CURRENT RESEARCH IN THE PLEISTOCENE

Volume 24 2007

A Peopling of the Americas Publication

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From the Editor—An Important Bulletin

This issue of *Current Research in the Pleistocene,* Volume 24, contains 81 papers, the most we have ever bundled together in a single volume. This is up 100 percent from just two years ago.

Unfortunately, *CRP* sales have not risen so dramatically. Last year, only 23 (about 30 percent) of our authors actually purchased Volume 23, and in the last two years, sales have only increased by about 20 percent. To pay for the rising cost of production, we need to increase sales. As a *CRP* reader and/or writer, you can do two things to help. First, if you have not purchased your copy of Volume 23 or Volume 24, consider doing it now (order forms are available in the back of this volume). Second, if you are an instructor or student, ask your university library to subscribe to *CRP*. We currently have surprisingly few institutional subscriptions, and in many cases the only way to get your library to subscribe is for YOU to make the request. The information contained in this issue and the previous 23 volumes of *CRP* should be accessible to both faculty and students, on the shelves of your institution's library. All previous issues, with the exception of volumes 1–4, are still available. Encourage your library to acquire a complete set, as well as the current issue.

In gathering these statistics, we realized, too, that very few *CRP* writers are active members of the Center for the Study of the First Americans, which produces and publishes *CRP*. In fact, of the 81 lead authors who contributed to Volume 24, only 11 (14 percent) are members. If you are a member, we want to thank you for your continued support of the Center. However, if you are not a current member, we want to encourage you to become one. With membership comes not only a subscription to the *Mammoth Trumpet,* the Center's quarterly newspaper, but also a sense of pride knowing that you contributed to the Center's mission to disseminate your and your colleagues' research about the peopling of the Americas to the general public.

Ted Goebel

Special Focus:
The Younger Dryas Cold Snap in North America: New Evidence for Its Cause and Effects

Evidence of the Younger Dryas Chronozone from Paleoecological Records of the Northern Rocky Mountains

Andrea Brunelle

This paper focuses on the palynological signal of the Younger Dryas chronozone (YDC) from sites in the Northern Rocky Mountains of Idaho and Montana (NRM). According to Alley et al. (1997) the YDC begins ca. 11,100 RCYBP (12,850–13,000 CALYBP) and terminates ca. 10,100 RCYBP (11,640 CALYBP). Although there are many sites from NRM that examine the vegetation and climate history of the region over the Holocene (Mehringer 1985; Whitlock et al. 2002), there are only a handful with chronologies that reliably extend back to the period of the YDC. Additionally, many sites that extend back to the YDC have a pollen signal that is difficult to separate from that of deglaciation. Records identified here are those with a distinctive change during the window of time associated with the YDC. To provide a regional context for the YDC in the NRM, additional sites from the Canadian Rocky Mountains and the Yellowstone National Park region are also included.

In the NRM most sites that extend back to the YDC exhibit a response to the climatic conditions at that time. The dominant signal for the YDC in this area is cold, with some sites also suggesting increased effective moisture. Lost Trail Pass Bog, Montana (Mehringer et al. 1977), records cooling associated with the YDC through an increased occurrence of *haploxylon* (white) pines (most likely whitebark pine, *Pinus albicaulis*) and an increase in spruce (*Picea engelmannii*). The YDC at Baker Lake, Montana (Brunelle et al. 2005) and Sheep Mountain Bog, Montana (Mehringer 1985), is marked by increases in whitebark pine and spruce, similar to Lost Trail Pass Bog, but also shows increases in fir (*Abies bifolia*) and alder (*Alnus* sp.), which suggest greater effective moisture than immediately before or after the YDC. Burnt Knob Lake, Idaho (Brunelle and Whitlock 2003), records a higher percentage of fir as well

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as distinctive increases in the influx (grains/cm^2/year) of spruce and larch (*Larix* sp.) during the YDC. The record for Teepee Lake, Montana (Mack et al. 1983), only begins ca. 10,500 RCYBP, so it is difficult to say if the high occurrence of whitebark pine at that time reflects cool conditions associated with deglaciation or a cooling associated with the YDC. However, subsequent decreases in whitebark pine contemporaneous with the end of the YDC suggest that the vegetation response is at least in part being driven by YDC cooling.

Moving south in the Rocky Mountains to the Yellowstone region provides many more sites to examine. Similar to NRM sites, the Yellowstone region has a YDC signal of cooling. Most sites in Yellowstone record the YDC with an increase in spruce pollen or macrofossils (Lily Lake fen, Fallback Lake, Divide Lake, Emerald Lake, Mariposa Lake, and Slough Creek Pond) (Whitlock 1993; Whitlock and Bartlein 1993). Lily Lake fen also demonstrates a significant increase in fir along with the increase in spruce during the YDC, and Emerald Lake shows a concurrent decrease in juniper (*Juniperus* sp.) with an increase in spruce (Whitlock 1993).

Many of the Canadian Rocky Mountain lakes were not deglaciated early enough to register a YDC signal. However, notable exceptions provide an interesting record of the YDC in the more northern regions of the Rocky Mountains. Crowfoot Lake in Alberta, Lake O'Hara in British Columbia, and Toboggan Lake in Alberta all mark the YDC with the input of glacial sediments into the lake basins associated with a YDC-age glacial advance. There is little paleoecological evidence of the YDC from these sites, as the YDC glacial sediments overlay those of the previous advance; however, the termination of the YDC is indicated by a rapid shift from glacial to organic sediment (MacDonald 1989; Reasoner and Hickman 1989; Reasoner and Huber 1999).

Lower-elevation sites in British Columbia provide palynological evidence of a YDC cooling event. Mike Lake on the Fraser Lowlands (Pellatt et al. 2002) indicates a short period of cool conditions during the YDC (ca. 10,400–10,000 RCYBP). Sites on both the northern and southern parts of Vancouver Island also suggest a cool, moist YDC with increases in western hemlock (*Tsuga mertensiana*), lodgepole pine (*Pinus contorta*) and alder (*Alnus crispa*) (Brown and Hebda 2002; Lacourse 2005). Matthews (1993) also suggests cooling during the YDC from evidence on the British Columbia coast (both marine and terrestrial sites).

While not all sites in the northern Rocky Mountains are old enough or sensitive to climate changes associated with the YDC, those that do record the event suggest the YDC was cooler and in some cases wetter than before or after the chronozone. Currently no sites suggest warming associated with the YDC, so it is most likely that the YDC, although originating in the North Atlantic, also led to cool conditions as far west as the northern Rocky Mountains.

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Response of Glaciers and Vegetation to Younger Dryas Cooling in Western North America

John J. Clague and Thomas R. Lakeman

The Younger Dryas Chronozone was the time of final decay of the Cordilleran ice sheet in western North America (11,000–10,000 RCYBP). The ice sheet was

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less than half its maximum size, which it had attained only a few thousand years earlier at the peak of the last (late Wisconsin) glaciation. A change in ocean circulation and cooling climate in the northeast Pacific Ocean (Hendy et al. 2002; Hetherington and Reid 2003; Patterson et al. 1995) drove vegetation change and glacier resurgence during the Younger Dryas.

Paleoecological studies document a sudden return to a cool climate in the northeast Pacific during the Younger Dryas. Herb-rich parkland and shrub- and herb-dominated tundra became reestablished in coastal British Columbia and Alaska about 11,000 RCYBP or shortly thereafter (Engstrom et al. 1990; Hansen and Engstrom 1996; Hu et al. 1995, 2002; Lacourse 2005; Mathewes 1993; Mathewes et al. 1993; Peteet and Mann 1994).

Glacier advances of Younger Dryas age have been identified in the southern Coast Mountains of British Columbia (Friele and Clague 2002a, 2002b), the southern Canadian and northern American Rocky Mountains (Osborn and Gerloff 1997; Reasoner et al. 1994), the northern Cascade Range of Washington (Kovanen and Easterbrook 2001), and southwestern Alaska (Briner et al. 2002) (Figure 1). The Younger Dryas, however, was not the only cold interval during the late-glacial period (14,000-9500 RCYBP). Advances several hundred years to more than 1000 years earlier than the Younger Dryas have been identified in southwest British Columbia (Armstrong 1981; Clague et al. 1997; Friele and Clague 2002a, 2002b) and in the southern Canadian and northern American Rocky Mountains (Osborn and Gerloff 1997).

Figure 1. Sites where late-glacial glacier advances have been identified:
1, Bond (2004); **2**, Bond and Kennedy (2005); **3**, Clague (1985); **4**, Clague et al. (1997); **5**, Friele and Clague (2002a, 2002b); **6**, Hamilton (1981); **7**, Hughes (1990); **8**, Jackson et al. (1991); **9**, Kennedy and Bond (2004); **10**, Kovanen and Easterbrook (2001); **11**, Lakeman (2006); **12**, Osborn and Gerloff (1997); **13**, Reasoner et al. (1994); **14**, Riedel et al. (2003); **15**, Roots (1954); **16**, Saunders et al. (1987); **17**, Tallman (1975); **18**, Watson and Mathews (1944).

Younger Dryas–age glacier advances differ in extent throughout western North America. Some glaciers, for example, those in the Rocky Mountains, advanced only short distances, commonly less than 1 km beyond present margins (Osborn and Gerloff 1997; Reasoner et al. 1994). In coastal southwest British Columbia, outlet glaciers at the wasting margin of the ice sheet advanced many kilometers and, in at least two instances, reached tidewater (Friele and Clague 2002a, 2002b). Large alpine glaciers in the Finlay River area in northern British Columbia persisted at intermediate and high elevations as the Cordilleran ice sheet decayed by downwasting and frontal retreat (Lakeman 2006). Large terminal and lateral moraines were constructed in tributary valleys in this area during Younger Dryas time. The advance coincided with final decay of a network of remnant, thin tongues of the northern Cordilleran ice sheet in trunk valleys. Trunk glaciers were below both resurgent alpine glaciers and the lowered regional equilibrium line altitude that allowed alpine glaciers to advance up to 9 km from their source cirques.

The marked differences in the size of Younger Dryas–age advances suggest variable glacier responses to late-glacial climate change. The different responses probably reflect differing rates and magnitudes of late-glacial climate change, different styles of deglaciation, different temperature and precipitation gradients, and variable effects of remnant ice masses on local atmospheric circulation. Such factors, despite being affected by hemispheric Younger Dryas climate change, were nonetheless characterized by general volatility coinciding with rapid late-Pleistocene changes in the atmosphere and oceans, which have yet to be fully understood. The stochastic nature of these changes probably accounts for the sporadic occurrence and varied scale of Younger Dryas glacier advances in western North America.

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Paleoenvironmental Response of the Northern Chihuahuan Desert to the Bølling/Allerød–Younger Dryas Climatic Oscillation

Camille A. Holmgren

The northwestern Chihuahuan Desert, where Arizona, New Mexico, and Mexico intersect, contains several key Paleoamerican and megafauna sites (Haury et al. 1953, 1959; Haynes 1991; Jull 1998). Reconstructing the region's paleoenvironmental history is thus critical to understanding conditions faced by the First Americans, including possible impacts of abrupt climate change during the Bølling/Allerød–Younger Dryas (B/A-YD). The purpose here is to review evidence for the B/A-YD climatic oscillation in the northern Chihuahuan Desert.

Wetland and lake records indicate a regional-scale hydrologic response with warmer/drier B/A conditions, and a cooler/wetter YD. B/A aridity is seen at Murray Springs where formation of the Coro Marl marsh deposit ceased ca. 15,600 CALYBP (Haynes 1987, 1991; Pigati et al. 2004) as groundwater levels declined until reaching their lowest levels ca. 12,750 CALYBP during the "Clovis-aged Drought" (Haynes 1991). Groundwater levels rapidly rebounded in the YD and deposited black organic mats from ca. 12,600–11,240 CALYBP (Haynes 1991; Jull et al. 1998) and new evidence for an ejecta layer at the base of these deposits has led to the recent suggestion that an extraterrestrial impact may have triggered the Younger Dryas (Becker et al. 2007; Firestone et al. 2007; West et al. 2007). Pluvial lake highstands in southeastern Arizona (Waters 1989) and central New Mexico (Anderson et al. 2002) following B/A desiccation also suggest a cooler/wetter YD, although dating uncertainties preclude definite placement of these highstands within the YD. Additional support for a cooler/wetter YD comes from a glacial advance seen in alpine bog cores from the southern Sangre de Cristo Mountains just north of the Chihuahuan Desert (Armour et al. 2002). In contrast, paleolake data from Alta Babicora basin in northern Mexico indicate drier YD conditions (Metcalfe et al. 1997, 2000), possibly reflecting sharply decreased winter westerly storm penetration southward into Mexico. Additional northern Mexican records should help resolve this.

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Speleothem growth rates and stable isotopes also provide evidence for the B/A-YD. In New Mexico's Guadalupe Mountains, a stalagmite growth hiatus indicates decreased moisture supply during the B/A, with renewed deposition during the YD (Polyak et al. 2004). Likewise, a high-resolution speleothem $\delta^{18}O$ record from southeastern Arizona exhibits a B/A-YD oscillation roughly synchronous with North Atlantic ice-core records, with increasing $\delta^{18}O$ values at 15,060 CALYBP signifying rapid B/A warming/drying and a return to more negative $\delta^{18}O$ values indicating cooler/wetter conditions at ca. 13,000 CALYBP during the YD (Cole et al. 2006; Wagner 2006).

The B/A-YD similarly impacted regional vegetation, as reflected in packrat middens. During the late Pleistocene, pinyon-juniper woodland expanded downslope along pluvial lake margins into elevations now occupied by desert scrub in response to more mesic conditions in the northern Chihuahuan Desert. During the B/A, declining *Pinus edulis* (Colorado pinyon) abundances are seen in middens collected in the Peloncillo Mountains along the Arizona–New Mexico border from 15,410 to 13,115 CALYBP (Holmgren et al. 2006) and in the Hueco Mountains of western Texas from 14,800 to 13,900 CALYBP (Van Devender 1990; Van Devender and Riskind 1979), while in Rough Canyon in south-central New Mexico both *Pinus edulis* and *Juniperus scopulorum* (Rocky Mountain juniper) declined between 15,270 to 13,670 CALYBP (Betancourt et al. 2001). *Pinus edulis* abundance rebounded dramatically in the Peloncillo Mountains at 12,405 CALYBP (Holmgren et al. 2006), suggesting a YD return to wetter/cooler conditions. This pattern is not reproduced in the other Chihuahuan Desert midden series because final occurrences of *Pinus edulis* are earlier in these records and sampling densities are low, although the B/A-YD is seen in a more remote midden study from the Grand Canyon (Cole and Arundel 2005). Taken together these records demonstrate a clear YD signal in the Chihuahuan Desert, with a return to cooler/wetter conditions following a warmer/drier B/A.

The exact mechanism for propagating B/A-YD changes from the North Atlantic to the northern Chihuahuan Desert is uncertain, but may involve an atmospheric linkage between the North Atlantic and North Pacific (Hendy et al. 2002), a key moisture source for the Chihuahuan Desert. This is consistent with similar B/A-YD patterns recorded in the Chihuahuan Desert and ocean cores from Santa Barbara Basin (Behl and Kennett 1996; Cannariato et al. 1999; Hendy and Kennett 1999; Kennett and Ingram 1995) and the Gulf of California (Keigwin and Jones 1990). Climate models likewise support transmission of temperature and precipitation anomalies generated in the North Atlantic across much of the globe (Broccoli et al. 2006; Dahl et al. 2004; Vellinga and Wood 2002). Persistent El Niño/Southern Oscillation (ENSO) cycles in the tropics may also drive abrupt climate changes including the YD (Clement et al. 2001), although teleconnections to the Chihuahuan Desert are less straightforward (Holmgren et al. 2006). Despite uncertainty regarding how abrupt climate changes are communicated to the region, a growing number of records nevertheless provide an emerging picture of B/A-YD impacts in the northern Chihuahuan Desert.

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Evidence for the Younger Dryas on the Columbia Plateau, U.S.A.

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The Columbia Plateau (CP) extends across much of eastern Washington State and vicinity and is composed of numerous Miocene basalt flows with a discontinuous surface veneer of Quaternary alluvial, lacustrine, and eolian sediment. Lying in the rain shadow of the Cascade Range, the area receives ca. 15–30 cm of annual precipitation, and modern natural vegetation is largely shrub or bunchgrass steppe. Humans entered the region no later than 11,400 RCYBP (Davis and Schweger 2002), and a few archaeological sites have been dated to the Younger Dryas (YD) or between 11,000 and 10,000 RCYBP (Craven 2004; Galm and Gough 2000; Hicks 2004; Huckleberry et al. 2003).

During the YD much of the CP was recovering from the effects of Cordilleran glaciation. Continental and valley glaciers extended onto the margins of the

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plateau (Easterbrook 2003), but by 12,000 RCYBP most of the Cordilleran ice had retreated north of the U.S.–Canadian border, while alpine glaciers had retreated upslope to their source areas. Although most of the plateau was not glaciated, much of it was impacted by numerous catastrophic floods due to ice-dam failures (Gaylord et al. 2003), with the last megaflood occurring ca. 12,500 RCYBP. The terminal Pleistocene was also a time of numerous volcanic eruptions in the Cascades, perhaps tied to crustal dynamics associated with glacial retreat. Eruptions from Glacier Peak and Mt. St. Helens provide key tephra markers for deposits dating 13,000–10,500 RCYBP (Foit et al. 1993; Mullineaux 1996).

There is general agreement that CP cold/dry steppe environments of the late glacial maximum were followed by warmer and drier conditions that peaked in the early Holocene ca. 6000–9000 RCYBP (Chatters 1998; Thompson et al. 1993). However, details of the timing and nature of the Pleistocene-Holocene transition are still being resolved. Evidence for the YD must demonstrate a temporary reversal of warming that began with the Bølling/Allerød ca. 13,000 RCYBP. There is glacial (Friele and Clague 2002; Kovanen and Easterbrook 2002; Osborn et al. 1995, 2005), palynological (Doerner and Carrara 2005; Grigg and Whitlock 2005) and isotopic (Vacco et al. 2005) evidence for such a reversal in areas adjacent to the CP. However, YD evidence on the plateau is less certain due in part to a young, post-flood landscape with few preserved proxy records of pre-YD climate. Another complication is that biophysical systems on the CP (e.g., plant communities, rivers, soils, hillslope deposits) were recovering from recent physical disturbances associated with glacial flooding that might obscure signatures of climate change.

Despite these limitations, there are proxy records of climate on the CP with evidence for cool and/or moist conditions 11,000–10,000 RCYBP that might be interpreted as a local manifestation of the YD. Stable oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) isotopic signatures in pedogenic carbonate and organic matter from hillslope and floodplain contexts suggest fluctuations between warm/dry and cool/moist conditions 10,500–10,000 RCYBP in the lower Salmon River Canyon (Davis et al. 2002) and stable cool/moist conditions 10,600–9700 RCYBP in the lower Snake River Canyon (Huckleberry and Fadem 2007). Changes in soil formation are better suited for documenting longer-term (10^3–10^5 yr) climate change (e.g., Sweeney et al. 2004), but rapid pedogenic processes, e.g., oxidation and humification, have potential to record century- to millennial-scale changes in moisture. Soils containing redoximorphic features (e.g., iron mottles) and well-developed A horizons indicate localized fluctuating water tables and enhanced vegetation growth 12,000–10,000 RCYBP (Galm and Gough 2000; Huckleberry et al. 2003; Lenz 2006). Cool/moist conditions during the YD are also indicated by sedimentary evidence of paleolakes and marshes in the Channeled Scablands (Huckleberry et al. 2003), although these wetlands may be vestiges of pre-YD climate. Perhaps the best evidence for the YD is from Williams Lake Fen, where detailed pollen analysis indicates a shift from sagebrush/grassland steppe to an expansion in conifers 11,200–10,200 RCYBP, followed by a return to steppe (Johnson et al. 1994; Wigand and Hicks 2004). However, other CP pollen records (e.g., Whitlock and Bartlein 1997) do not contain evidence of this temporary reversal in drying during the Pleistocene-Holocene transition.

The CP experienced dramatic environmental changes at the end of the Pleistocene. Unfortunately, there is a paucity of climate proxy records of appropriate age and resolution necessary for identifying the YD on the CP. Despite these constraints, issues pertaining to human adaptation and regionality of climate change during the Pleistocene-Holocene transition make it worthwhile to continue searching for local records of postglacial environmental change on the CP.

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The Younger Dryas Cold Event in Paleoecological Records from the North Pacific Coast

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Climate change during the Younger Dryas (YD) chronozone, also known as Greenland Stadial 1 (Björck et al. 1998), is evident in numerous terrestrial and marine paleoecological records from British Columbia and elsewhere along the North Pacific coast of North America. Although the exact cause of the YD cooling is still debated, it is likely related to glacial meltwater diversion in eastern North America (e.g., Broecker 2006). General circulation modeling suggests that cooling in the North Atlantic region was transmitted primarily to the North Pacific through atmospheric teleconnections and that oceanic transmission was secondary (Mikolajewicz et al. 1997). Mathewes (1993) provides a comprehensive review of the fossil pollen evidence for YD vegetation and

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climate change on the North Pacific coast available at the time. The best support comes from distinct increases in mountain hemlock (*Tsuga mertensiana*) pollen in lake and bog sediments from the Alaskan Panhandle to the northern Washington coast, which indicate decreased summer temperatures and increased winter precipitation during the YD chronozone. Mathewes (1993) also describes reversals from pine-dominated forest to shrub and herb tundra in pollen records from southeastern Alaska (Engstrom et al. 1990; Hansen and Engstrom et al. 1996) and the Queen Charlotte Islands (Mathewes et al. 1993), vegetation changes similar to those at many YD sites in northern Europe and eastern North America. Mathewes (1993) proposes that maximum cooling and increased moisture occurred between 10,700 and 10,000 RCYBP, but cautions that better-constrained ^{14}C dating is needed.

