitney terrace. The Wilder terrace could correlate with the Sunrise terrace in the eastern Boise Valley or be intermediate between the Gowen and Sunrise terraces. The Sunrise terrace is correlated with OIS 8 while the Gowen terrace is correlated with OIS 12 and 14 (Othberg et al. 1996). If these correlations are correct, the mammoth fossils in the gravel pit are likely to be middle Pleistocene in age (~250–575 ka) (Othberg et al. 1997). Thus, mammoth localities from the WSRP are apparently associated with lacustrine and alluvial deposits ranging in age from the early to late Pleistocene, providing examples from both the Irvingtonian and Rancholabrean.

Special thanks to Duane Bellows for the invitation to conduct field studies, and to Duane and Stephanie Bellows for providing information and collecting materials. Thanks to Ken Reid, Shelby Day, and Bill Akersten for their help or advice, and to Cheryl Hill, who served as field assistant.

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Micromorphological Investigations at the Tarkio Valley Sloth Site, Page County, Iowa

Richard L. Josephs

➤ **Keywords**: Tarkio Valley Sloth Site, Micromorphology, Iowa Vertebrate Paleontology

In 2001, Robert and Sonia Athen discovered the skeletal remains of a late-Pleistocene adult Jefferson's ground sloth (*Megalonyx jeffersonii*) in West Tarkio Creek, behind their residence in Page County, Iowa. The Athens brought examples of their find to the University of Iowa's Department of Geoscience for identification. This prompted the assembly of a multi-disciplinary research team, under the direction of Dr. Holmes Semken and Mr. David Brenzel, to intensively investigate the site. This specimen represents the second most complete and second largest adult *Megalonyx* recovered to date (Horgen et al. 2007). In 2006, the remains of two distinct juvenile *Megalonyx jeffersonii* were found alongside those of the adult. This marks the first time that juvenile *Megalonyx* remains have been found in situ with an adult specimen (Horgen et al. 2007).

Samples of the sediment matrix, encompassing an adult vertebral fragment (SUI 101037CJ) and a juvenile clavicle (SUI 102849S), were selected for micromorphological analysis to determine the environment of deposition (Josephs and Bettis 2003). Petrographic thin-section descriptions focused on sample composition (mineral and organic), texture (particle size, shape, and sorting) and fabric (the geometric relationships among the constituents) (Bullock et al. 1985; Stoops 2003).

The fossil-bearing sediments at West Tarkio Creek have a silt loam texture consistent with derivation from a loess parent material. Loess mantles the uplands and upper hill slopes of southwestern Iowa's Southern Iowa Drift Plain physiographic province (Prior 1991). The sediment's microstructure is massive and contains very little void space. The sediments display a double-spaced porphyric coarse/fine related distribution pattern (c/f-RDP) with the coarser (sand-size) grains occurring in a dense groundmass of finer silt- and clay-sized particles.

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The coarse fraction is composed primarily of well-sorted, subangular to subrounded, very fine sand-sized monomineralic grains. The more angular grains have a moderately expressed horizontal orientation, evincing microstratification in the sediments consistent with fluvial deposition. Scattered throughout the sediment are very few (< 5%) subangular to subrounded fine, medium, and coarse sand-sized mono- and polymineralic grains. The identifiable mineral grains include quartz, K-feldspar, plagioclase feldspar, biotite and muscovite micas, and opaques (Fe-oxide minerals). Rock fragments include chert and compound mineral grains composed of quartz, feldspars, and biotite. These polymineralic grains are likely granitic (metagranitic/metagranodioritic) fragments derived from nearby glacial tills.

The clay domains produce interference colors because of the birefringent (double-refractive) properties of the clay particles. The sediments display horizontally oriented domains of undifferentiated and crystallitic (unistrial) birefringence fabrics (b-fabric) that enhance the microstratification when viewed in cross-polarized light (XPL). An undifferentiated b-fabric is characterized by an absence of interference colors in the micromass. Undifferentiated b-fabrics are virtually opaque and typically produced by clay rich in Fe-Mn oxides or organic matter. A unistrial b-fabric displays one preferred parallel orientation and indicates inherited sedimentation characteristics (Stoops 2003).

Numerous bone fragments were observed in the silt loam matrix. In cross-polarized light, bone fragments display low interference colors (first-order gray) and an undulatory extinction pattern upon rotation of the microscope's stage. The primary bone mineral, apatite, produces a uniaxial-negative interference figure. The two largest bone fragments, both roughly 6 by 2 mm, have their long axes oriented horizontally, parallel with the angular mineral grains and therefore the supposed trend of flow. Both display compact bone tissue with visible osteons and Haversian canals. Based on the views of the osteons and Haversian canals, the two fragments appear to represent longitudinally oblique sections (Cuijpers 2006). The osteons, Haversian canals, and post-depositional microfractures contain clay coatings, mineral infillings, and fecal pellets.

The micromorphological evidence suggests that the *Megalonyx* remains were originally buried by fluvially redeposited loess under low-energy flow conditions that would have had minimal disturbance potential. The field excavations support the micromorphological conclusions, having revealed only a minor scattering of the skeletal elements buried by a dense, fine-grained deposit. Bone distribution at the Tarkio Valley site suggests that the sloths died in or near the water. The carcasses then partially decayed and broke into body segments that floated and dispersed prior to burial. The presence of smaller bones and absence of abrasion also implies deposition in a low-energy stream.

Although the remains of juvenile sloths have been discovered previously, none have ever been found directly associated with an adult specimen. This is compelling evidence that these individuals are related, and DNA samples have been submitted to assess genetic similarity. The sloth-bearing sediments contain

pollen, seeds, and mollusks that will provide significant paleoecological information about the Tarkio Valley site. Together, the analysis of the three individuals should furnish unique insights into the behavior, habitat, nutrition, and family dynamics of this extinct species, as well as the transitional late-Pleistocene paleoenvironment in which they existed.

I would like to thank Dr. Holmes Semken, Emeritus Professor, Department of Geoscience, University of Iowa, for giving me the opportunity to examine the sediments from the Tarkio Valley Sloth site.

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Dissertation or thesis: Phippen, P. G. 1988 Archaeology at Owl Ridge: A Pleistocene-Holocene Boundary Age Site in Central Alaska. Unpublished M.A. thesis, Department of Anthropology, University of Alaska, Fairbanks.

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