Paleoclimatic estimates based on changes in relative pollen abundances at Cape Ball on the Queen Charlotte Islands suggest a decrease of 2–3ºC in summer air temperature as well as increasing precipitation between ca. 11,100 and 10,200 RCYBP, coincident with YD cooling in the North Atlantic, albeit lower in magnitude (Mathewes et al. 1993). This estimate of decreased temperatures is corroborated by decreases in sea-surface temperatures inferred from increases in coldwater benthic foraminifera on the central coast of British Columbia (Mathewes et al. 1993; Patterson et al. 1995), the disappearance of temperate bivalve species in the Queen Charlotte Islands area (Hetherington and Reid 2003), decreases in saturated alkenones in marine sediments west of Vancouver Island (Kienast and McKay 2001), and lower $\delta^{18}O$ values in stalagmites from a cave in the Klamath Mountains, Oregon (Vacco et al. 2005).

In addition to new records of glacier readvances during the YD in British Columbia (Clague and Lakeman 2007), new paleoecological records from the North Pacific coast provide additional evidence for climatic cooling coincident with the YD. On northern Vancouver Island, increases in mountain hemlock, lodgepole pine (*Pinus contorta*), and shrub alder (*Alnus crispa*) pollen at the expense of Sitka spruce (*Picea sitchensis*) and red alder (*Alnus rubra*) again suggest a return to cooler conditions (Lacourse 2005). Similar vegetation changes have also been found on southern Vancouver Island (e.g., Brown and Hebda 2002) and in the Fraser Lowland in southwestern British Columbia, where a late-glacial pollen record indicates cooler conditions between 10,400 and 10,000 RCYBP (Pellatt et al. 2002). To the south in western Washington and Oregon, increases in pine pollen in several records coincide with the YD, but cooling here seems to have been less pronounced and appears to lag YD cooling in the North Atlantic by several centuries (e.g., Grigg and Whitlock 1998).

In general, vegetation changes along the North Pacific coast indicate the expansion of herbs and shrubs along northern sections of the coast, increases in mountain hemlock particularly in coastal British Columbia, and elevated pine further south. These vegetation changes are generally followed by indicators of rapid warming in the early Holocene. As pointed out by Mathewes (1993) and others, the YD signal appears to be stronger in marine and coastal sediments compared with more-inland sites, which is a similar feature of the YD event around the North Atlantic.

It is beyond the scope of this short review to explore whether events in the North Atlantic were directly responsible for changes in vegetation and climate along the North Pacific coast. However, it is evident from many paleoecological records that climatic cooling and increased winter precipitation occurred in the region during the YD chronozone. Current records remain hampered somewhat by dating precision and/or sampling resolution, but the available evidence suggests there was a temporal lag in the delivery of YD cooling to the North Pacific region and/or a lag in ecosystem response to climate change. Research aimed specifically at determining the timing, degree, and spatial extent of YD cooling on the North Pacific coast is still needed. This should focus on high-resolution multi-proxy analyses and AMS ^{14}C dating including calibration to calendar years, so that the precise timing and rate of vegetation changes can be determined.

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Post-Glacial Landscape Changes and Paleoamericans in the New England Maritimes Region

Paige Newby and James Bradley

Unlike many areas of the Americas, the New England and Maritimes region (NE/M) (36–50°N, 75–53°W) was glaciated until ca. 21,000 CALYBP and remained partially covered by the Laurentide Ice Sheet (LIS) north of 44° until ca. 14,700 CALYBP (Ridge 2003). Prior to ca. 13,500–13,000 CALYBP, no archaeological sites are known within the region; after ca. 12,900–12,600 CALYBP, Paleoamerican materials are found as far east as Nova Scotia (Keenleyside 1991; Spiess et al. 1998). Here we use recent refinements to the deglaciation chronology to hypothesize Paleoamerican movement into this freshly uncovered landscape (Donnelly et al. 2005; Rayburn et al. 2005; Ridge 2003). In particular, we speculate that the sequence of changes in the postglacial landscape between 13,800 and 13,100 CALYBP, closely followed by the onset of the Younger Dryas chronozone (YDC) at 12,900 CALYBP, set the stage for movement into the region.

After 14,700 CALYBP, the rapid retreat of the LIS was interrupted by the Older Dryas oscillation (14,150–13,800 CALYBP), correlated with a regional readvance that held the ice from the Champlain Valley to the coast of Maine (Ridge 2003). Proglacial Lake Albany abutted this ice front to the north, divided New England along the location of the present Hudson River Valley, and could have functioned as an extensive corridor into the region (Figure 1A) (Donnelly et al. 2005; Rayburn et al. 2005). Between 13,400 and 13,100 CALYBP, rapid ice recession first triggered catastrophic drainage through the Narrows. This event was followed by a series of short-lived lakes (e.g., Glacial Lake Candonna) and then by inundation of lowlands, which formed the Champlain Sea and exposed beach lines that served as corridors for movement (Figure 1B) (Donnelly et al. 2005; Rayburn et al. 2005). Shortly after, ^{14}C dates and sites evidence widespread Paleoamerican presence in the region (Newby et al. 2005).

The readvances that punctuated the retreat of the LIS are linked with freshwater discharge "re-routings" and rapid late-glacial climate oscillations (Clark et al. 2001). Associated temperature "switches" appear inconsequential

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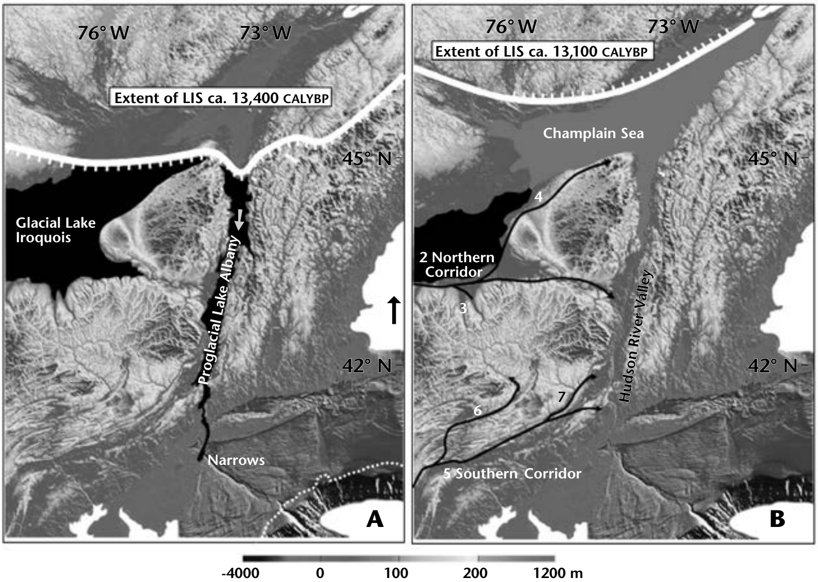

Figure 1. Modern elevation and palaeofeatures for part of NE/M showing dramatic changes between 13,400 (**A**) and 13,100 CALYBP (**B**). **A.** After ca. 13,800 CALYBP, the LIS formed a proglacial lake along the present course of the Hudson River Valley. Around 13,400 CALYBP, the ice front moved further north (1), Glacial Lake Iroquois rapidly drained southward, breeching the Narrows Dam, New York. **B.** By 13,100 CALYBP, the ice sheet was north of New England and the portions of the St. Lawrence Lowlands were inundated. We hypothesize two corridors of movement into the region. A northern corridor (2) extended east along the Onondaga Escarpment continuing down the Mohawk Valley to the Hudson Valley. Two side branches ran south into the upper Susquehanna drainage (3) and north along the old Lake Iroquois shoreline (4). A southern corridor (5) followed the Great Valley east with branches up the Susquehanna (6) and Delaware/Wallkill Valleys (7) into the Hudson Valley (Bradley 1998).

for Paleoamericans advancing toward NE/M or living nearby, as does the highly seasonal climate present during the late Glacial. Our work shows that the fastest vegetation changes coincided with the Paleoamerican interval. Further, the onset of the YDC produced abrupt and different changes in regional vegetation that resulted in spruce-dominated forests in southern New England to more open, tundra-like landscapes in the northernmost Maritimes (Newby et al. 2005). We surmise that these varied landscapes, favorable to migratory herd animals, plus the diverse resources of the Champlain Sea, may have drawn in the earliest humans after ca. 13,000 CALYBP (Newby et al. 2005). The process of deglaciation produced ever-changing landscapes, vegetation, resources and corridors. We conclude that the sequence of drainage events and onset of the YDC created conditions in landscape, vegetation, and animal populations favorable to Paleoamericans.

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Meltwater Discharge and Its Dynamical Role during the Younger Dryas

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The original suggestion, by Rooth (1982) and refined by Broecker et al. (1989), that the Younger Dryas (YD) was due to a reduction or shutdown in the large ocean heat conveyor (thermohaline circulation, THC) triggered by a meltwater flood from eastward diversion of pro-glacial Lake Agassiz outflow (Figure 1), has been widely accepted for over a decade (Teller and Leverington 2004). This hypothesis fits inferred timing for a major reduction of southern outflow via the Mississippi River, as recorded in various paleoceanographic proxies from marine sedimentary cores from the Gulf of Mexico (Aharon 2003; Broecker et al. 1989; Brown and Kennett 1998; Marchitto and Wei 1995). Furthermore, paleoceanographic evidence for a reduction in the rate of deep overturning circulation during the YD has become quite robust (Hughen et al. 1998; Keigwin et al. 1991; McManus et al. 2004; Muscheler et al. 2000; Piotrowski et al. 2004). However, over the last few years challenges have arisen. To assess our current understanding, here I address three key issues in turn.

First, a plausible meltwater source of sufficient volume and appropriate timing is needed. Recent observations have called into question both eastern and northwestern diversion of Lake Agassiz drainage during YD onset (Fisher and Lowell 2006; Lowell et al. 2005; Teller et al. 2005; Yansa and Fisher 2007)

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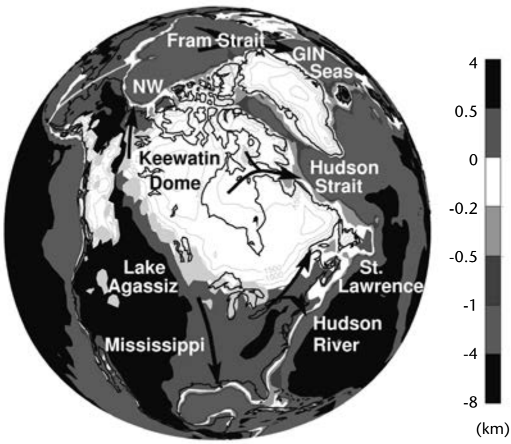

Figure 1. Possible drainage routes, pro-glacial lakes, surface elevation, and bathymetry near the onset time of the Younger Dryas as computed by a 3D glacial systems model.

and have left the actual routing chronology in a state of confusion. Sea surface salinity reconstructions for the Gulf of St. Lawrence also appear to rule out enhanced surface meltwater flows during the YD (de Vernal et al. 1996).

In identifying an appropriate freshwater source, it is worthwhile considering the actual distribution of land ice. Both long-held inferences from glacial geology and geomorphology (Dyke and Prest 1987) along with geodetically constrained modelling of North American deglaciation (Peltier 2002; Tarasov and Peltier 2004) indicate the presence of a large Keewatin ice dome dominating the ice-complex over North America. This ice dome offers the largest potential meltwater and iceberg source. Through isostatic crustal depression, it also creates an expanded drainage basin for northwestern flow into the Arctic Ocean via the Mackenzie River basin. During the YD interval outflow from the Arctic Ocean was only via Fram Strait (off the northeast tip of Greenland) directly into the primary region of present-day North Atlantic Deep Water (NADW) formation.

Substantiating this conceptual picture, large-ensemble modelling calibrated against geodetic observations and ^{14}C-dated relative sea-level data finds the peak Arctic discharge from the Keewatin region to be during the YD onset interval (Tarasov and Peltier 2005, 2006). This is not only the largest computed meltwater and iceberg discharge into any sector during this time, it is also the largest Arctic discharge during the whole deglacial interval. The key uncertainty requiring further field investigations is the exact deglacial margin chronology in this difficult-to-access region (Dyke 2004; Dyke et al. 2002). Sidestepping a related issue, the computed dominance of Arctic discharge is robust with respect to current uncertainties in the routing of Lake Agassiz outflow.

Paleoceanographic evidence for or against Arctic discharge during the YD is sparse and subject to large dating uncertainties associated with poorly constrained ^{14}C reservoir times for the Arctic Ocean. Nonetheless, four planktonic data points from around Fram Strait (Bauch et al. 2001; Norgaard-Pedersen et al. 2003) along with data from the Chukchi Sea (Polyak et al.

2007), which is downstream of the Mackenzie River outlet, are consistent with a major surface-freshening event during YD onset. Data from the eastern shelf of Greenland (Jennings et al. 2006) also indicate meltwater presence during onset (though perhaps of local origin).

Secondly, in order to significantly impact NADW formation, this freshwater must be transported relatively intact as a surface plume or as ice to the sites of NADW formation. However, transport of discharge from either the eastern seaboard of North America or the Gulf of Mexico would have been along the highly baroclinic (and thereby turbulent) Gulf Stream (e.g., Bush et al. 1996). Furthermore, depending on sediment loading and temperatures, meltwater discharge into the ocean can result in bottom-riding hyperpycnal flows (Parsons et al. 2001). Such hyperpycnal flows have been confirmed for the Mississippi during the meltwater pulse 1-a interval on the basis of paleoceanographic evidence from marine sedimentary cores (Aharon 2006). These two mechanisms plausibly explain why the much larger meltwater discharge during meltwater pulse 1-a, when eustatic sea level rose approximately 20 m within 500 years (Fairbanks 1989; Hanebuth et al. 2000), had a disproportionately weaker impact. On the other hand, the cold waters of the Arctic Ocean are subject to much less turbulence and are highly stratified (Aagaard and Carmack 1989), and thereby more inhibiting of bottom-riding hyperpycnal flows. Arctic conditions would have preserved discharged icebergs during transport. Meltwater discharge into the Arctic Ocean would also have likely increased sea-ice export through Fram Strait as has previously been hypothesized for a possible Arctic discharge trigger for the Preboreal Oscillation that followed the YD (Fisher et al. 2002; Teller et al. 2002). Expanded sea-ice cover is even more efficient at impacting deep-water formation and would have also directly contributed to atmospheric cooling.

Thirdly, a mechanism is needed to globally transmit the regional impacts of the restructured THC (Broecker 2003; Seager and Battisti 2007). General circulation climate model experiments of freshwater "hosings" in the North Atlantic have been unable to replicate the near global extent of impacts inferred from paleo data (Dahl and Broccoli, 2005) or the abrupt warming at the end of the YD (Manabe and Stouffer 1997; Peltier et al. 2006; Vellinga et al. 2002). Sea ice has become a critical factor in this debate (Broecker 2006; Gildor and Tziperman 2003; Piotrowski et al. 2004; Seager and Battisti 2007). Paleoclimate records (Atkinson et al. 1987; Broecker 2006; Denton et al. 2005) arguably (Lie and Paasche 2006) suggest that much of the YD cooling was due to an extreme change in seasonality, with most of the cooling occurring during winter. This is best explained by a major extension of winter sea ice, which would severely attenuate the otherwise large flux of heat and moisture from the ocean into the atmosphere.

This globalization issue has also focused attention on the main alternate hypothesis for a YD trigger involving changes in the tropical climate system (Pierrehumbert 2000; Seager and Battisti 2007). Tropical climate processes such as El Niño are known to have global impacts; however, there is no obvious direct trigger for tropical climate system reorganization that would explain why the YD occurred when it did. Furthermore, tropically driven processes do not contain the dynamic flywheel to explain the 1200-year persistence of the YD. The only component of the climate system that operates on this time scale is deep ocean circulation. Nevertheless, given the dynamic interconnectedness of the climate system, it may well be that the tropical system globalized climate response to THC changes and may have amplified changes in THC and sea ice extent (Seager and Battisti 2007).

A further wrinkle has arisen with new evidence for an extraterrestrial bolide impact in North America at 12,900 CALYBP (Firestone et al, 2007). Though such an event may have helped trigger the YD climate re-organization, it would not explain the 1200-year persistence of the YD, nor even more clearly its abrupt termination (warming of 10 ± 4° C over central Greenland within several decades [Grachev and Severinghaus 2005]).

In summary, though the meltwater trigger hypothesis has yet to be refuted, the picture has become more complicated. Evidence is growing towards a significant Arctic discharge component. Furthermore, though it is well established that the dynamic mechanism of YD climate change involves a restructuring of THC, the global character of the climate signal indicates that other processes, possibly involving severe changes in winter sea-ice extent and tropical climate components, were also involved.

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Absence of a Younger Dryas Signal along the Southern Shoreline of Glacial Lake Agassiz in North Dakota during the Moorhead Phase (12,600–11,200 CALYBP)

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Broecker et al. (1989) proposed that the Younger Dryas (YD) Cold Episode was triggered at 13,000 CALYBP by a switch in meltwater drainage routed through glacial Lake Agassiz. Southward flow to the Gulf of Mexico switched to eastward flow into the North Atlantic Ocean where the freshwater pulse caused a slow down or cessation of thermohaline circulation. This largely accepted scenario has recently been challenged in light of new ice-recession data suggesting that the eastward drainage route was blocked by the Laurentide Ice Sheet at the onset of the YD (Lowell et al. 2005; Teller et al. 2005). Previous evidence against this meltwater hypothesis was the lack of indicators for a meltwater surge through the St. Lawrence system to the Atlantic Ocean (deVernal et al. 1996; Rodrigues and Vilks 1994). Most recently, a reexamination of the chronologic evidence for the lake level drop at the beginning of the Moorhead phase (Figure 1B), when Lake Agassiz was to have drained east, postdates the start of the YD by ca. 200 years (Fisher and Lowell 2006). For further discussion see Tarasov (this volume). In this short paper we briefly discuss the Lake Agassiz chronology (^{14}C ages calibrated following Stuiver et al. (1998) and Reimer et al. (2004)) and paleoenvironmental conditions from a few key sites in the Lake Agassiz basin with in situ plant macrofossils.

The new Redwood Loop site (Figure 1A) is located on the Grand Forks Air Force Base (GFAFB) in North Dakota (47° 58′ N), and serves as a reexamination of a key site in the ^{14}C-date catalog of North Dakota (Moran et al. 1973). Previously, three sites, each containing wood in Ojata Beach sediment ranging in age from 10,960 ± 300 (W-723) to 10,050 ± 300 (W-1005) RCYBP (12,800-11,760 CALYBP), were used to infer that abandonment of the southern outlet and opening of an eastern outlet were coeval with the start of the YD (Broecker et al. 1989). Fisher et al. (in review) re-sampled the W-723 site, obtaining 19 new AMS ^{14}C ages indicating that the Ojata Beach records a transgression in Lake Agassiz at about 11,660 CALYBP, not a regression synchronous with the start of the YD (12,950 CALYBP). At present, the abandonment of the southern outlet and lowering of Lake Agassiz cannot be ascribed to opening of lower eastern outlets (Lowell et al. 2005; Teller et al. 2005). Perhaps the Embarrass Gap and/or Prairie River spillways (Hobbs 1983) in northern Minnesota were active then.

The Redwood Loop site contains in situ macrofossils and transported

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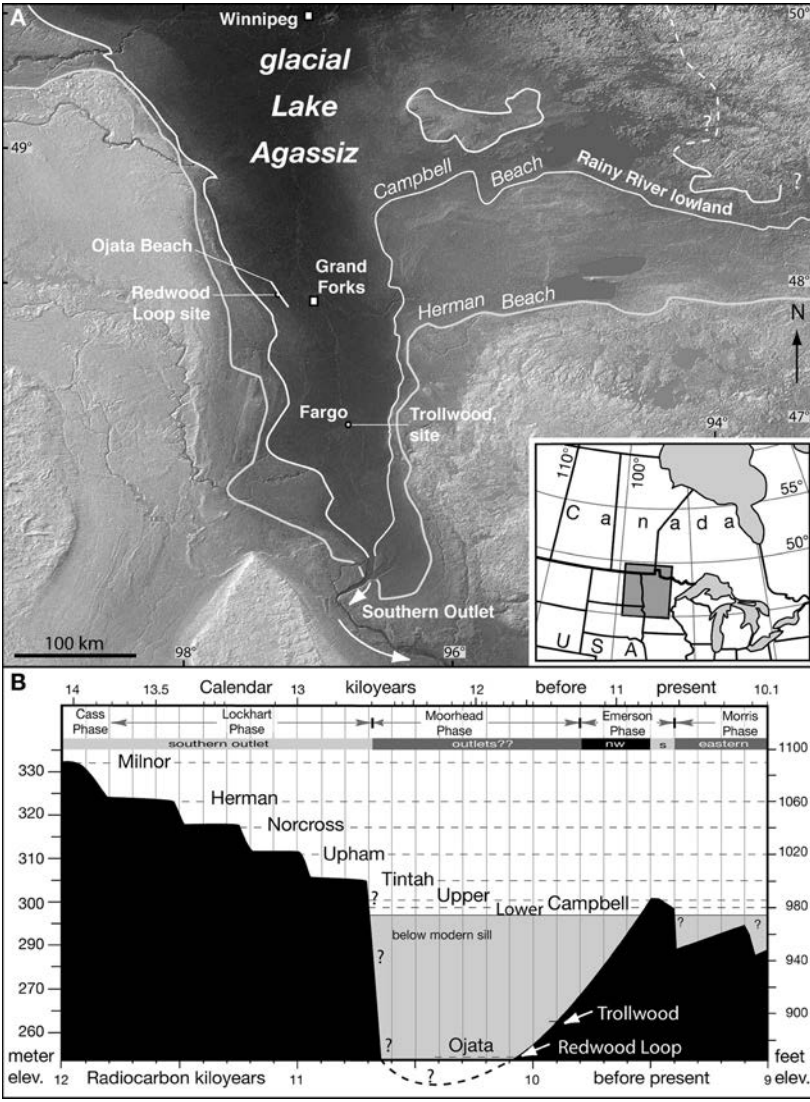

Figure 1. **A,** Location of the Redwood Loop and Trollwood Park sites in North Dakota. Location of Campbell and Herman Beaches is approximate, and is based on Teller et al. (1983). **B,** Lake level and phase diagram for the southern outlet is modified from Fisher (2005). Early chronology of Lake Agassiz is based on Lepper et al. (2007).

wood. Burial of a trunk of a *Populus* (poplar) tree by the transgressive lake occurred at 11,660 CALYBP (2s mean of 10,160 ± 70 RCYBP [ETH-32675] and 10,010 ± 70 RCYBP [ETH-32676]). The deltaic deposit at the Trollwood Park site in Fargo (Yansa and Ashworth 2005), 130 km south of the Redwood Loop site (Figure 1A), indicates that Lake Agassiz had transgressed south to the Fargo area and flooded it by 11,320 CALYBP (9920 ± 80 RCYBP [AA34343]). Continued transgression resulted in reoccupation of the southern outlet just after 10,720 CALYBP (9500 ± 66 RCYBP, [AA38306]) and abandonment by 10,620 CALYBP (9390 ± 76 RCYBP, [AA-40114]) (Figure 1B) (Fisher 2003, 2007).

The paleoenvironment of the southern Lake Agassiz coastal zone was surprisingly temperate given the close proximity of the vegetation to this proglacial lake. Vegetation of the Trollwood Park site was a deciduous parkland-marsh wetland that colonized a prograding delta (Yansa and Ashworth 2005). This flora was dominated by abundant aquatic and shoreline herbs, *Salix* (willow) shrubs, and scattered *Populus tremuloides* (trembling aspen/aspen poplar) trees with lesser amounts of *Picea* (spruce) and *Ulmus* (elm). Similar vegetation is documented from 120 km farther west (Yansa 2006), suggesting that a cold "lake effect" climate along its southwestern shore did not exist at this time (Yansa and Ashworth 2005). The coeval and slightly older Redwood Loop site to the north supported a spruce-sedge parkland/wetland, dominated by lowland "boreal" conifers and several species of *Carex* (sedge) and *Juncus* (rush). Specifically, abundant needles and seeds of *Picea mariana* (black spruce), *Larix laricina* (larch/tamarack), and *Abies balsamea* (balsam fir), with lesser amounts of *Picea glauca* (white spruce), *Populus tremuloides* and *Betula* sp. (birch), were identified (Fisher et al. in review). This fossil assemblage is similar to those of the Rainy River area in northwestern Ontario (Bajc et al. 2000) and immediately east in Minnesota (Ashworth et al. 1972; Hu et al. 1997; Moran et al. 1971; Whitlock et al. 1993). Differences in vegetation between the Redwood Loop site (and nearby sites in Ontario and Minnesota) and the Trollwood Park site are interpreted as a latitudinal temperature gradient rather than a localized cooling induced by Lake Agassiz.

In summary, the timing for closure of the southern outlet and opening of eastward drainage of glacial Lake Agassiz does not coincide with the onset of the Younger Dryas. Plant macrofossils from sites located along the southern shoreline of glacial Lake Agassiz in North Dakota indicate that the local climate was fairly temperate during the middle part of the Moorhead phase, between 12,600 and 11,200 CALYBP.

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Archaeology: Eurasia

Siberia in the Late Glacial, ca. 18,000–10,000 RCYBP (20,000–12,000 CALYBP): Did Climate Impact Paleolithic Populations?

Stuart J. Fiedel, Yaroslav V. Kuzmin, and Susan G. Keates

Large ^{14}C datasets for the Paleolithic of Siberia (Kuzmin and Orlova 1998; Vasil'ev et al. 2002) now permit correlation between the variable intensity of human occupation and climatic fluctuations in the latter part of the late Pleistocene (Dolukhanov et al. 2002). Recently, Graf (2005) compared dated Upper Paleolithic occupations of Siberia with Greenland ice core records. After averaging ^{14}C values for each Upper Paleolithic cultural component and calibrating weighted mean ages, she found that after ca. 20,000 CALYBP the number of sites increased sharply and reached a first peak at ca. 17,000–18,000 CALYBP, then decreased at ca. 15,000–17,000 CALYBP, and hit a second peak at ca. 14,000–15,000 CALYBP. A good correlation was observed between the occupation increases and climatic ameliorations (Graf 2005:3, Fig. 1).

We used the same ^{14}C database as Graf (2005) (see original ^{14}C dates in Vasil'ev et al. 2002), and counted occupation frequencies for the late Glacial in Siberia (ca. 18,000–10,000 RCYBP, or ca. 20,000–12,000 CALYBP), following the approach of Kuzmin and Keates (2005), i.e., combining individual ^{14}C date series into occupation episodes, each 1000 ^{14}C-years long. The average episode ages were calibrated (Calib 5.1 rev. software) to find out the calendar value for occupation "centroids." This value was obtained by calibrating the mean ^{14}C ages of centroids using an arbitrary conventional standard deviation of ± 100 years (regardless of individual standard deviations), and calculating the median calendar age of each centroid. The GISP2 ice-core record (Johnsen et al. 2001) was used as the reference climatic sequence for the Northern Hemisphere. The calibrated occupation frequencies were drawn against the oxygen isotope curve (Figure 1). Despite quite cold climatic conditions at ca. 20,000–16,000 CALYBP, occupation frequency in-

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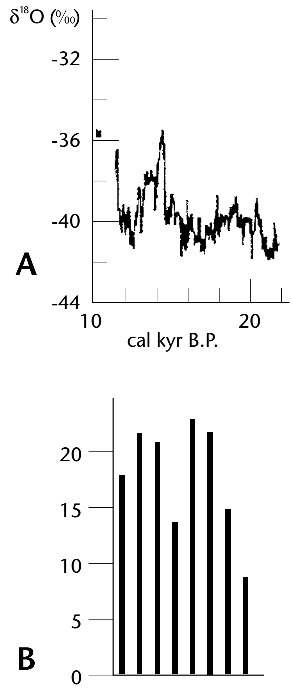

Figure 1. **A,** Climatic oscillations interpreted from the GISP2 ice core record (after Johnsen et al. 2001); **B,** frequency of human occupations in Siberia from 20,000 to 12,000 CALYBP.

creased significantly, only to drop at ca. 16,000–15,000 CALYBP. At the time of quite warm conditions ca. 15,000–13,000 CALYBP (Bølling-Allerød), the occupations increased. However, during the subsequent cold phase from 13,000 CALYBP to 11,500 CALYBP (Younger Dryas), no dramatic decrease in frequencies is observed.

These results represent only a first degree of approximation in an effort to discern any correlation between climatic changes during the last 45,000 years and diachronic human settlement patterns in Siberia. Nevertheless, the apparent absence of a direct relationship between the intensity of human occupation and climatic fluctuations is noteworthy. Orbitally calculated summer insolation for 60° N starts to increase at about 20,000 CALYBP (Berger and Loutre 1991). This might have had appreciable effects on plant cover, thus increasing forage for the herbivores upon which Siberian hunters were dependent. In the Laptev Sea region, summed ^{14}C dates for fauna hit an extreme low point at 17,500–15,000 RCYBP, but this is followed by a steep (threefold) increase at 15,000–12,500 RCYBP (Hubberten et al. 2004). Again, this increase *precedes* the Bølling-Allerød warming (12,500 RCYBP, 14,700 CALYBP). Perhaps increasing availability of prey animals was the proximate cause of the growth and expansion of Siberian Upper Paleolithic populations. In any case, it appears that these people effectively coped with abrupt climatic changes after ca. 24,000 CALYBP.

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Khanzat-1, a Geoarchaeological Investigation in Eastern Mongolia

Masami Izuho and Batmunkh Tsogtbaatar

As a part of the joint Japanese-Mongolian expedition called "Zuun Mongol Paleolit" ("Paleolithic in Eastern Mongolia") in the Kherlen River Basin and Khenty Mountains, we conducted the first excavation of the Khanzat-1 site in September 2006 (Izuho et al. 2005, 2007a, 2007b; Tsogtbaatar 2003). The Khanzat-1 site is located 15 km northwest of Kherlenbayan Ulaan village in the Delgerkhaan district of Khenty province, eastern Mongolia (N 47° 18′, E 108° 36′). Lithic artifacts recovered from both the surface of the site's unconsolidated deposit and on exposed granite bedrock include discoidal cores, blade cores, sidescrapers, blades, and triangular flakes, all of which

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techno-morphologically resemble those of Middle and early Upper Paleolithic assemblages in the Altai Mountains and Transbaikal regions of Russia.

Within the Khanzat-1 lithic scatter, we recognized some artifact concentrations that may be the result of past activity areas, similar to surface concentrations observed at sites in arid/semi-arid Mongolia (Derevianko et al. 1998). Based on these surface concentrations, we investigated the integrity of original artifact distribution and degree of postdepositional disturbances by setting a 5.5-x-3-m excavation unit on a gentle slope at the base of a mountain slope that faces southward to the Kherlen River. To examine variation in site stratigraphy across the site, we further excavated five 1-m^2 test pits. Our research design focused on geoarchaeological methods to understand the mechanisms and processes that created these surface lithic concentrations. The present climate of Mongolia is classified as continental; in the Khanzat-1 area, the disparity of annual temperature is ca. 40°C and annual precipitation is ca. 300–250 mm. The vegetation is steppe, consisting of grasses and scattered shrubs, and the local fauna consists of large to mid-sized mammals such as red deer, argali sheep, and Siberian marmot, reflecting the biogeographic boundary of high mountain and temperate steppe zones (Dorjgotov 2004). Based on these present environmental and ecological conditions, we expected that potential agents of post-depositional disturbances would include wind, graviturbation, cryoturbation, floralturbation, and faunalturbation.

Although at the excavation unit the thickness of unconsolidated sediment was very thin (20 cm in depth), we identified four stratigraphic units (Figure 1). From bottom upwards, they include: grayish yellow-brown sand (Unit VI, weathering horizon of granite basement), brown silty sand (Unit III, eolian sediment), grayish brown silty sand (Unit II, Kastanozem, that are soils originally covered with grassland vegetation, which produces a brown surface layer), and grayish brown sandy gravel (Unit I, gravel pavement) (Figure 1). In contrast, at test pit Ge (which reached 120 cm deep), a thick accumulation of sediments was observed, and six stratigraphic units were recognized: grayish yellow-brown sand with debris (Unit VI), slope sediments (Unit V, the lower part is orange silty sand, and the upper part is dull yellow orange sandy silt), dull yellow-orange sandy silt (Unit IV, Bk horizon, originally eolian sediment), brown sandy silt (Unit III), dark brown sandy silt (Unit II), and grayish brown sandy gravel (Unit I). Units I and II can be assigned to the Holocene, while the other units presumably formed during the Pleistocene. Our tentative explanation for the lack of Unit IV and V in the sampling unit is that they were deflated by intensive wind under arid/semi-arid conditions of the Last Glacial Maximum, and the original cultural component's level had possibly existed at deflated unit V.

A total of 544 specimens was recovered from the excavation, including 322 specimens from the surface, 210 from Unit I, and 12 from Unit II. They consist of chipped-stone artifacts (n = 501), pebbles (n = 25), and faunal remains (n = 18). The chipped-stone assemblage consists of polyhedral cores, blade cores, retouched blades, retouched triangular flakes, blades, and flakes. The faunal assemblage includes remains identified as Perissodactyla, Artiodactyla, and Aves. Some faunal bones were collected for the AMS ^{14}C dating; these are currently being dated at Nagoya University, Japan.

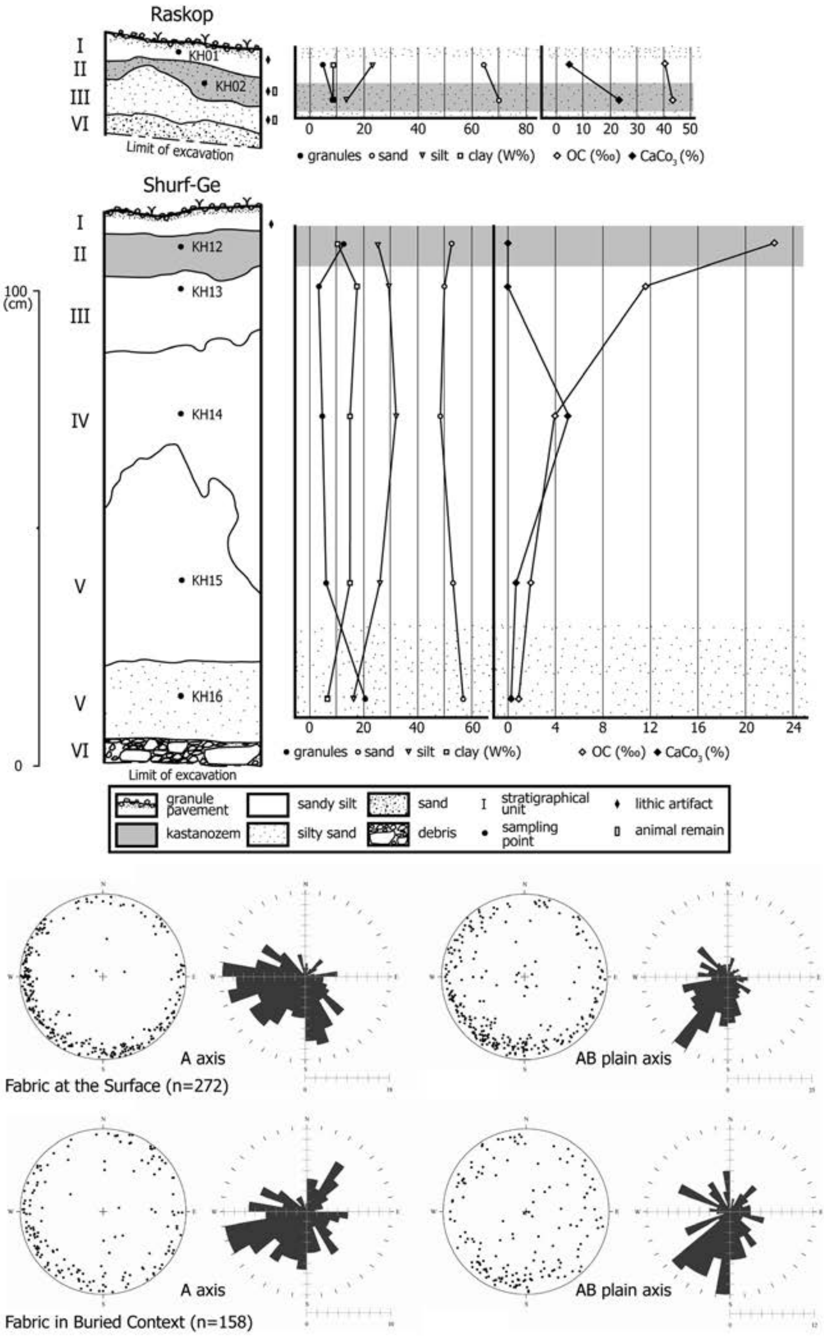

Figure 1. Stratigraphic units and fabric of lithic specimens in Khanzat-1 site.

Fabric analysis was conducted on lithic artifacts from both surface (n = 272) and buried contexts (n = 158), following Lenoble and Bertran (2004). Resulting Schmidt-net diagrams show a slight isotropic structure that indicates random direction of specimens, while the planar structure that indicates specimens laid horizontally is notable among those in buried context (Figure 1; lower part) (Hayashi et al. 2007). These patterns suggest that unless the lithic artifacts were not arranged by linear structure prior to their burial, downslope movement due to graviturbation or water flow did not affect the original artifact distribution. The observed slight isotropic structure among the buried samples, however, indicates some degree of vertical displacement of artifacts has occurred, perhaps by natural agents such as wind deflation, periodic freezing and thawing, and floralturbation. Despite the presence of potential effects of natural disturbance, we believe that the spatial integrity of artifacts is still high.

We will further tackle the issue of varied accumulation of sediments at the Khanzat-1 site in the next field season to further provide a picture of human adaptation in eastern Mongolia during the late Pleistocene.

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Geochronology and Paleogeography of the Early Upper Paleolithic in the Trans-Baikal, Russia

Ludmila V. Lbova

A few sites in central Asia and Siberia have both Middle and Upper Paleolithic components together in stratigraphic order, and previously the age of the Middle-to-Upper-Paleolithic transition (or early stage of the Upper Paleolithic [EUP]) was estimated to be about 43,000–28,000 RCYBP (Derevianko 2001; Kuzmin 2004). Additional EUP complexes in the Trans-Baikal date to about 43,900–38,200 RCYBP, according to recent ^{14}C dating of the Podzvonkaya, Kamenka and Khotyk sites (Kuzmin et al. 2006; Lbova, 2002; Orlova et al. 2005; Vasil'ev et al. 2002).

The western Trans-Baikal is situated deep in the Eurasia continent, within the contact area of two large geographical zones: the subcontinents of north and central non-tropical Asia. This region is included in the Mongolian-Siberian folded region representing a wide range of environmental conditions at the present time. Particularly, all EUP sites are associated with the middle-elevation mountain landscape complex, which has considerable altitudinal differences between peaks and valleys. Elevations of all sites are 600–700 m above sea level.

The majority of the above-named sites have been studied by a complex of natural-scientific disciplines, and ages of the sites have been confirmed by a variety of dating methods. Geoarchaeological analyses have made it possible to reconstruct environmental conditions during the Paleolithic human occupation (Lbova et al. 2003). For the end of the Zyryanka stage and the beginning of next Karginian stage (ca. 55,000–60,000 RCYBP), there were characteristically cool and arid climatic conditions and semidesert landscapes. In the whole, during middle and late-Karginian time, pollen data, character of mammalian fauna, and soils at various localities show a mosaic of landscapes; however, we can establish some paleogeographically different characteristics for the first and second waves of human occupations.

It is necessary to note that during the Karginian period (ca. 55,000–60,000 to 28,000–25,000 RCYBP) the region's pedocomplex includes from two to five zones of soil genesis, with various characteristics for each formation. The upper, middle, and lower portions of the Karginian pedocomplex correspond to different chronometric periods. The lithological layers bearing the most

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ancient cultural material are associated with the middle-Kargian soil formation and include Kamenka A, Khotyk (layers 3 and 4), and Varvarina Gora (layer 3). Overlying these is a layer of late Karginian soil formation, associated with sites Kamenka B, Khotyk (layer 2), Varvarina Gora (layer 2), and Tolbaga. These were mostly destroyed by solifluction occurring during Sartan time (Lbova et al. 2003).

In warmer and less humid conditions of the middle-Karginian period (ca. 35,000–40,000 RCYBP) soils characteristic of steppe landscapes formed, similar to modern steppe soils in the Trans-Baikal. The earliest EUP complexes (Kamenka A, Khotyk (layers 3 and 4), Varvarina Gora (layer 3) correspond to this time interval. The associated faunal complex includes horse (*Equus caballus*), kulan (*Equus hemionus*), Mongolian gazelle (*Procapra gutturosa*), wild sheep (*Ovis ammon*), giant deer (*Megaloceros giganteus*), large bull (*Bison priscus, Bos primigenius, Poephagus baikalensis*), camel (*Camelus* sp.), and lion (*Pantera* cf. *leo*) (Germonpre and Lbova 1996).

The second period of occupation of the Trans-Baikal steppe zone coincided with the formation of soil horizons of the second half of Karginian period (ca. 33,000–30,000 to 28,000–25,000 RCYBP) and occurred during moderately humid and warm conditions with forest-steppes and steppes. Still, climate was relatively arid, and paleosols similar to modern chernozems dominated (Lbova et al. 2003). Palynological spectra testify to the return of woodlands (to 66–75 percent) characterized as light coniferous forests with birch and a mixture of broadleaf species such as elm, alder, and hazel associated with meadows.

The mammalian faunal assemblage reflects steppe and forest steppe landscapes of the second half of the Karginian period. The following species are dominant in the cultural complexes: horse, Mongolian gazelle, woolly rhinoceros (*Coelodonta antiquitatus*), and wild sheep. Other species, such as woolly mammoth (*Mammuthus primigenius*), antelope (*Spiroceros kiakhtensis*), large bull (*Bison priscus* or *Bos primigenius*), wolf (*Canis lupus*), steppe fox (*Vulpes corsac*), and hare (*Lepus* sp.) are also present (determinations of A. Klement'ev).

In recent years, we have discovered and examined a new series of Middle and early Upper Paleolithic sites in the Trans-Baikal region. The tentative scheme of organization of the Paleolithic complexes suggests the existence of several technological trends. Cultural modifications of the Trans-Baikal EUP represent two evolutionary trends: a predominant one based only on blade technologies; and a secondary one based on flake reduction techniques as well as blade (e.g., Kamenka B, Kunalei, Chitkan in Transbaikal; Kurtak-4 in Enisei). Art objects along with a rich non-utilitarian artifact assemblage at Podzvonkaya, Khotyk, and Kamenka in the Trans-Baikal, and at Tolbor in Mongolia indicate the presence of modern symbolic behavior in central Asia during the EUP. Based on the multi-disciplinary work presented here, I conclude that cultural complexes associated with anatomically modern humans appeared in the Trans-Baikal region around 40,000 RCYBP.

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The Late-Glacial Microblade Assemblage from the Kamihoronai-Moi Site in Hokkaido, Northern Japan: A Newly Discovered Yubetsu Site

Yuichi Nakazawa, Masami Izuho, and Fumito Akai

This paper reports a recently discovered late-glacial microblade assemblage recovered from the Kamihoronai-Moi site in central Hokkaido, northern Japan. The Kamihoronai-Moi site is situated at the eastern edge of the southern Ishikari Lowland in central Hokkaido (42° 47′ 15″ N, 141° 59′ 56″ E; 65.6 m above sea level). The site is on the left bank of the Atsuma River, which flows down the west slope of the Yubari Mountains and runs into the present Pacific

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coast about 30 km to the southwest. Since 2004, archaeologists affiliated with the Atsuma Board of Education undertook the full excavation of the Kamihoronai-Moi site after test excavations conducted in 2002 and 2003. This was done under the mitigation of the construction of a water reservoir initiated for agriculture and flood control (Atsuma Board of Education 2006:15–16). A total of 8,460 m^2 was excavated during 2004 and 2005. The final monograph was published and the present authors were responsible for reporting the Paleolithic component of this site (Atsuma Board of Education 2006).

The local terrain topography was divided into 7 units consisting of the flood plain (T_0), 5 river terraces (T_1-T_5), and mountain/hill slope (H). Terrace T_3, where the Upper Paleolithic occupation was identified, is approximately 350 cm thick and lies above the mudstone bedrock. It is divided into 5 lithostratigraphic units, labeled V to IX from bottom to top. Unit V (100 cm in thickness) consists of gravels that were deposited along the ancient channel. Unit VI (20 cm thick) is a fluvial deposit composed of layered sand and silt. Unit VII is composed of the lower dark loam and upper dark sandy loam. The Paleolithic assemblage and an associated hearth were contained within 10 cm of the lower dark loam (also called "layer IXc") and were horizontally accumulated across the entire T_3 area (260.2 m^2). AMS ^{14}C dates were obtained from Unit VII; they consistently range between ca. 14,700 and 14,500 RCYBP: 14,565 ± 50 (PLD-5275), 14,560 ± 50 (PLD-5276), and 14,650 ± 80 RCYBP (IAAA-41577).

A total of 1,412 artifacts consisting of chipped-stone artifacts and thermally altered stones were recovered from 295 m^2 of the excavation area in Unit VII. These artifacts are horizontally scattered approximately 4 m in an east-west direction and 7 m in a north-south direction. Vertically, artifacts are encompassed within 30 cm; 95 percent are distributed unimodally within a 20-cm thickness (65.5–65.7 m above sea level). One hearth identified as a burnt patch with fragmented, thermally altered stones was located at the southeastern margin of the lithic scatter. Because no significant erosion and disturbance were observed in the sediments of Unit VII and all artifacts were plotted by the Electric Distance Meter, this site has the potential to elucidate behavioral and physical processes that created the observed spatial pattern.

The chipped-stone artifacts include 151 microblades (21 have edges with microflakings), 3 wedge-shaped microblade cores, 6 sidescrapers, 2 endscrapers, a retouched flake, a perforator, a burin, and 10 burin spalls. The wedge-shaped microblade cores are classified as the Sakkotsu type, shaped by organized core preparation steps known as the "Yubetsu method" (Bleed 2001; Nakazawa et al. 2005:281; Ohnuma 1993; Tsurumaru 1979; Yoshizaki 1961), which have been notably found among late-glacial sites of northeastern Asia (e.g., Derevianko 1996; Goebel 2002). After the removal of several bifacial thinning flakes, a thick spall was detached from the bifacial preform to make the platform of the wedge-shaped microblade core. Unlike the typical "Yubetsu method," microblades were detached not only from this wedge-shaped core, but also from the spall (Figure 1). The tool classes show distinctive use of lithic raw materials. That is, microblades and microblade cores are

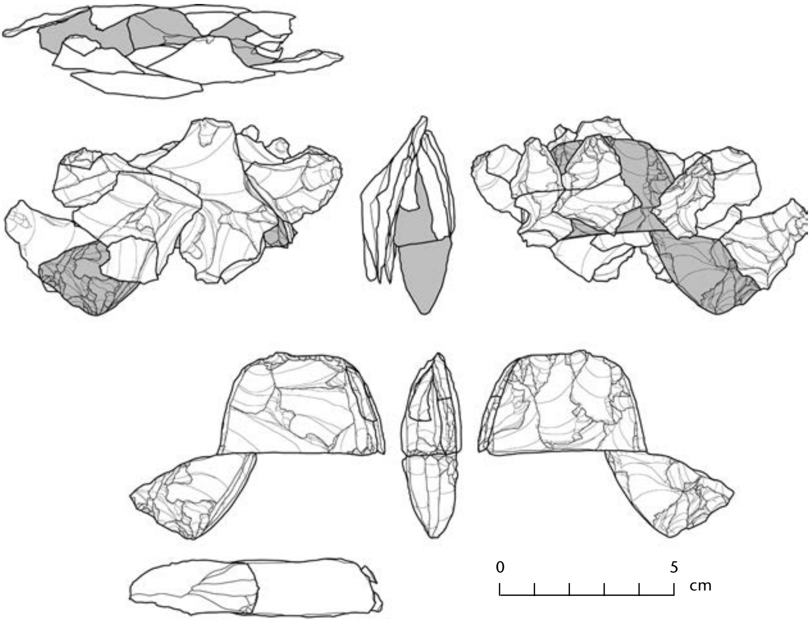

Figure 1. The refitted microblade cores with bifacial thinning flakes. Shaded artifacts are microblade cores.

made solely from obsidian, while burin and endscrapers are made on hard shale flakes. The perforator is made from agate. All chipped-stone artifacts (i.e., obsidian, hard shale, and agate) are made of high-quality material not locally available. This suggests that foragers occupying the present site transported microblade cores and bifacial preforms across long distances. Moreover, it implies that foragers left the site prior to reaching a threshold to procure local materials to compensate for the used portion of the transported package of lithic implements.

Although reliable paleoenvironmental data of the late glacial are lacking from this region, the identified microblade core reduction may have been optimal for sustaining mobility strategy to specifically exploit easily depleted resource patches (Elston and Brantingham 2002) or to forage the landscape where lithic material availability was unpredictable. In the future, we need to build a plausible explanation about the relationship between site occupational history and microblade technological organization by a thorough examination of site structure and assemblage formation processes.

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New Evidence of Endscraper Reduction in Upper Paleolithic Japan

Jun Takakura

Endscrapers are one of the major tool classes among the Upper Paleolithic assemblages of northern Japan. The microblade assemblages in Hokkaido, dated between 20,000 and 12,000 RCYBP, consist principally of abundant endscrapers on blades (Nakazawa et al. 2005). In spite of the general attention paid to the complexity of endscraper reduction processes (e.g., Blades 2003; Morrow 1997), there have been few explicit attempts to assess the various resharpening patterns of endscrapers from the Upper Paleolithic assemblages in Japan. In this paper, I present new evidence evaluating the edge-resharpening processes of endscrapers, based on observations of the refitted specimens from the Inada-1 and Beppu-1 sites located along the margins of terraces on the Tokachi Plain, eastern Hokkaido (Kitazawa and Yamahara 1997; Kitazawa and Sasajima 2003). The assemblages from both sites are characterized by endscrapers (Inada-1, n = 101; Beppu-1, n = 8) made on blades detached from prismatic obsidian blade cores. A small concentration of charcoal associated with the lithic assemblages at the Beppu-1 site yielded AMS ^{14}C dates of 13,400 ± 70 (Beta-149443) and 3730 ± 40 RCYBP (Beta-149444) (Kitazawa and Sasajima 2003); AMS ^{14}C dates were not obtained from

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the Inada-1 site. The technological and typological features observed on the stone tools demonstrate that both assemblages may be attributable to the "late period" of microblade assemblages in Hokkaido (Nakazawa et al. 2005; Takakura 2004).

Four specimens of endscrapers refitted with resharpening flakes and spall on the working edges are identified. A refitted specimen (Figure 1A) from the Inada-1 site shows that the former working edge was completely rejuvenated by a blow, and a new working edge was prepared by removing small chips. Because some broken endscrapers (Figure 1B–C) also demonstrate identical edge-resharpening processes, the observed specimen was not exceptional. Additionally, on four specimens from the Inada-1 site (Kitazawa and Yamahara

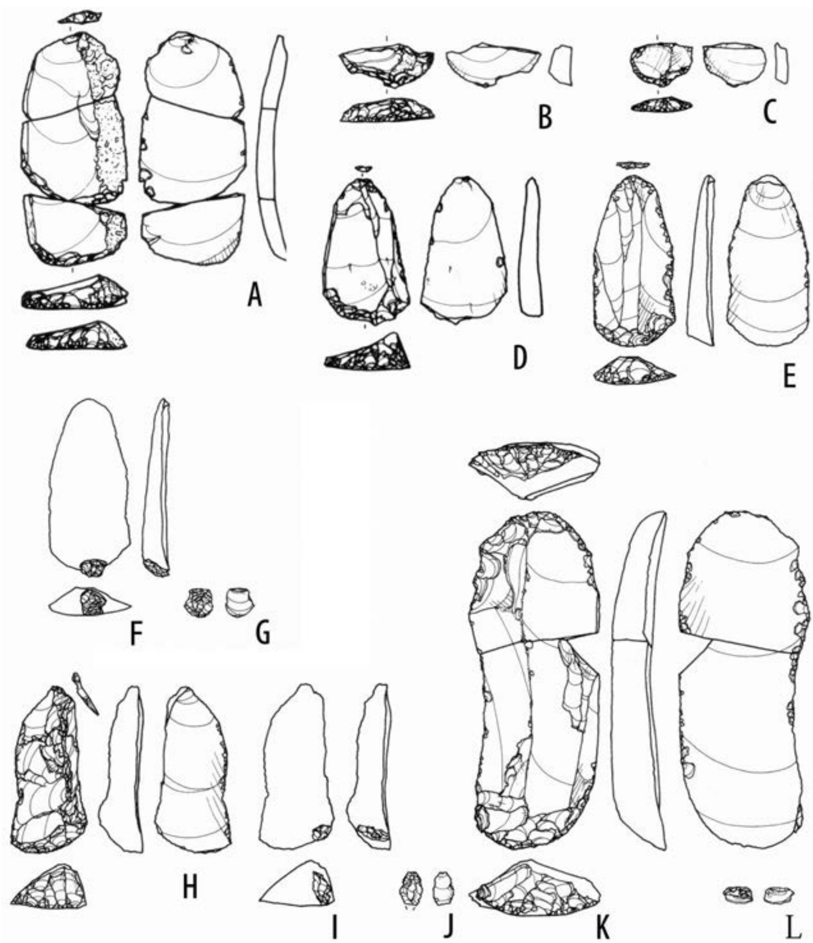

Figure 1. Lithic artifacts from the Inada-1 site (**A–D**) and Beppu-1 site (**E–L**). **A, F, I, K,** refitted specimens; **B, C, D, E, H,** endscrapers; **G, J, L,** chipped flakes (after Kitazawa and Yamahara 1997; Kitazawa and Sasajima 2003).

1997) part of a Hertzian cone can be observed on the dorsal face above the working edges of endscrapers (Figure 1D). Thus, these indicate that the spalls on working edges are not the result of accidental breakage while hafting, but were produced by deliberate percussion on the dorsal face to remove all working edges. In the Beppu-1 assemblage, three specimens (Figure 1: F, I, and K) are original endscrapers with small chipped flakes along their working edges. Endscrapers from the Beppu-1 site might have been reduced by removing small chips along the striking axis of blade blanks; this in turn gradually shortened their lengths. Unlike the Inada-1 site, this site has not yielded endscrapers broken by blows. Here, I measure the working edge angle formed between the unretouched ventral face and the retouched dorsal working edge. The angle is measured at the center of the working edges of the endscraper or chipped flake, and is recorded in degrees using a contact goniometer. Interestingly, the measurements of working edge angles reveal that the angles of former working edges (Figure 1G, 67°; 1J, 70°; 1L, 68°) are steeper than those of renewed ones (Figure 1E, 63°; 1H, 61°; 1K, 52°).

Obviously, these refitted specimens yield unique data that directly relate to variation in the edge-resharpening processes of endscrapers. Archaeologists analyzing endscrapers (e.g., Morrow 1997; Movius et al. 1968; Shott 1989; Yanase 1985) have interpreted the small ratio of length relative to initial blank size and the high steepness of the working edge angle as indicators of high intensities of retouch or utilization. However, the refitted specimens from Inada-1 and Beppu-1 sites suggest that shorter lengths and steeper edge angles do not necessarily signify intensive utilization of the endscrapers. They imply that variation in edge-resharpening processes can affect various morphological attributes of endscrapers, especially lengths and working edge angles. As a result, the reliability of inferences about the relationship between reduction intensity and morphological attributes of endscrapers will be improved by studying the influence of edge-resharpening processes.

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Archaeology: Latin America

Three Undescribed Fell's Type or Fishtail Points from Argentina: A Possible Barb-like Shoulder Variation

Tom Amorosi, Joseph Diamond, and Sumru Aricanli

The regional concentrations of Fell's Type or Fishtail points are uneven across South America. These points are known to be more frequent in the southern cone area (Borrero 1983; Chauchat and Briceño 1998; Flegenheimer 2006, 2001; Flegenheimer and Bayón 1996:17–19; Flegenheimer and Zárate 1989; Léon Canales et al. 2004; López et al. 2001; Miotti 1995; Mazzanti 2006; Nami 2001; Politis 1991; Suárez 2006, 2003, 2001; Valverde 2003). Better resolution of these distribution patterns will emerge as more undescribed points are published. Three such points were noted in an unpublished illustration while reorganizing Junius Bird's notes for the reanalysis of Pali Aike rockshelter (Amorosi 2006). After consulting the AMNH, Division of Anthropology archives it was found that these points were not from Pali Aike, but were surface finds from Argentina. There is a handwritten note kept with the specimens:

> [AMNH] 41.2/6426 a–c: 3 points found at Punta Bareos south of Puerto Deseado. This is the location where Sr. Dietrich Amoluno's collection came from (he is Betty Grants husband). From his comments it must have been a place of importance to the natives for a long period of time. Sand dunes shifting exposed shell deposits & variety of artifacts & many flakes etc. He gave me these (J. Bird) so I can check the basal fluting to see it was done before or after chipping shaped stems. 41.2/6426 a, 6427 out for Dick Gould's show July 1969.

It could not be ascertained if Bird ever did report back to Amoluno. Curated with these points are two scrapers and a modified flat cobble. It is unclear if these artifacts were from the same location. A replica projectile point created by Don Crabtree (AMNH 41.2/6427) for the above mentioned 1969 exhibit is also stored with these artifacts and is similar to 6427a.

The blade of specimen 41.2/6426a (Figure 1A) has overshot flaking on both

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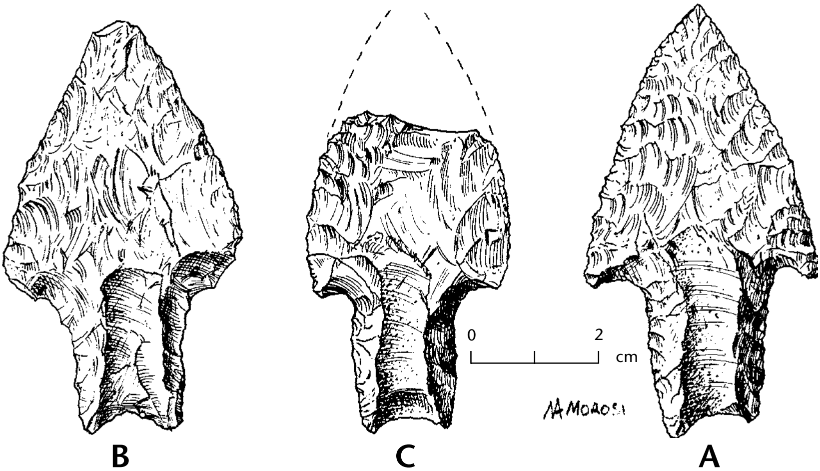

Figure 1. The Fell's or Fishtail projectile points catalogued as AMNH 41.2/6426a–c. Specimen 6426b is on the left, 6426c is in the middle, and 6426a is on the right. The illustration scale is indicated and was done by the late Nicholas Amorosi in 1969.

the front and obverse aspects. The striking pattern moves from right to left. The blade has been rejuvenated; the working edge is sharp, and the stem's edges are ground. Measurements (after Justice 1995): blade length 41.92 mm, maximum length 63.34 mm, stem/haft length 22.71 mm, shoulder width 35.85 mm, basal width 17.19 mm, channel flute length 26.85 mm, channel width 6.09 mm, thickness of the point 8 mm. The point is made from a high-quality unidentified tan chert that was possibly heat-treated. The shoulders have an unusual barb-like shape not commonly seen with the larger pronounced shouldered Fishtail points (Suárez 2006:69, 2003:32-33). The barbed shoulders are most likely created by rejuvenating the blade's cutting edge.

Specimen 41.2/6426b (Figure 1B) exhibits a similar overshot flaking pattern on both the front and obverse aspects. The blade edge is dull and the stem has been ground. Measurements: blade length at 40.4 mm, maximum length 62.83 mm, stem/haft length 23.61 mm, shoulder width 36.26 mm, basal width at 18.01 mm, channel flute length 25.39 mm, channel flute width 10.90 mm, thickness of point 9 mm. This point is made of a similar high-quality chert as 41.2/6426a.

Finally, the blade of specimen 41.2/6426c (Figure 1C) has suffered impact damage and was probably discarded at this stage. Although the blade suffers from an impact fracture, an overshot flaking pattern is still evident. The remaining blade is sharp, there is no indication of retouch, and the stem is ground with somewhat barb-like shoulders. Measurements: stem/haft length 21.35 mm, shoulder width 30.97 mm, basal width 15.42 mm, channel flute length 24.52 mm, channel flue width 6.99 mm, thickness of point 6 mm. It is made of a dark brown chert.

The variation seen among these three points alone confirms Suárez's (2006:70) observation. There is a great variability in reduction strategies for the manufacture and maintenance of Fishtail points. Based upon the senior author's experimentation, the sharpening of the blade of a rounded-shoulder point can cause the shoulder to be more notched or barb-like. Whether this barb-like effect was purposeful or experimental will require a further review of the published literature, museum and private collections.

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Lapa das Boleiras Rockshelter: Geoarchaeological and Paleoenvironmental Aspects of a Paleoamerican Site in the Lagoa Santa Region, Brazil

Astolfo Gomes de Mello Araujo and Walter Alves Neves

Lapa das Boleiras Rockshelter (19° 30′ 58″ S and 44° 04′ 05″ W) is located in the State of Minas Gerais, central/southeastern Brazil. The rockshelter is part of a limestone outcrop facing two sinkholes, one of them active today as a swallet of an intermittent stream. The sheltered area is 43 m long and 12 m wide, aligned roughly north-south, with an area of 280 m^2. The shelter's mouth faces west, and its floor is slightly inclined (12 percent) toward the north.

Excavation of the site was carried out between 2001 and 2003, and in this article we present data regarding site formation processes, chronology, and paleoenvironmental implications. Data regarding Paleoamerican technology and subsistence for the rockshelter was published earlier (Araujo et al. 2002). Sediments inside the rockshelter can be regarded as having two origins, anthropogenic and geogenic. Anthropogenic sediments are mainly derived from burnt vegetation, in the form of ash (Karkanas 2001; Karkanas et al. 1999). Geogenic sediments are mainly colluvial, coming from the top of the outcrop and entering the southern portion of the shelter by gravity. The limestone is extremely pure, more than 95 percent $CaCO_3$, and therefore subject to heavy leaching in a subtropical climate. Sediment contribution from the walls, either in the form of roof/speleothem falls or dust, can be regarded as minimal.

The sterile layers of the site are yellow-red (5YR 5/8), composed of ancient karstic fill. The basal archaeological layers are light gray (10YR 7/2), interpreted as ash layers, with intercalations of thin, dark brown facies (7.5YR 6/3, 7.5YR 4/3), interpreted as related to trampling. Chemical analyses by ICP-AES and X-ray diffratometry supported the interpretations.

The upper layers are much more disturbed, either by pre-colonial

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anthropic activities, or by channel erosion and subsequent deposition of colluvial materials. Bioturbation, also a major aspect of site formation, is easily recognizable in the profiles (although not during excavations or in the square plans). Armadillos and tree roots seem to be the main agents of bioturbation.

Our chronology is based on 31 ^{14}C and 5 OSL ages. The earliest age associated with human activities is 10,150 ± 130 RCYBP (Beta-168451). Charcoal in the sterile sediments, near the interface with the first archaeological layer, was dated to 12,240 ± 50 RCYBP (Beta-168457). The 30 ^{14}C ages associated with archaeological materials cluster into 2 groups: 24 are earlier than 7500 RCYBP, and 5 are later than 800 RCYBP. There is only one middle-Holocene age, 3830 ± 60 RCYBP (Beta-159235), which supports our hypothesis of a hiatus in the human occupation of central Brazil during the middle Holocene (the "Archaic Gap" of Araujo et al. [2005]).

Data from Lapa das Boleiras and other sites in the Lagoa Santa region (Lapa do Santo, Lapa de Taquaraçu), as well as other archaeological and paleoenvironmental studies performed in central Brazil (Behling 2002; Ledru 1993; Ledru et al. 1996; Martin et al. 1997; Servant et al. 1993) and elsewhere in South America (Araujo et al. 2006), converge on the same pattern: The early Holocene seems to be humid and is well represented in archaeological terms, but the middle Holocene (7500 to 1000 RCYBP) was probably a time of increasing dryness (possibly an extended dry season) and low human population densities. Therefore we postulate that humans living in tropical/subtropical areas can be viewed as sensitive environmental markers, but only when population densities are sufficiently low to prevent territorial constraints, allowing easy mobility and/or large territories.

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Dating of the Bahía La Ballena Site (J69E), a Possible Terminal-Pleistocene Occupation in Baja California Sur, Mexico

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Pleistocene-age sites positioned along the New World Pacific Coast are known from only a few spatially scattered localities and represent an important source of information on a poorly understood aspect of regional prehistory (Davis et al. 2004; Des Lauriers 2006; Erlandson 1993, 1994; Erlandson et al. 1996; Fedje et al. 2005). Recent archaeological investigations on Espíritu Santo Island, which lies 25 km to the north of La Paz in the Sea of Cortez of Baja California Sur, may represent a new addition to the short list of early coastal sites. Reported initially by Fujita and Poyatos de Paz (1998), site J69E is located in the Bahía La Ballena and appears as a dense scatter of shell and lithic artifacts mixed with fine sediments and volcanic rocks, all of which rests on a mesa of igneous bedrock about 95 m above sea level and 550 m east of the Sea of Cortez. Fujita (2002: Table 1) reports a single ^{14}C date of 11,284 ± 121 RCYBP (unadjusted for reservoir effect) on an *Ostrea fisheri* shell sample collected from the surface of J69E. The author led excavations at J69E during summer 2004 in the location of fossilized human bone he discovered while visiting the site with Fujita in 2003. A second season of archaeological investigation led by the author occurred in summer 2006, which included excavation in areas adjacent to the 2004 block. To date, a total of 23 m^2 has been excavated at J69E.

The 2004 and 2006 excavations at J69E produced a large quantity of cultural materials including hundreds of lithic tools, dozens of shell and coral tools, thousands of pieces of lithic debitage, and hundreds of kilograms of faunal remains. Faunal analyses to date indicate an intensive use of marine environments represented by 21 different gastropod species and 25 bivalve species, various reef fishes, dolphin, and sea lion. Limited use of avian and terrestrial animals is reflected in the low number of bird and artiodactyl bone. Excavations also recovered fragments of heavily fossilized post-cranial human bone. Analysis of these datasets is currently in progress, with detailed results to be reported in the coming year.

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Three marine shells collected from the bottom of the site returned ^{14}C ages between 7380 ± 70 and 8100 ± 60 RCYBP (unadjusted for reservoir effect). Efforts to date human bone were mixed, producing younger ages in similar contexts. Subsamples of human bone submitted for AMS ^{14}C dating at the University of California–Irvine produced ages of 2320 ± 25 and 3875 ± 40 RCYBP. Other subsamples from the same bone specimens were sent to Thomas Stafford of Stafford Research, Inc., who could not extract sufficient quantities of bone collagen for analysis.

Nearly all bone and shell recovered from J69E shows indications of contamination through secondary carbon exchange. Because the island is composed of igneous bedrock types, we may rule out carbon exchange from local geologic sources. The source of this diagenesis is traced to the effects of Pacific hurricanes and tropical storms that produce extreme wet conditions in Baja California Sur. Postdepositional alteration of marine shell is indicated by carbonate dissolution features (e.g., single and dendritic rills, pits, roughening of texture, and/or graying on shell surfaces). These dissolution features were most prominent among shells from the bottom of the site's stratigraphic profile, suggesting they were in contact with meteoric water for longer periods as it perched on the underlying bedrock surface. Given this taphonomic context, we currently assume that all bulk ^{14}C dates from J69E derived from bone and shell include an error caused by the diagenetic introduction of younger carbon through the processes of saturation, dissolution, and recrystallization of carbonate. Thus the currently available shell and bone dates probably represent minimum ages and the site's occupation dates to an indeterminately older period. Moreover, since pre-middle-Holocene sea levels exposed portions of the Baja California continental shelf, Fujita's 11,280 RCYBP date on surficial shell may represent a fossil shell acquired and transported to the site by prehistoric peoples. Given these dating problems, means of establishing better temporal control are sought in the potential application of other chronometric techniques, including AMS dating of the shell conchiolin fraction of shell tools (e.g., hooks and hook production items), pulp cavity organics from intact teeth, thermoluminescence dating of site sediments, uranium-series dating of coral tools, and electron-spin-resonance dating of culturally modified coral and shell. Diagenetic degradation of the organic conchiolin fraction of shells is expected to making fossil shells unsuitable materials for the production of finely made shell hooks and other tools. Thus, direct dating of shell tools should provide insights into the timing of occupation.

If J69E at Bahía La Ballena is shown to date to the late Pleistocene, it will be one of the most important sites in the Baja California peninsula, particularly regarding questions of the peopling of the Americas. At a minimum, the investigation of J69E has contributes additional evidence on the antiquity and character of New World coastal adaptations.

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Rodents at Late-Pleistocene Contexts in Central and Southern Chile

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The rodent record in archaeological contexts has been widely discussed regarding its anthropogenic or natural taphonomic depositional status. This question is particularly significant for late-Pleistocene sites where investigations tend to emphasize the role of large-mammal consumption over smaller mammals such as rodents. Nonetheless, studies of small-mammal utilization suggest that they represent a potential and sometimes abundant food source (Stahl 1982) that is often stable and/or reliable (Hayden 1981). In late-Pleistocene contexts, evidence of large mammals overshadows the presence of small mammals; yet the latter's value as a potential resource of food and skin should not be excluded, for a high density of rodent bones is found at many sites, and both food consumption and skin use are ethnographically recognized (Gusinde 1982).

A preliminary overview of late-Pleistocene sites in southern Chile and observations carried out in the northern semiarid coastal zone identified at least seven rodent species (Table 1). In cave and rockshelter contexts of Chilean Patagonia (Tres Arroyos 1 rockshelter, Fell's Cave, Cueva del Medio, and Cueva Laguna Sofía 1), the anthropogenic origin of rodent-bone assemblages is generally discredited owing to the absence of cut or fire marks that could suggest human consumption. Natural taphonomic factors are most

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Table 1. Rodent species at late-Pleistocene sites in Chile.

Site	Genus/species	Reference
Tres Arroyos 1	*Ctenomys magallanicus* *Reithrodon physodes* *Euneonys chinchilloide*	Latorre 1998
Cueva Fell	*Ctenomys magallanicus*	Saxon 1976
Cueva del Medio	*Ctenomys magallanicus*	Prieto 1991
Cueva Laguna Sofía 1	*Ctenomys magallanicus*	Prieto 1991
Taguatagua 1	Octodontidae	Casamiquela 1976
Quereo I y II	Octodontidae *Phillotis* sp.	Núñez et al. 1983
El Membrillo	*Abrocoma bennetti* *Octodon* sp. *Spalacopus cyanus* *Phyllotis* sp.	López 2004

probable depositional agents in these archaeological contexts. In the case of open-air campsites in central Chile (Taguatagua I, Quereo I and II, and El Membrillo), evidence also suggests natural taphonomic factors in rodent incorporation into archaeological sites, such as wind transport in sand dunes or gravitational movement in steep areas.

Research at late-Pleistocene sites in the northern semiarid coastal zone of Chile (Los Vilos) exposed abundant rodent remains, either with or without associated cultural remains (Jackson 2002, Jackson et al. 2005, López et al. 2005). Sampling at the "Valle de los Caballos" locality yielded a natural, non-cultural context mainly with remains of *Octodon* ssp. (NISP 144; NMI 73, 51.05 percent) and *Abrocoma bennetti* (NISP 106; NMI 64; 44.76 percent), well preserved and with high integrity of long bones, suggesting natural taphonomic post-depositional agency in their incorporation. The main identified taphonomic process is strigiform bird (i.e., owl) regurgitation. These birds do not break bones during food ingestion, thus maintaining bone integrity, as opposed to falconiforms and foxes (*Pseudalopex* ssp.), which crush their prey (Stahl, 1996). Locally these observations are confirmed by the presence of several rodent remains included in compact calcium carbonate pellets produced by strigiform birds. Throughout, *Spalacopus cyanus* only appears in very low frequencies (NISP 6; NMI 2; 2.79 percent), suggesting lesser capture probability. At El Membrillo, one of the sites yielding cultural remains (Jackson 2002), the complete skull of an *Abrocoma bennetti* was recorded in surface association with *Mylodon, Palaeolama,* and *Equus* bones. This particular specimen is also considered as part of strigiform bird regurgitation. Of the species recorded in the northern study area, only a high frequency of *Spalacopus cynaus* may eventually be considered of anthropogenic origin. This diurnal species has a very low chance of being captured by strigiform birds, and thus being incorporated as a component of their regurgitation. Though some species are in fact burrowing rodents, the data presented are of discrete accumulations, consistent with regurgitation rather than dispersed natural deaths.

Hypothetically, once archaeological sites were abandoned, especially open-air sites, scavengers should have gathered around carcasses and organic leftovers, thereby introducing rodent bones as part of their regurgitation into archaeological contexts. The presence of rodents in late-Pleistocene sites should always be considered problematic. Evidence suggests regurgitation by strigiform birds as the main taphonomic post depositional agent, though other, yet unstudied factors could be intervening as well.

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ELS1, a Fishtail Projectile-Point Site from Central Argentina

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Since 2001 our team archaeologists, bioanthropologists, geologists, and paleontologists has been carrying out a project focused on the peopling of the Sierras of Córdoba and San Luis ranges, northwest of the Pampas in central Argentina, during the Pleistocene-Holocene periods. Until recently, the available information on the earliest occupations referred to sites with a technology of foliate projectile points (known as Ayampitín) dated to 8000 RCYBP (González 1960) and supposedly linked to Andean origins. A review of sites discovered in the 19th and 20th centuries with possible associations of megafauna, lithics, and charcoal, as well as data available on early Holocene settlements in the adjoining regions (Flegenheimer and Bayón 1996; Martínez 1997; García 2003; Nuñez et al. 1994), allow us to hypothesize an earlier peopling of the zone, from the Pampas.

Geomorphological and paleoenvironmental studies in the high open grasslands of the hills (Cioccale 2002) showed that these zones provided environmental refugia for megafauna at the beginning of the Holocene. Our main research hypothesis maintains that the peopling of the region was initiated at the Pleistocene-Holocene boundary in a predominantly east-to-west direction through the most-direct, least-cost migration routes along the main rivers that connect the Sierras de Córdoba and San Luis with the Pampas plains.

In relation to this hypothesis, bioanthropological studies based on analysis of cranial morphological variation through cluster and matrix correlation analyses of prehistoric skeletal populations demonstrate that the ancient inhabitants of these Sierras show close morphological similarities with the Patagonian and Tierra del Fuego populations (Fabra et al. 2006). Recent archaeological research at the site of El Alto, 3, 200 km northeast in the Sierras de Córdoba range (Rivero and Roldán 2005), yielded two ^{14}C dates of ca. 11,000 RCYBP.

The discovery of fishtail projectile points at Estancia La Suiza 1 (ELS1), an open site in the vicinity of a stone quarry (Estancia La Suiza 2, ELS2), opens new expectations. The site is located in the western piedmont of the Sierras

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de Comechingones in the province of San Luis (32° 56′ 55.07″ S, 65° 07′ 45.07″ W), at the confluence of two creeks in a landscape of low rounded hills (Figure 1). Considering the usual context of fishtail points, a late-Pleistocene/early-Holocene age is extrapolated for this locality.

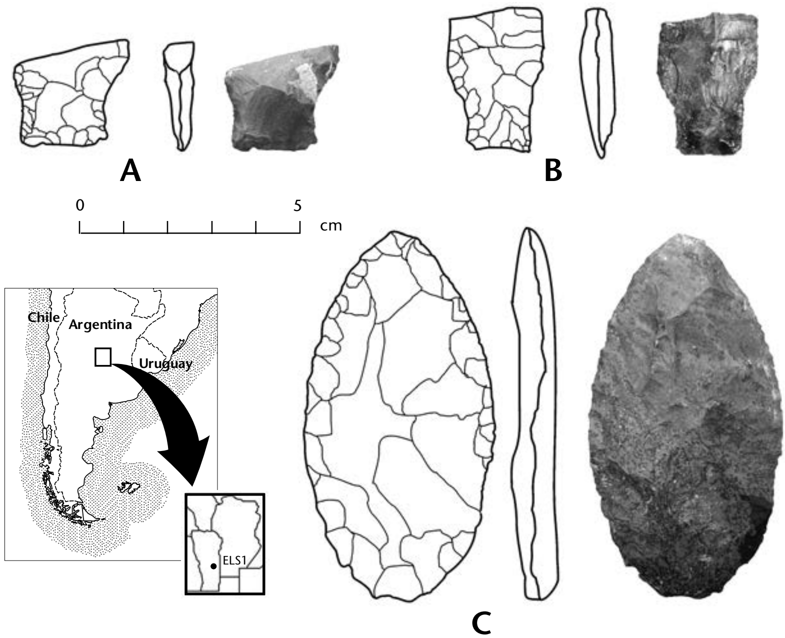

Figure 1. Map of the study area and representative artifacts from ELS1: **A** and **B,** broken fishtail projectile points; **C,** biface.

Remains obtained from systematic survey at ELS1 include two broken fishtail points (Figure 1A, B), 7 scrapers, 5 sidescrapers, 6 manos, 5 knives, 2 unifaces, 5 bifaces (Figure 1C), 9 retouched flakes, 2 preforms, and 7 fragments of cores. Almost 70 percent of the discarded tools are fragmented. Most of the 196 flakes recovered correspond to early stages of manufacture, but among these also occur five bifacial reduction flakes. The archaeological quarry of chert (quartz and other siliceous materials in minor quantities) was recorded 1.2 km northwest of ELS1. It has a concentration of surface materials including cores, tools, flakes, and debris. This site seems to be the source of raw material for ELS1.

Continued fieldwork next season at ELS1 and ELS2 may provide stratigraphic information, including datable organic materials, that will allow us to gain new insights about early human technological strategies and the relationships with similar processes in another regions.

We would like to thank Dr. Luis E. Gallo, from Tilisarao, who made the first discovery of the site and generously gave us the information and his support. This project is funded by ANPCyT-FONCyT, BID 1728/OC-AR PICT 15187.

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Geological Context of the Archaeological Record from the Late Pleistocene through Holocene in the Middle Río Negro Valley, Argentina

Heidi Luchsinger

From its confluence, the Río Negro flows eastward from the Andes along the northern Patagonian boundary to the Atlantic coast. This geoarchaeological study reconstructed the landscape of the middle valley from the late Pleistocene to the present (Luchsinger 2006). Fieldwork included detailed recording of sediments, soils, geomorphological features, and archaeological sites, which was combined with analysis of aerial photographs, satellite imagery, topographic maps, geologic maps, and sedimentology. Chronology of the regional stratigraphy was based on ^{14}C and optically stimulated luminescence (OSL) dating. Prates (2006) recently conducted archaeological survey and excavation in this region. Through collaboration, we were able to consider the known archaeological record in its geological context.

Underlying the valley is the Río Negro Formation (Figure 1). This bedrock

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formed during the Pliocene and consists of medium to fine bluish-gray sandstones intercalated by siltstones and claystones (Andreis 1965; Angulo et al. 1979; Suriano et al. 1999; Uliana 1979). During the later part of the Pleistocene, this region underwent tectonic uplift which initiated the incision of the Río Negro Valley (Suriano, et al. 1999). In some portions of the valley, two alluvial gravel terraces remain from the late Pleistocene and were deposited by a large braided river (Luchsinger 2006). The most extensive set of Pleistocene terraces lie along the southern valley margin southeast of the Choele Choel village. The Pleistocene alluvial terraces are composed of a fining upward sequence of gravel (5–15 cm) and sand. Each terrace is capped with a paleosol characterized by extensive calcium carbonate accumulation.

After the late Pleistocene, the Río Negro continued to flow as a braided stream, depositing thick deposits of sandy fine gravels. During the middle to late Holocene, it shifted to a meandering regime and jumped its course (or avulsed) at least on three separate occasions in the middle valley. As a result, three large abandoned avulsion channels lie across the landscape (Figure 1), and archaeological sites have been found associated with each avulsion channel before and after channel avulsion. These channels may have been reoccupied after they were abandoned because semipermanent ponds developed within these channels and served as a habitat for various animals and plants in

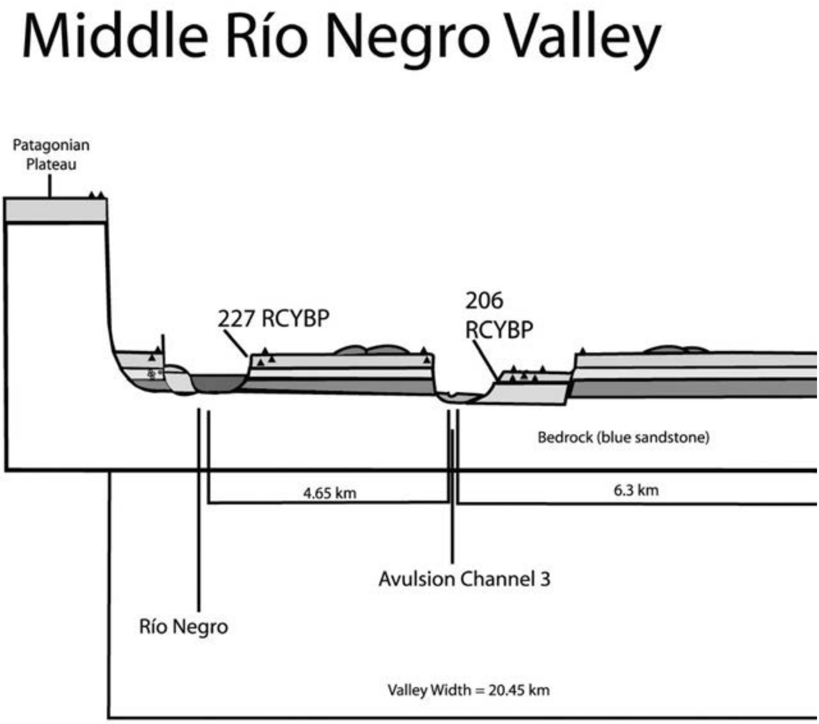

Figure 1. Generalized stratigraphic cross section of the Middle Río Negro Valley.

this arid environment. Late-Holocene river activity of the Río Negro had an impact on settlement patterns for human groups occupying this region, since the Río Negro provided the main source of freshwater in this region.

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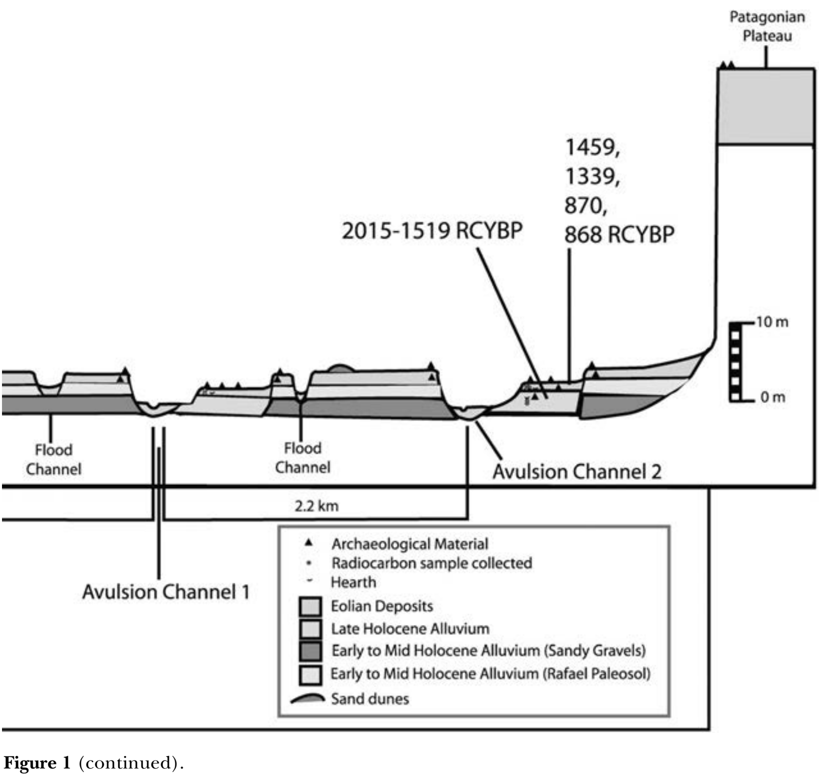

Figure 1 (continued).

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A Gap Between Extinct Pleistocene Megafaunal Remains and Holocene Burial Contexts at Archaeological Sites in the Southern Argentinian Puna

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Recent investigations carried out in the southern Puna of northwest Argentina confirmed the presence of giant ground sloth (*Megatheriinae*) and Pleistocene horse (*Hippidion* sp.), which were dated to the late Pleistocene, between 13,350 and 12,510 RCYBP (three uncalibrated dates) (Martínez et al. 2004). These megafauna taxa, not previously reported above 3400 m a.s.l., were found in two high-altitude archaeological sites under study, Peñas de las Trampas 1.1 (PT1.1; 3582 m a.s.l.) and Cueva Cacao 1A (CC1A; 3730 m a.s.l.), both located in Antofagasta de la Sierra, Catamarca, Argentina. The ^{14}C dates were obtained on stratified megaherbivore dung samples very well preserved because of the extreme aridity of this ecoregion (precipitation less than 50 mm/year). The samples come from two rockshelters, which also show evidence of Holocene human utilization after 10,000 RCYBP.

The dung dates mark the final stage in the presence of these large mammals in this part of the Puna. Hence, the interpreted paleoecological and paleoenvironmental conditions for the late Pleistocene need to be restated for this area. The record of these taxa indicates that until 13,350–12,510 RCYBP there was a relatively high degree of effective humidity and high plant and biomass density capable of meeting the food requirements of these megaherbivores.

A recent ^{14}C analysis of dung corresponding to layer 4 of excavation unit 2E of site PT1.1 yielded a date of 19,610 ± 290 RCYBP (LP-1546). This layer, the earliest stratigraphic unit with dung, is found on a sandy fine sediment of eolian origin. Hence identification of the megafauna extends its presence in the area back to ca. 20,000 RCYBP, within the Last Glacial Maximum, and may provide an impor-

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tant beginning date for deglaciation at this elevation, which is according to paleoclimatic models designed for the Andean tropical zone (Paduano et al. 2003). In the study area, High-andean steppe is now found at 4200–4800 m a.s.l., but under these conditions, plant biomass likely increased locally with reference to dominant conditions of the glacial maximum.

The archaeological context of occupations in both high-altitude rockshelter sites is linked to mortuary activities within the Holocene period. Although no evident hiatus is observed in CC1A, there is a large interval of undated deposits between a date of 13,350 ± 300 RCYBP (UGA-9075), corresponding to the megafauna, and material evidence of a burial offering ca. 3000 RCYBP (Olivera et al. 2003). There is no evidence of a sediment hiatus in PT1.1 either, but the interval between ^{14}C-dated events is shorter. Radiocarbon dates corresponding to the upper layer of megafauna dung [12,920 ± 190 RCYBP (UGA-9074) and 12,510 ± 2 40 RCYBP (UGA-9258)] are followed by a date of 8440 ± 40 RCYBP (UGA-9073) on a pit feature excavated into the dated upper stratum containing the Pleistocene megafauna dung.

A large number of cultural elements found inside the oval feature in site PT1.1 gives evidence of an intentional deposit. The edge of the feature, which measures 95 by 65 cm, was lined with bundles of graminaceous plants that provided the sample yielding the 8440 RCYBP date. We assume that the archaeological remains inside correspond to this date. There were human bone fragments belonging to a minimum of three individuals in a multiple secondary burial. Their ages are estimated to vary from a newborn to a 7-year-old child (M.G. Colaneri, pers. comm. 2006). The recovery of these human remains, among the oldest in northwest Argentina, is a valuable contribution to the analysis of paleobiological aspects of these individuals through the study of isotopic analysis (paleodiets), DNA, paleopathologies, etc., as well as a means to explore ancient mortuary practices in which certain anatomical parts of deceased persons frequently may have been transported.

These human bones were found in association with garment pieces and other organic remains that were highly fragmented in spite of their excellent preservation. The set of handicrafts represented shows a remarkable variety of raw material utilization as well as important complex artistry. Among the findings there were chamois-like pieces of leather painted red and sewn together; numerous necklace beads made from non-local plant seeds; red dyed mesh or net fragments painted in black, probably made from foreign plant fibers as well; and a probable headband or *vincha* of intertwined feathers and thin strings of plant fiber. It was determined that the fiber is of *Acrocomia chunta*, a kind of palm tree whose area of origin would have been more than 600 km away (Rodríguez and Aschero 2007).

The presence of exotic elements in this and other Puna sites, whether as ritual or utilitarian goods (according to their context), clearly shows the existence of mechanisms of social interaction among human groups that occupied different and distant environments synchronously during early Holocene. This interaction should be thought of not only in terms of exchanging goods, but also in terms of genetic and information exchange as part of a web of social relations that would have sustained the flow of these elements over time. Explaining the absence of early-Holocene evidence synchronic with PT1.1 outside the Puna region is still a pending issue in the archaeology of northwest Argentina. Discovery will reveal and explain complex social and technological aspects of these early connections between Puna hunter-gatherers and the inhabitants of remote ecozones.

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Current Evidence and Radiocarbon Chronology from the Santa Julia Late-Pleistocene Settlement in the Semiarid Coast of Chile (31° 50′ S)

César Méndez, Donald Jackson, and Roxana Seguel

Santa Julia (LV. 221) is a late-Pleistocene site (ca. 13,000 CALYBP), whose evidence suggests a briefly occupied hunter-gatherer camp associated with resources provided by a small lake basin near the Pacific coast (Jackson et al. 2007). This water body was probably trapped by a dune field since 16,000 CALYBP, as suggested by an analogous system ca. 9.5 km south (Jackson 2002), lasting until 2690 ± 40 RCYBP (Beta-216693), when the actual ravine where the site lies was formed and its drainage began. The 2690 RCYBP assay was obtained from the highest organic sediment stratum (layer 3, peat) of the 10.4 m profile that exposes the sedimentary sequence. During the late Pleistocene, hunting resources within the basin were probably abundant and diverse (mastodon, giant sloth, native horse, paleocamelids, extinct deer), as suggested by bone assemblages at several Pleistocene sites within the region (Méndez et al. 2004; Núñez et al. 1994) and evidence gathered along the ravine.

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A multidisciplinary team, including archaeologists, geologists, ecologists, and conservators, has conducted ongoing research at the Santa Julia locality, concentrating on the exposed profile. Its main sedimentary sequence shows 38 sand and peat intercalated strata. At the base of the profile (layer 38), excavations exposed *Mylodon* sp. remains without any cultural association within a 50-cm-thick sandy sublayer. Overlying layer 37 is a fine-grained organic black peat yielding the late-Pleistocene human occupation. The rest of the sequence is mainly a culturally sterile deposit, whose only human evidence is suggested by thin charcoal episodes, probably from wood-clearing episodes throughout the Holocene. The top sandy layer (ca. 10 m above the late-Pleistocene level) exhibits a discrete Inka-aged occupation, with evidence of shellfish gathering, decorated and utilitarian pot sherds, and a TL date of 580 ± 60 CALYBP (UCTL-1740).

Three field seasons from 2004 through 2006 unearthed a total area of 27 m^2, revealing an undisturbed primary context only 5–8 cm thick. In situ *decapage* excavations yielded mainly lithic instruments and extinct fauna associated with a hearth. The lithic assemblage was composed of three stone types. The least are immediately available coarse-grained pebbles only marginally modified. These are followed by a medium-quality local siliceous tufa (Galarce 2002), mainly in the form of large unretouched and marginally retouched flakes. Edge morphology, angles, and retouch type (when present) classify them as butchering instruments used to cut and disarticulate prey. Most abundant are small bifacial chipping debris and microdebitage of quartz crystal spatially concentrated, therefore suggesting a knapping area. Additionally, excavations exposed a bifacial fragment and fluted projectile point blank manufactured on this lithic resource. Bones are rare within the excavated context; as yet only native horse (*Equus* sp.) is represented. In a central area, a ca. 1-m-diameter hearth is mainly associated with the local siliceous tufa instruments. This has been preliminarily interpreted as a processing and discarding area.

Owing to the exceptional preservation of the site, some pieces of wood were recovered, including a ca. 20-cm-long sharpened piece. Direct AMS dating of this wood instrument (feature 4) yielded an age of 11,060 ± 80 RCYBP (Beta-215090). Another hearth charcoal sample yielded an AMS age of 11,090 ± 80 RCYBP (Beta-215089). Both dates confirm initial chronology proposed for the context (Jackson et al. 2007); added to previous radiometric assays, they show a combined 2-σ range within 13,350 and 12,880 CALYBP. Currently, in the wider region of central Chile, only the Taguatagua 1 (TT1) site (Montané 1968) and the second level of the Quereo (QII) site (Núñez et al. 1994) lie within the time span of Santa Julia. It is worth noting that even if there are differences in the sites' functions (LV 221 being a brief camp, and TT1 and QII being initial processing sites), each location is associated with stable water bodies (of different sizes) which congregated megaherbivores (Núñez et al. 1987).

Santa Julia's precise stratigraphic and spatial resolutions illuminate the discrete activities conducted at an open-air camp during the late Pleistocene. Its undisturbed stratigraphy and coherent ^{14}C assays yield reliable data for integrating the site into the wider discussion of the initial settlement of the South American Pacific coast. Current evidence suggests hunter-gatherers at this latitude, moving towards hunting resources around lake systems, carried long-lasting curated artifacts and manufactured processing instruments with locally available stones.

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Current Research at Paleoamerican Sites in Sonora, Mexico

Guadalupe Sanchez, Edmund P. Gaines, and Alberto Peña

The Mexican state of Sonora exhibits abundant evidence of a widespread late-Pleistocene/early-Holocene human occupation consisting of Paleoamerican artifacts from at least 12 locales (Robles 1974; Sanchez 2001). The University of Arizona and the Instituto Nacional de Antropología e Historia (INAH) have recently begun a collaborative program of systematic geoarchaeological research at six of these early sites located in a variety of geographical settings, from the Basin and Range province in the northeast to the central coastal

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plain near the Gulf of California. The purpose of this article is to briefly describe the sites under study and report our findings to date.

The majority of known Paleoamerican sites in Sonora are located in alluvial systems in the Basin and Range province (Figure 1). In the San Pedro Valley, just south of the international border, a quartz crystal fluted point is from site AZ:EE:16:5 (Gaines 2006). Situated 50 km northwest of the town of Carbó, site

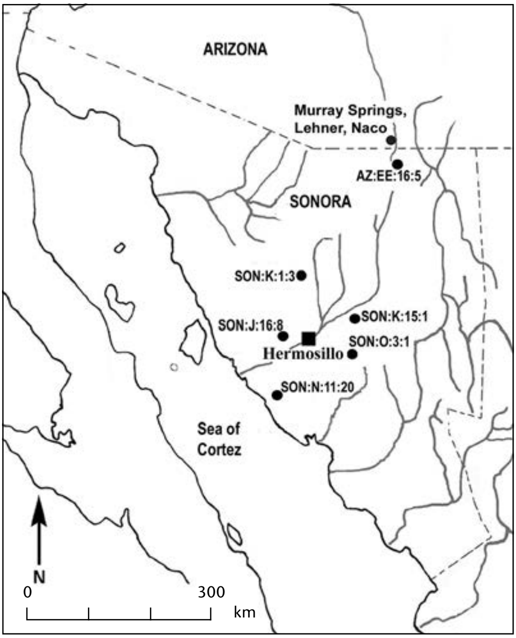

Figure 1. Paleoamerican sites in Sonora, Mexico.

SON:K:1:3 represents the largest concentration of Paleoamerican materials currently known. The site consists of fluted points, bifaces, blades and blade cores, and lithic debitage extending over an area of approximately 4 km^2. In the Río Mátape Valley, 60 km east of Hermosillo, site SON:O:3:1 extends over 2 km and has yielded 5 fluted points, 40 endscrapers, and bones of mammoth and other Pleistocene fauna. Recent excavations at sites SON:K:1:3 and SON:O:3:1 recovered buried archaeological materials and identified several discrete activity areas (Sanchez and Carpenter 2003, 2006). About 50 km northeast of Hermosillo, several late-Paleoamerican artifacts and one fluted point were recovered from site SON:K15:1 (Robles 1974). Recent investigations at SON:K15:1 identified subsurface artifacts and a 3.5-m-thick alluvial sequence consisting of calcareous clays, silts and sands, and at least four distinct black clay horizons.

Two sites are located on the central coastal plain. Over 27 diagnostic Paleoamerican projectile points have been collected from a dune field on the edge of a large playa at SON:N:11:20 (Sanchez 2001). At least 17 of these points are classic Clovis, while 10 exhibit characteristics reminiscent of late-Paleoamerican technologies such as Dalton (Gaines 2006:104–105). Recent investigations at the site identified stratified archaeological materials to a depth of 3.6 m below the surface. Four fluted points are reported from site SON:J:16:8, roughly 20 km west of Hermosillo. Subsurface testing here revealed the presence of at least 6.5 m of alluvial deposits and a series of four buried soil horizons, underscoring the potential for intact, buried archaeological remains.

These early sites in Sonora contain deep sequences of intact late-Quaternary deposits and have yielded a plethora of Paleoamerican archaeological materials. Ongoing interdisciplinary investigations promise to yield important information about Paleoamerican adaptations and changing environments in Sonora during the terminal Pleistocene and early Holocene.

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First Fossil Records of Characiformes (Boga Fish) in Uruguay: Evidence Recovered from Pay Paso Site, Locality 1, a Paleoamerican Site in South America

Rafael Suárez and Andrés Rinderknecht

Nine early archaeological and paleontological localities have been identified at the Pay Paso site, located on the left bank of the Cuareim River in northwestern Uruguay. Pay Paso locality 1 is a Paleoamerican multicomponent site with three early human occupations dated to ca. 11,000–10,600, 10,200 and 9600 RCYBP (Suárez 2007).

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Specimens of late-Pleistocene fauna are scarce in early archaeological sites in Uruguay; the first discovery was made during archaeological excavations at the Pay Paso site by the lead author (Suárez 2003b:114). During these excavations, we discovered remains of a juvenile giant Cingulate (*Glyptodon* sp., armadillo-like) associated with lithic blades, bifaces, flakes, projectile points, and other tools in an archaeological component dated to late-Paleoindian times in the early Holocene, ca. 9600–9100 RCYBP (Suárez 2003a). Between January and March 2006, we excavated a new block-area of 56 m^2 in Pay Paso locality 1, where we recovered fish remains. Based directly on their ^{14}C dates (Suárez 2007) and stratigraphic position, the remains have an age of terminal Pleistocene, ca. 10,600 RCYBP. Fish discoveries have not been reported previously for archaeological or paleontological sites dating to this period in Uruguay.

The fish identification has been carried out through dental specimens. We recovered 141 acrodont buccal teeth of which only the enamel has been conserved; of these, 73 were complete and 68 were half or quarter fragments and small parts. The teeth have a low cross section and are oval-rectangular in form. The surfaces are lightly depressed, wide, and flat; some of them have two crests. The particular morphology of the teeth, their relatively large size, and comparisons with actual teeth specimens classifies them as *Leporinus* genus, boga fish (Figure 1). This genus includes some of the largest members in the Characiformes order, with species as much as 0.80 m in length (Cordiviola and Pignalberi 1985) and weighing 8–10 kg at most (O. Chamorro, pers. comm. 2006). These fish are freshwater herbivores (fruits and seeds) and insectivores (mainly ants) and are broadly distributed in South America. Some species are prized because of the quality of their meat (Nelson 1994).

Figure 1. Tooth-enamel specimens of boga fish (*Leporinus* sp.) recovered from excavation 1 at Pay Paso locality 1 during 2006 archaeological excavations.

The specimens presented here are the first fossil discoveries of the Characiformes order from Uruguay.

Complex site formation processes were conditioned by the fluvial dynamics of the Cuareim River. The stratigraphy indicates a sandy-slime-loam wavy sequence for the late Pleistocene and early Holocene. The sandy units containing archaeological material are separated by loamy strata that do not contain any archaeological material. The records of *Leporinus* are associated with archaeological lithic material and earliest human occupations.

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Cerro El Sombrero, Argentina: Fractured Stones on a Flat Hilltop

Celeste Weitzel and Nora Flegenheimer

Cerro El Sombrero Cima, a 12,000-m^2 hilltop site in a quartzite outcrop in the Argentine Pampas, stands out as a unique site among other early Pampean sites owing to its dimensions and the large lithic collection recovered from stratigraphic excavations and its surface. The assemblage includes a variety of tool types, among which the most diagnostic are fishtail projectile points (Flegenheimer 1995). At this hilltop site, which must have served as an important panoramic viewpoint, the final stages of the lithic manufacturing process were completed: Point preforms and broken tools as well as associated

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small debitage were abandoned. Therefore the hilltop has been interpreted as a retooling site owing to its high breakage index (Flegenheimer 1994). This interpretation is confirmed by abundant evidence of knapping errors, for example, perverse fractures (Crabtree 1972), and use-related fractures on a high proportion of projectile-point stems.

We here report on a current project dedicated to analyzing causes of fractures of lithic artifacts recovered at the site. Possible causes taken into account include post-depositional processes such as trampling, as well as activities affecting artifacts during their manufacture and use life. The latter include breakage caused by manufacture mistakes, use-related fractures, and intentional breaking (Crabtree 1972; Deller and Ellis 2001; Frison and Bradley 1980; Johnson 1979; Lintz and Dockal 2002).

Most of the toolstone is Sierras Bayas Group orthoquartzite brought from a locality about 50 km west of the site (Flegenheimer 2003). Since breakage patterns on this specific raw material are not yet well known, an experiment to identify intentional fractures on the site toolstone was recently conducted by Weitzel and Colombo (2006), and trampling experiments are underway. During experimentation it became clear that orthoquartzites are durable rocks and not easily broken.

The lithic assemblage from Cerro El Sombrero consists of 1,631 flaked tools. All types of fractures mentioned above have been found on these specimens. However, the breakage index is particularly high, with 93 percent of the studied flaked-tool assemblage being fractured (Weitzel and Colombo 2006), and we still have not identified all the causes that account for the entire broken sample. We assume that if post-depositional processes such as trampling were involved, these would be more noticeable in the surface remains. Hence, in order to assess the possible impact of post-depositional processes we here compare the fracture percentage differences between the surface and excavated assemblages.

The surface sample was found scattered on the 12,000-m^2 flat hilltop surface. This area is a quartzitic outcrop partly covered by sediments and vegetation; artifacts are found on both the rock and vegetated ground surfaces. In this assemblage, 810 (95 percent) of a total of 849 tools exhibit different types of fractures. These artifacts show various signs of weathering: They usually have rounded edges and are covered with lichens and oxide stains (Flegenheimer 2003).

The excavated assemblage was recovered from test pits distributed along the hilltop, which comprise a total area of 37 m^2. In this sample, 717 of a total of 782 tools are fractured (92 percent of the assemblage). Among these buried remains, cases of refitted pieces are very infrequent, suggesting that many tools arrived at the site as previously fractured specimens. Also, they are free of lichens and stains and exhibit microscopic use-wear traces, meaning they did not suffer long exposure on the surface (Flegenheimer 2003). According to Hiscock (1985), if artifacts are only exposed for a short time, post-depositional breakage should not be frequent.

Although the difference in the fracture percentages appears to be small, it is statistically significant. The Difference between Two Proportions test (z = 3.25; two tails $p < .025$) resulted in a significant difference; and results of a Chi-square test of independence ($X^2 = 9.4$; $df = 1$; $p < .05$) show that the broken or complete state of tools is related to their provenience (surface or excavation). We therefore conclude that post-depositional processes may account for this variation between assemblages. Since the hilltop has not suffered any recent important anthropic modification, these processes could include weathering and trampling.

At this time we cannot account for the processes involved in the production of most of the fractures in the site, but exhaustive analysis of these samples has only recently started. These processes are probably related on the one hand to choices concerning the manufacture, use, and discarding of tools among these early hunter-gatherers, and on the other to the choice of this landmark as a place where specific activities were performed and worn-out tools were discarded.

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Archaeology: North America

Two Great Basin Crescents in the Steve Caligore Collection from Southeastern Wyoming

Daniel S. Amick

Chipped-stone crescents are typically associated with terminal-Pleistocene assemblages from the Great Basin (Beck and Jones 1997:206-208; Carlson 1983; Justice 2002:116-125). Commonly reported from pluvial lake margins, concentrations are known from the Black Rock Desert (Amick 1995, 1999; Clewlow 1968; Mitchell et al. 1977), Long Valley (Hutchinson 1988; Tadlock 1966), Big Smoky Valley (Pendleton 1979), south-central Oregon (Butler 1970; Fagan 1988), Mojave Desert (Campbell et al. 1937; Davis 1975, 1978; Rogers 1939, 1966), and Tulare Basin (Riddell and Olsen 1969; Wallace and Riddell 1988). Crescents come from buried contexts at Lind Coulee (Daugherty 1956:247–49), Borax Lake (Harrington 1948:93-97; Meighan and Haynes 1970), Fort Rock Basin (Bedwell 1970; Cressman et al. 1936, 1940), and Danger Cave (Jennings 1957: Figure 156).

Crescents are rarely found east of the Great Basin. Exceptions include two from Pleistocene Lake San Agustin in New Mexico (Carlson 1983: Figure 6.5), one in the Fenn Clovis Cache (Frison 1991: Figure 2.13; Frison and Bradley: Plate 22), and another from northeast Colorado (Steve Holen, pers. comm. 2006). Frison (1991:44) suggests the Fenn crescent, made of Green River chert, is "strongly suggestive of a western contact since these are hitherto unknown from Clovis sites in the Plains-Rocky Mountain area."

Assigning crescents to any specific techno-complex is difficult because most associations occur as palimpsests, but crescents often co-occur with Black Rock Concave Base, Great Basin Stemmed, and Western Fluted or Clovis projectile points (for type descriptions see Clewlow 1968:13–14; Justice 2002; Pendleton 1979:61–69). Crescents range in age from 11,000–7000 RCYBP, but the most secure estimates are 11,000–10,000 RCYBP (Beck and Jones 1997; Justice 2002:119-121; Jones and Beck 1999).

The crescents in the Steve Caligore collection (Figure 1) were reportedly found in 1965 in a road-cut between Guernsey and Hartville, Wyoming. A Clovis point was also found nearby. Henry Irwin, who was excavating the

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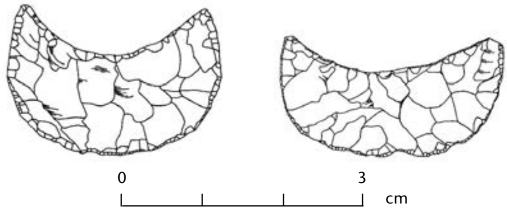
Figure 1. Diminutive crescents in the Steve Caligore collection from Platte County, Wyoming. Left: translucent milky chalcedony, right: mottled red chert (note use damage on right tip). Both are abraded on their back (convex) margins.



nearby Hell Gap site (Frison 1991:23, 50; Irwin-Williams et al. 1973), made notes and photos of the findspot (now covered with housing). Casts are curated at the Frison Institute in Laramie, Wyoming (color photos of the original artifacts can be seen at http://lithiccastinglab.com/gallery-pages/2003junecrescentspage1.htm). One crescent is made of translucent milky chalcedony and lacks use damage (total length 26.3 mm, body width 12.9 mm, maximum width 17.3, maximum thickness 3.7 mm). The second is made of red chert and has damage on one tip (total length 28.1 mm, body width 10.0 mm, maximum width 14.8, maximum thickness 2.8 mm). Both have plano-convex cross sections suggesting manufacture from flakes. These crescents are small compared with the Fenn crescent (total length 60.0 mm, body width 21.5 mm, maximum thickness 6.5 mm) and averages of 424 lunate crescents from the Great Basin (total length 49.7 mm, body width 17.4 mm, maximum width 20.8, maximum thickness 5.6 mm). Although the Caligore crescents are not outside the size range of Great Basin crescents, they are more than two standard deviations below the mean size of this population. The primary significance of the Caligore crescents is their location on the northern High Plains about 850 km east of Lake Bonneville and their possible association with a Clovis point. This find may lend additional support to notions of possible interactions between Clovis and early Great Basin populations.

Special thanks to Dr. Frison for bringing this interesting collection to my attention during a research fellowship at the George C. Frison Institute in December 2003. Thanks also to those who provided comparative collections for this study, including the Nevada State Museum, the Northeastern Nevada State Museum, M. Dick, L. Hoss, R. Mudge, J. Peterson, K. Taber, J. Taylor, and most especially S. Wallmann, who helped document and track down many of these now widely dispersed Great Basin crescents.

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A Buried Early-Holocene Shell Midden on the South-Central Coast of San Miguel Island, California

Todd J. Braje, Jon M. Erlandson, and Tracy Garcia

Over the last decade, systematic survey and ^{14}C dating of San Miguel Island archaeological sites by University of Oregon archaeologists have produced an amazing record of early-Holocene shell middens and lithic scatters. At least 20 sites on San Miguel have shell middens dated between about 11,000 and 7500 CALYBP, with at least four more sites containing diagnostic early-Holocene chipped-stone bifaces including crescents or Channel Islands Barbed points (Braje 2007; Braje and Erlandson 2006; Braje et al. 2004, 2005; Erlandson and Braje 2007, n.d.; Rick et al. 2005). Most of these sites have been identified by focusing reconnaissance on the Simonton paleosol (Johnson 1972), a dark soil and stratigraphic marker dating between about 17,000 and 7500 RCYBP. The majority of early-Holocene sites have been identified on the northwest coast of the island where reliable, freshwater springs probably drew people to inland locations. Recently, however, several early-Holocene sites have been identified on the south-central coast, clustered near the base of the steep southern escarpment where seasonal freshwater and protection from strong northwesterly winds can be found.

The largest and most extensively investigated of these sites is CA-SMI-608, a ca. 9500 RCYBP shell midden and lithic scatter (Figure 1). Excavations and surface collections at this locality by Braje and Erlandson have yielded a

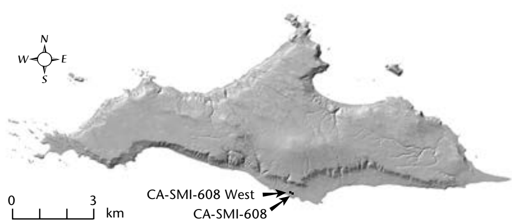

Figure 1. Map of San Miguel Island, showing locations of sites mentioned in text.

diverse array of shellfish and fish remains, nearly 150 chipped-stone artifacts, bone gorge fishhook fragments and production debris, and eight purple olive snail (*Olivella biplicata*) beads (Erlandson et al. 2005). Erosion in the vicinity caused by de-vegetation and overgrazing during the historic period recently exposed a western midden locus (CA-SMI-608W) situated in a gully about 50 m west of the main site area. Two discrete shell midden exposures have been identified at this locality, an exposed low-density midden and a denser buried

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component that is just beginning to be exposed by erosion in the arroyo floor.

Well-preserved marine shells were collected from in situ soils in both midden exposures, a black abalone (*Haliotis cracherodii*) shell fragment from the low-density midden and a whole California mussel (*Mytilus californianus*) shell from the buried midden. These samples were submitted to the NOSAMS facility at Woods Hole for AMS ^{14}C dating and yielded 1-σ calibrated age ranges of 9870–9640 (9270 ± 50 RCYBP, OS-48348) and 8710–8540 (8370 ± 45 RCYBP, OS-56598) CALYBP, respectively. These dates suggest that early-Holocene islanders may have revisited this location over at least a millennium and that CA-SMI-608W may also contain a substantial record of subsistence, technologies, and paleoecology. Preliminary analysis of a midden sample from the buried locus at CA-SMI-608W suggests that rocky shore shellfish dominate the site constituents, especially the remains of large mussels and black abalones. We will continue to monitor erosional exposures in the area and hope to conduct larger scale subsurface excavations in the years to come.

The identification of yet another early-Holocene shell midden on San Miguel adds to the evidence for a substantial settlement of California's Northern Channel Islands by early maritime peoples. Because rising postglacial sea levels have submerged terminal-Pleistocene and early-Holocene paleoshorelines and coastal lowlands on the islands, moreover, the 25 early sites documented on San Miguel so far may represent just a fraction of the paleocoastal settlements that once existed. Ultimately, further research at the buried and well-preserved component at CA-SMI-608W may help us better understand the nature of these early Channel Islanders and their interactions with island environments.

Our research has been supported by Channel Islands National Park, the National Science Foundation, the Marine Conservation Biology Institute, Western National Parks and Monuments, the University of Oregon, and a Mellon Mays Undergraduate Fellowship (Garcia). We thank Ann Huston, Kelly Minas, Robert DeLong, and Ian Williams for their support of our research on San Miguel Island.

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Three Rediscovered Clovis Points from the Field Museum Collections

Scott J. Demel

While helping select projectile points for the new Ancient Americas Exhibition at the Field Museum, the author rediscovered three previously unrecorded Clovis points among the archaeological collections. The acquisition history of these specimens is equally interesting as collections were purchased, sold, and traded often in the late 19th and early 20th centuries. The Clovis points provide an example of three such acquisitions during George A. Dorsey's tenure as Curator of Anthropology (1897–1914).

The Clovis point from Wisconsin is one of 26 "spear points" listed in accession file No. 97. It was manufactured from a mottled gray/cream-colored chert with fossil inclusions, likely Galena or Prairie du Chien chert (No. 52879-14). Although neither the Department of Anthropology accession file nor the database confirms the origin of these lithics collected by the Wyman brothers, they are housed in boxes labeled "Vernon Co., Wisconsin." Also, "Lake Ripley" and "1883" are written on one of the bifaces. Lake Ripley in Jefferson County is in south-central Wisconsin, whereas Vernon County is west along the Mississippi River. Many of the lithics have iron streaks indicating that they were probably collected from a plowed field. Six tools are made of the same chert as the Clovis point and appear to be Paleoindian in age. The collection was exhibited at the 1893 World Columbian Exposition in Chicago and purchased in the same year; in 1901 a portion was sent to Liverpool, England.

The second Clovis point (No. 54231) was rediscovered in a collection of 300 "chipped flint" objects found by Miss Maggie Skinner of Kalida, Ohio. In accession file No. 601 it is described as a "stemless chipped flint—edges parallel and straight . . . base concave . . . " It is of a gray/brown banded, mottled type of chert similar to Plum Run or Flint Ridge cherts.

W. Mills [Department of Anthropology, Ohio State University] wrote Dorsey stating that "Dr. Orton was satisfied that the Skinner collection was a local collection made, with few exceptions, in Putnam County along the valley of Sugar Creek." The 1899 sale account describes the objects as "prehistoric relics of stone, flint, etc., from graves, village sites, surface . . . " Portions were shown at

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the 1904 Louisiana Purchase Exposition. Several items were later sold to M. G. Chandler of Flint, Michigan (1936), and a group from the museum's "sales room" was sold to Paul Warner of Chicago (1938). Some objects were traded to H. E. Bouwknegt of Grandville, Michigan, for trade silver (1943). As seen in the accession and de-accession files, it was a fairly common practice to dispose of "damaged or broken specimens without numbers."

After the 1904 Louisiana Purchase Exposition, the Field Columbian Museum was inspired to amass artifacts for display (Haskin et al. 2003:67). Collectors regularly made offers to the museum, and purchases were common. The Wyman brothers in Chicago, once friendly acquaintances of the museum, later became bitter antagonists as collections they offered were rejected or payments due to them were delayed.

Like others, Walter C. and E. F. Wyman had their own motivations for selling collections (Wyman 1905). They were in the "coal and coke" business and collected throughout the Midwest, hunting for artifacts in agricultural fields as well as digging and looting graves. Collections were sold to support their tight-for-cash business enterprises. Most often, provenience went unrecorded; other times, excellent information and maps were included.

The Clovis point from Georgia (No. 205080-6) is one of 53 "chert projectiles" listed in the database from the Big Kiokee Creek Site, Columbia County, Georgia. Accession file No. 923 indicates that this is part of an archaeological collection purchased in 1905 by Dorsey from the U.S. National Museum in Washington D.C. and sent by Dr. Roland Steiner of Grovetown, Georgia. Steiner noted that 10 boxes of prehistoric objects were deposited in the National Museum, and "all the objects were collected within an area of five miles of . . . [the site]". A map in the accession file shows that portions of the collection are from "village sites" and "shell heaps" along Big Kiokee Creek in Columbia, Darke, and Greenville Counties. This Clovis point is made of black chert, similar in texture to rhyolite.

It is clear that the Field Museum archaeological collections still hold many secrets that are waiting to be rediscovered. The efforts of many early collectors can still yield data that are useful to researchers. Statistical data are available upon request.

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Clovis Biface Lithic Technology at the Gault Site (41BL323), Bell County, Texas

William A. Dickens

The recent analysis of 55 bifaces recovered from the Clovis layers at the Gault site in central Texas has revealed a number of insights into Clovis lithic technology (Dickens 2005). The lithics were recovered by Texas A&M University during two field seasons from a portion of the Gault site known as the "Lindsey Pit."

The bifaces were manufactured from either fine-grained blocky or brick-like tabular pieces of chert. The thick "squared" nature of the sides on many of these tabs required special techniques to reduce them into usable thin preforms. To accomplish this, a variety of overface flaking and blading techniques were employed.

One of the more recognizable techniques associated with Clovis biface manufacture is the use of overshot flaking (Bradley 1982; Ferring 2001; Frison and Bradley 1999; Sanders 1990). So much has been written on this technique in recent years that it has become an established part of Clovis reduction. But was it? The presence of so many overshot flakes on Clovis sites does tend to support that idea. However, the analysis of the Gault bifaces and overshot flakes has shed some new light on their intended use. Two distinct forms of overshot flakes were recognized. Owing to the thick vertical nature of the raw material's edges, some flakes terminated over the opposite edge retaining part of the vertical edge without plunging completely onto the opposite face. These flakes are the *partial overshot* type. The *full overshot* type is the more traditional form, where termination plunged onto the opposite face removing portions of both dorsal and ventral surfaces.

The use of partial overshot flakes was restricted to the early stages of reduction where they aided in angling the tabular surface toward the opposite surface in a rapid manner without removing too much width. Each successive removal followed the previous plunging angle near the edge, further increasing the angle toward the opposite face. The partial type continued in use until the vertical square edges began to come together.

Once the middle stages were formed and the dorsal and ventral faces approached each other, the full overshot type became prevalent. It is at this point that their intentional production becomes problematic. Many Clovis bifaces exhibit large overface flake scars that, if they approach the opposite margin, are usually identified as an overshot flake scar. While some are overshot scars, many have had their opposite margin flaked back, effectively removing any evidence for the type of termination that occurred.

Most of the Gault site full overshots appear to represent unintentional removals. Using complete flake length, I calculated the amount of ventral

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edge loss, or the width of the ventral surface removed with each flake. I found that edge loss ranged between 6 percent and 56 percent, with an average of 27 percent per removal. Using biface width computed from the overshots, and comparing them with the complete widths of recovered middle stage bifaces, I determined that only one or two such removals could be accomplished before biface width became too narrow for continued reduction. Thus it appears that most were unintentional and that the flaking was intended to terminate somewhere near the edge rather than plunge over it. Small edge removals, up to 10–12 percent, were acceptable throughout reduction, but owing to the force required to remove large flakes completely across the surface and the proper support and angle of blow required, it is difficult to completely control every termination.

Blade production is also prevalent on many Clovis sites (Collins 1999), and the use of this technology was also applied in biface reduction. The square edges, along both the lateral margins and ends of tabs, were removed in long blades and blade-like flakes; this operation was performed in conjunction with the overface removals. As a biface was formed and became thinner, blade-like flakes were removed over the entire surface from either end of the biface, a technique known as *end thinning*. This strategy was necessary because intended overface flaking was often unsuccessful; terminations occurred randomly on the biface surface, forming hinges, stacks, and high spots, all of which had to be removed.

End thinning decreased in the later stages, with the possible last end thinning removal being the final flute removal. This suggests that fluting may have evolved from blading and end thinning techniques as part of the overall reduction and manufacturing process developed by Clovis, not as a separate technology that developed in situ or through diffusion from another culture.

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New Obsidian Hydration Findings Suggest the Use of Split-Stem Points by Great Basin Paleoindians

Daron Duke, Tim Carpenter, and David Page

Results of a large obsidian hydration study in western Utah are providing much-needed clarification of Paleoindian point typology in the Great Basin. The points of the Western Stemmed Tradition (WST) consist of several types diagnostic of this period, but their relationship with split-stem types, often referred to as "Pinto," has been debated (e.g., Basgall and Hall 2000; Thomas 1981; Vaughan and Warren 1987). Our hydration readings indicate that Pinto is part of the same technology as stemmed points in late-Paleoindian contexts.

This hydration study represents the largest to date on early Great Basin points and benefits from a unique approach to weathered artifacts. Step fractures extending into the artifacts from their exposed surfaces were targeted. This eliminates degradation of the hydration rim through sandblasting as a source of error. Step fractures provided readings at a 70-percent success rate and are the only reading types included in the dataset described below.

Our sample of stemmed and Pinto points is taken from a copious surface record on the mudflats of the Great Salt Lake Desert, with later points mostly from Holocene dunes. These flats are barren now, but a vast wetland once existed on the southern margin of early-Holocene Lake Bonneville and along the distal delta of an extinct drainage system. A date range of 10,000 to 8500 RCYBP is estimated for primary occupation based on partial inundation of the area by Lake Bonneville (Oviatt et al. 2005) and a series of radiocarbon dates on marsh sediments ending at 8590 ± 80 RCYBP on late paleochannels (Young et al. 2006). People abandoned the area when the wetlands disappeared, leaving a record markedly devoid of later materials.

A total of 559 items were examined, 401 of which are early types (n = 323, WST; n = 78, Pinto). Figure 1 is restricted to Topaz Mountain obsidian, from which almost 60 percent of the points are made. This graph shows box plots of hydration rind measurements, given in microns, by major projectile point type. Only results within two standard deviations of the mean were used. The results show a clear trajectory from early to late types, with Pinto falling neatly alongside the stemmed series at roughly 9.0 microns. Notched dart points of the Elko series are next to arrive, followed by Rosegate series arrow points, and finally arrow points of the Desert series, which were used into recent history.

These findings demonstrate the co-occurrence of Pinto and stemmed points that has been inferred elsewhere in the Great Basin (Amsden 1935; Harrington 1957; Warren 1980). We cannot say, however, whether Pinto is a

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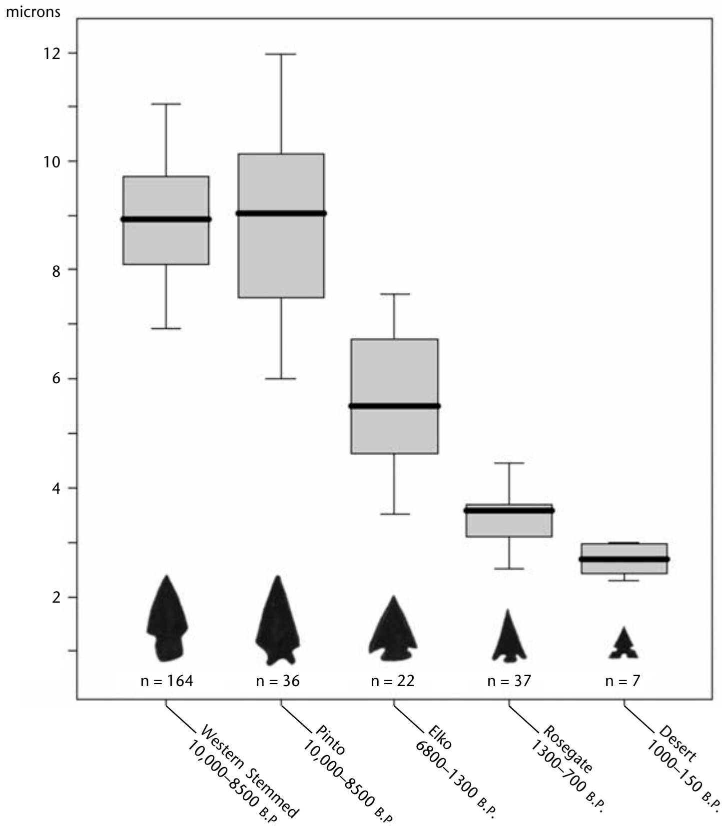

Figure 1. Hydration analysis results within two standard deviations of the mean for Bonneville Basin point types made from Topaz Mountain obsidian.

component of the earliest Paleoindian toolkits. Work continues toward increasing our sample and finding functional reasons for the concurrent usage of these two distinct morphological types.

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The Little John Site (KdVo-6), a Late-Glacial Multi-Component (Nenana–Denali Complex) Site in the Far Southwest of Yukon Territory, Canada

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Located just off the Alaska Highway, approximately 2 km due east of the International Boundary, the Little John site occupies a knoll overlooking Mirror Creek, the easternmost tributary of the Tanana River basin. Unglaciated during the Wisconsin (Rampton 1971), this site contains evidence of occupation from the recent past back to the late Glacial. In this paper we focus on the Nenana- and Denali-complex (Hoffecker et al. 1993; Powers and Hoffecker 1989; West 1996) components of the site (see also Easton and MacKay 2008).

The Nenana assemblage contains four teardrop-shaped Chindadn points, large bifaces, a variety of scraper forms, and blades (Figure 1). Recovered from the basal loess layer in the shallow deposits (ca. 30–40 cm) of the western area of the site, this component underlies a microblade-bearing horizon assigned to the Denali complex, consisting of abundant microblades, several core tablets, irregular core fragments, scrapers, and burins. This area of the site is undated owing to a lack of organic material, but the stratigraphic relationship of these assemblages indicates that they represent distinct techno-complexes.

The eastern portion of the site contains a paleosol complex capped by 40–60 cm of loess and 30–40 cm of brunisol strata. These paleosols contain a diverse

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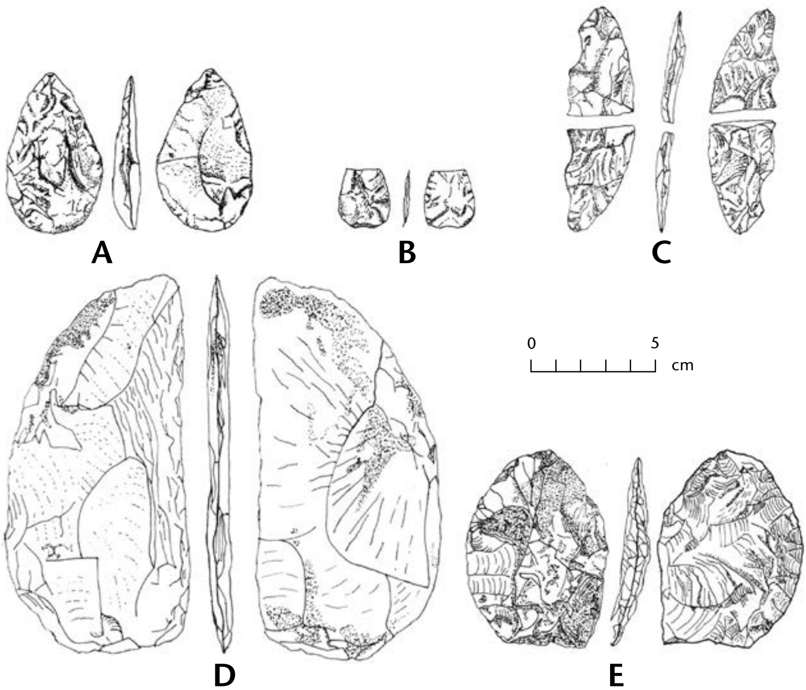

Figure 1. Selected artifacts from the Little John site. **A, B, D, E,** Nenana complex; **C,** Denali complex; **A, B,** Chindadn points; **C,** foliate biface; **D, E,** large bifaces.

assemblage of culturally modified fauna; AMS assays on three samples yielded dates of 8890 ± 50 (Beta 182798), 9530 ± 40 (Beta 217279) and 9550 ± 50 RCYBP (Beta 218235). Two biconvex bifacial knives, characteristic of Denali assemblages in interior Alaska (West 1967), a proximal microblade fragment, flakes, and two chisel-like bone tools were found directly associated with the dated fauna. Since the context is consistent with the stratigraphic relationship of the Nenana and Denali components in the undated deposit of the site, we suggest that the Nenana assemblage predates the fauna and associated Denali-type artifacts in the paleosol complex and thus dates to at least 10,000 RCYBP; this date is in general accordance with similar Nenana complex components in interior Alaska (Bever 2006; Hoffecker et al. 1993; Holmes 2001).

Identified fauna from the palesol complex include caribou (*Rangifer tarandus),* possibly moose (*Alces alces*), elk or wapiti (*Cervus elaphus*), hare (*Lepus* sp.), swan (*Cygni* sp.) and other unidentified birds, rodents, and canines (Hutchinson et al. 2007). This diverse faunal assemblage indicates a broad-spectrum subsistence strategy, similar to other late-Glacial/early-Holocene sites in the Tanana Valley (Holmes 2001; Yesner and Pearson 2002). Pollen from a core sample from a lake called *Yihkah Männ'* (ca. 5 km from the site) indicates that the transition from herb tundra to shrub tundra occurred ca. 11,000 RCYBP, 500–1000 years later than in the Tanana Valley (MacIntosh

1997). Occupation of the Little John site may correspond with this transition (Bigelow and Powers 2001; Hoffecker and Elias 2007). A successive eastward movement of Nenana and Denali culture bearers adapted to the subsistence opportunities offered by the shrub tundra environment of the Tanana Valley may explain the appearance of these complexes in southwest Yukon.

The Little John site extends the range of the Nenana and Denali complexes to the far southeast edge of Beringia during the terminal Pleistocene.

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Early Maritime Technology on California's San Miguel Island: Arena Points from CA-SMI-575-NE

Jon M. Erlandson and Todd Braje

Located on an ancient dune ridge overlooking a huge pinniped rookery at Point Bennett, CA-SMI-575 is 1 km long and 200 m wide. The site contains many discrete occupation areas, including loci dated to the early, middle, and late Holocene. In the northeast site area, we recently identified a small shell midden with hundreds of California mussel (*Mytilus californianus*) shells embedded in the Simonton Soil, a stratigraphic marker dated to the terminal Pleistocene and Early Holocene (Erlandson et al. 2005a). The rapidly eroding shell midden at CA-SMI-575-NE is ca. 30 x 40 m wide, with a somewhat larger scatter of stone tools.

A test pit excavated in an intact site area produced over 3 kg of well-preserved marine shell. A large mussel from the 5- to 10-cm-thick midden dated to 8190 ± 80 RCYBP (Beta-216733), with a calibrated age range of 8600-8270 CALYBP. No bones or diagnostic artifacts were found in our test pit, but five fragments of small, stemmed, and barbed points were found on the surface in the immediate area (Figure 1). Similar points—which we call "Puntas Arenas" (Arena points) or Channel Islands Barbed points—have been

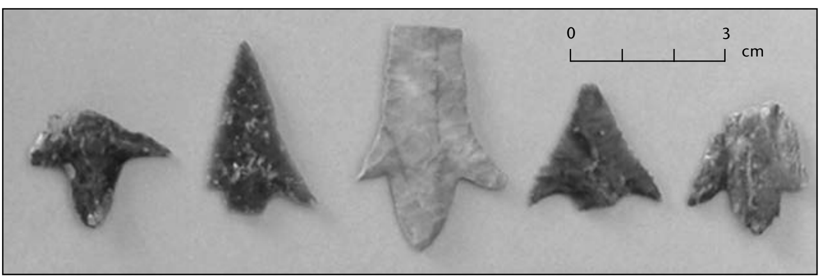

Figure 1. Punta Arena (Arena point) fragments from CA-SMI-575-NE (scale in cm; photo by J. Erlandson).

identified from the Northern Channel Islands, where they are now thought to date to ca. 9500–8000 CALYBP. Glassow (2006) recovered three specimens from the basal levels of CA-SCRI-109 at Punta Arena on Santa Cruz Island, dated to ca. 8400 CALYBP. Rozaire (1978) illustrated another from Daisy Cave, but its antiquity and significance were only recognized after Glassow's discovery. Another Arena point was recovered from CA-SMI-608, a shell midden on San Miguel Island's south coast dated to ca. 9600–8600 CALYBP (Erlandson et al. 2005b).

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Faunal data from most early Channel Island sites suggest that shellfish provided most of the meat eaten by early islanders. This is also true of CA-SMI-575-NE, but the finely made points recovered indicate a more diversified subsistence. Erlandson et al. (2005c) argue that Native Americans sharply reduced Channel Island sea otter populations by 8000–7500 CALYBP, and the relatively delicate Arena points from CA-SMI-575-NE may have been used to hunt otters. Whatever their use, Arena points represent a significant addition to early maritime technologies on California's Channel Islands.

Mike Glassow first brought the antiquity of Arena points to our attention, and Brendan Culleton and Bob DeLong participated in the fieldwork at CA-SMI-575. Our research was supported by Channel Islands National Park, Western National Parks Association, and the University of Oregon.

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A Continental-scale Perspective on the Peopling of the Americas: Modeling Geographic Distributions and Ecological Niches of Pleistocene Populations

J. Christopher Gillam, David G. Anderson, and A. Townsend Peterson

A recent innovation in predictive modeling, eco-cultural niche modeling (ECNM), is now being applied to explore population distributions and ecologi-

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cal niches of early hunter-gatherers (Anderson et al. 2005; Banks et al. 2006; Gillam and Tabarev 2006). This approach, originally developed for predictive modeling of plant and animal species distributions, has had great success in application to biological sciences (Soberón and Peterson 2004). In focusing on estimating ecological niches of species, this approach reconstructs key aspects of their distributional biology and ecology, and thus shows excellent predictivity in understanding their geographic distributions.

Preliminary analyses across East Asia and Siberia, Europe, and North America have been developed to explore the potential of ECNM for understanding Middle and Upper Paleolithic human population distributions in the Old World and those of Paleoindians in North America (Anderson et al. 2005; Banks et al. 2006; Gillam and Tabarev 2006). Initial analyses of over 1,500 Paleoindian fluted-point locations from the Paleoindian Database of the Americas (PIDBA; Anderson et al. 2006) illustrate the likely distributions of early populations in North America (Figure 1A). Projection of the North American Paleoindian niche model to East Asia and Siberia shows the possible parallel climatic and environmental locations for the cultural origins of the Paleoindians (Figure 1B). The darkest gray shading in the figures indicates areas of highest modeled probability for presence of human populations.

Although these analyses are exploratory at this stage, the patterns support the hypothesis that the earliest cultures of North America came from the southern latitudes of the Far East, rather than from the more northern latitudes of inland Siberia (Birdsell 1951). Eastern China, the Korean Peninsula, the Maritime region of the Russian Far East, Sakhalin Island, and the Japanese Archipelago look particularly promising as parallel climatic and environmental source regions and warrant further investigation; these regions are also logical choices for development of coastal adaptations and subsequent coastal migration into North America. Our results may also support the hypothesis that microblade occurrences in Alaska and Canada, which commonly post-date Clovis occurrences in the lower 48 states of the U.S. (Dumond 2001), could reflect a second migration from Siberia soon after the hypothesized coastal migration from the southern latitudes of the Far East (Birdsell 1951), perhaps as little as 1000–2000 calendar years later.

To clarify, the models presented here are based not upon comparisons of lithic technology, but rather on exploited ecological niches as manifested by geographic occurrences. The "Clovis"-based North American model projected onto Asia does not suggest where antecedents of Clovis technology are, but rather where antecedent human populations might have lived (i.e., under similar environmental conditions) prior to migration to the Americas (Birdsell 1951). We consider it unlikely that we can trace the origins of the first Americans through lithic technology, as many scholars have attempted, both over the decades and recently (Bradley and Stanford 2004; Brantingham et al. 2004; Collins 2005; Goebel 2004), but rather we need to focus on where parallel sets of conditions are manifested in coastal environments during the Pleistocene (Erlandson 2002). East Asia and the Japanese Archipelago, in particular, are the most likely cultural hearths when one also considers the

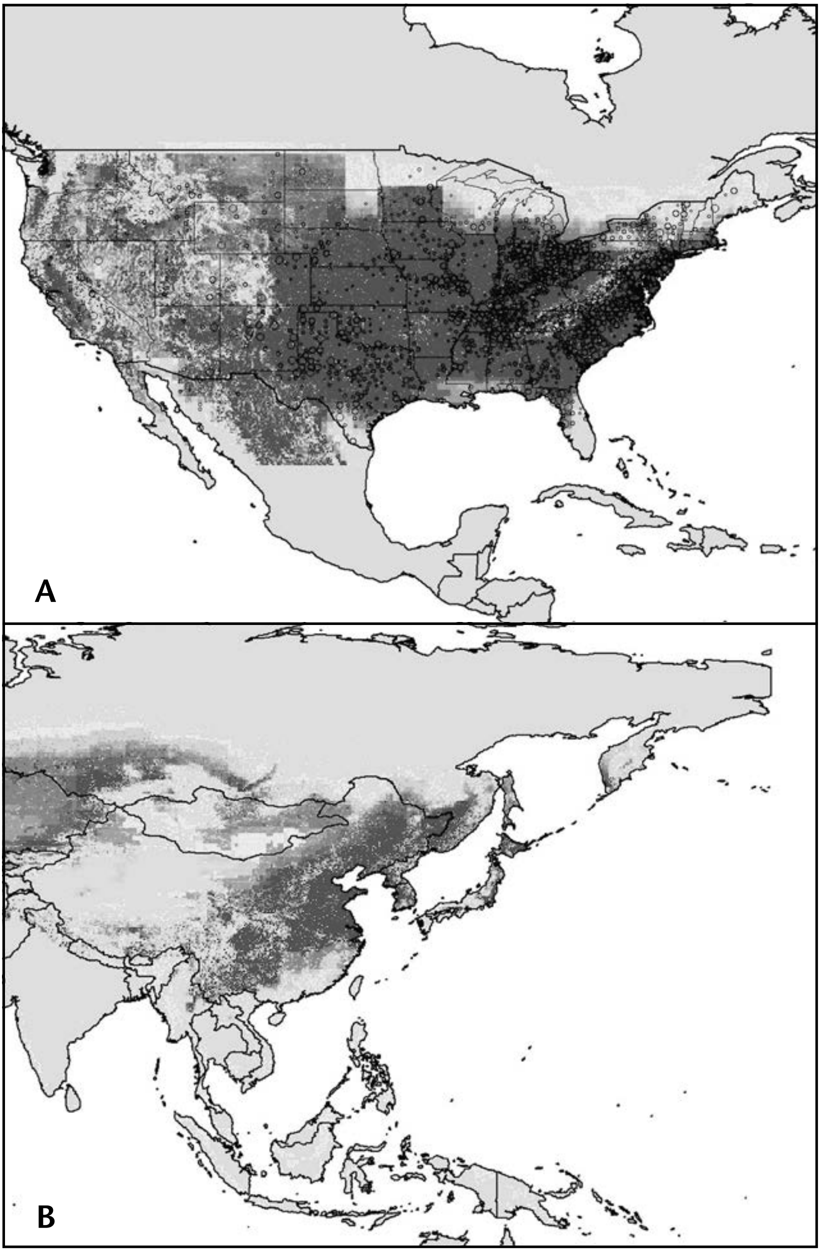

Figure 1. **A,** an ECNM-based predictive model highlights probable Paleoindian population distributions and exploited ecological niches in North America; **B,** the projection of the North American Paleoindian niche model onto contemporary conditions across Asia illustrates the possible ancestral population distributions of the "Clovis" Paleoindians.

flexibility that a fishing-hunting-gathering adaptation offers to a rapidly growing and migrating population in the northern Pacific setting. This is precisely what the archaeology of East Asia and the Russian Far East suggests is occurring, with increasingly sedentary populations, such as Incipient Jomon beginning around 16,000 CALYBP (Taniguchi 2006), pressuring more mobile coastal groups to shift their ranges northward during the terminal Pleistocene (Gillam and Tabarev 2006; Ikawa-Smith 2004; Kobayashi 2004). Our models are already in the process of being refined with finer-resolution paleoclimate data to define further the likely population distributions and ecological niches exploited by these early hunter-gatherers.

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New Dates from the Shawnee-Minisink Site, Pennsylvania

Joseph A. M. Gingerich and Michael R. Waters

Many ^{14}C assays for northeastern Paleoindian sites have large standard deviations or other problems that make precise dating of early occupations difficult (Bonnichsen and Will 1999; Carr and Adovasio 2002; Curran 1996, 1999:6; Fiedel 1999; Levine 1990). New excavations at Shawnee-Minisink, Pennsylvania, however, can contribute to the radiocarbon dataset for the Northeast by providing an accurate date for Clovis occupation in the region. This paper summarizes the radiocarbon dates for Shawnee-Minisink and presents the results of new AMS assays on probable food remains from a Paleoindian hearth.

Shawnee-Minisink represents one of the most intact Clovis assemblages in eastern North America. The loess deposit containing Paleoindian artifacts is protected by nearly 240 cm of alluvium deposited by the Delaware River. Artifacts and features recorded within this zone show little evidence of post-depositional disturbance. The Shawnee-Minisink site was discovered by Donald Kline in 1972. During his initial investigations of the site in 1972–73, Kline excavated a Paleoindian hearth that contained carbonized plant remains and fish bone (Kline 1985). Charcoal from this feature was dated to 10,590 ± 300 RCYBP (W-2994). Excavations led by American University from 1974–77 produced three more radiocarbon ages for the Paleoindian level that ranged from 9310 to 11,050 RCYBP (Table I). In recent years, a series of new dates have produced an extremely tight chronology for the Clovis-period occupation. In 1997, curated hawthorn seeds from Kline's original hearth were dated, producing ages nearly 400 years older than Kline's original sample (Dent 1999, 2002) (Table 1).

Over the past three years new excavations have been conducted at Shawnee-Minisink (Gingerich 2004, 2006). During this time a 40-m^2 area has been excavated, producing over 12,000 artifacts from the Paleoindian occupation.

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Table 1. Radiocarbon Ages for Shawnee-Minisink.

Lab Number	^{14}C Age	Sample
W-2994■	10590 ± 300	Kline's sample from 1973 excavations. Wood charcoal from hearth feature in association with Paleoindian artifacts and charred flora and faunal remains.
W-3134■	10750 ± 600	Wood charcoal from hearth exposed in NW portion of American's excavated area. In direct association with Paleoindian artifacts.
W-3388■	9310 ± 1000	Diluted sample of charcoal stained soil recovered from SE portion of original excavations.
W-3391■	11050 ± 1000	Alkali fraction of the charcoal stained soil from sample W-3388.
Beta-101935▼	10940 ± 90	Charred hawthorn seeds recovered from a hearth feature excavated by Kline. In direct association with Paleoindian artifacts. (Same context as same W-2994)
Beta-127162▼	10900 ± 40	Same context as sample Beta-101935.
Beta-203865	10820 ± 50	Charred hawthorn seeds recovered from hearth feature in Sq #2 of 2004 excavations. In direct association with Paleoindian endscrapers and debitage.
UCIAMS-24865	10915 ± 25	Same context as sample Beta-203865.
UCIAMS-24866	11020 ± 30	Same context as sample Beta-203865.

■From McNett et al. (1985) and Dent (2002:57); ▼from Dent (1999).

Excavated hearths from this level have provided a series of new dates that places the Clovis occupation near 11,000 RCYBP.

During our excavations in 2003–06, two hearths were identified in direct association with Paleoindian artifacts. Both these features were surface hearths consisting of dense lenses of charcoal surrounded by thermally altered sediment. Point-provenience artifact data showed a distinct clustering of activities around the hearths. To recover preserved floral and fauna remains, all features were collected for flotation. To date, analysis has been completed on one hearth feature. This hearth produced over 80 hawthorn seeds (C*ratageous* sp.), 5 hickory nut (C*arya* sp.) fragments, and 33 unidentified seeds (Lucinda McWeeney, pers. comm. 2006).

To confirm the age of archival hawthorn seeds presented by Dent (1999), three hawthorn seeds were AMS dated (Table 1). The first of these samples was processed by Beta Analytic and returned an assay of 10,820 ± 50 (Beta-203865) RCYBP, overlapping with the previous dates from the site at both the 1-σ and 2-σ calibration ranges.[1] Additional hawthorn seeds were pretreated by T. Stafford of Stafford Research Inc. and processed by the Keck-CCAMS Laboratory in Irvine, California. Dates of 10,915 ± 25 (UCIAMS- 24865) and 11,020 ± 30 (UCIAMS-24866) RCYBP were obtained from these samples. While there is some discrepancy between the 10,820 and 11,020 assays, both overlap at the 2-σ calibration. When the five dates are averaged using the protocol discussed by Long and Rippeteau (1974), the mean age for the Clovis occupation of Shawnee-Minisink is 10,935 ± 15 RCYBP.[2]

With the suite of new AMS dates, Shawnee-Minisink provides the most precise age estimate for Clovis in the Northeast. Currently, there are no Paleoindian sites north of Pennsylvania with reliable ages earlier than 10,700

[1] Calibration ranges obtained from OxCal v. 3.10 (Ramsey 2001, 2005)

[2] Two samples (Beta-203865 and UCIAMS-24866) failed a T-test of contemporaneity (Long and Rippeteau 1974:211). Each sample, however, can be considered contemporaneous with three other samples, forming two groups of dates (n = 4) that can be rigorously averaged. The mean ages for each group are 10,900 ± 20 and 10,947 ± 17, respectively.

RCYBP. Shawnee-Minisink, therefore, may represent one of the earliest human expansions into the region.

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Recent Research on the Interstate Park Bison Site, Polk County, Northwestern Wisconsin

Marlin F. Hawley, Matthew G. Hill, and Christopher C. Widga

The taphonomic history of the bison bonebed at Interstate Park is a long-standing, unresolved problem in Wisconsin archaeology. In the fall and early winter of 1936 and the summer of 1937, a copper pike and two chipped stone points were recovered in association with remains of *Bison occidentalis* (Cooper 1937; Kunsman 1937; Pond 1937). Unquestionably, it was an odd mix of material. With the discovery at Folsom, New Mexico, a decade earlier still fresh in the minds of archaeologists and vertebrate paleontologists, the scientific community was immediately skeptical (Blegen 1938; Howard 1937), and with good reason: Prior experience had demonstrated that such claims could not be taken at face value (Meltzer 2006).

Despite the assertion that the site was "possibly ten thousand or twelve thousand years old" (Pond 1937:51), thus ranking with Folsom in age, in the years to follow the site all but disappeared from the radar. Two decades later, it reappeared in a short article (Palmer 1954) highlighting the taxonomy of the bison and the age of the site in light of ^{14}C determinations from the Horner site (6619 ± 350, 7132 ± 350 RCYBP) (Griffin 1952) and the first ^{14}C dates for the Old Copper Complex (5600 ± 400, 7510 ± 340 RCYBP) (Ritzenthaler 1954). This development brought the bison and artifacts more in line with each other, and Palmer (1954:318-319) recommended additional work at the site to clarify the nature of the association.

Nobody followed Palmer's recommendation, and a report on the site and bison remains was never prepared. Despite this, the site has since been cited as a possible (Theler and Boszhardt 2003:66) or definite (Mason 1997:105) late-Paleoindian bison kill/butchery bonebed. Other researchers have simply noted that the artifacts were recovered either directly or possibly in association with the bison remains (West and Dallman 1980:32), or mention only the bison (Kuehn 1998:468). Regardless of whether the animals were killed by prehistoric hunters, in a natural catastrophe, or suffered attritional deaths, resolving the taphonomic history of the bonebed is a problem commanding attention. The site holds substantial implications for early- to mid-Holocene archaeology and paleoecology in the Upper Midwest. To this end, we highlight aspects of our recent research on the site.

The faunal collection totals ca. 1,300 specimens and includes the remains of at least 42 bison (*B. occidentalis*), 9 elk (*Cervus elaphus*), and a white-tailed deer

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(*Odocoileus virginianus*). Physical preservation is outstanding, with most cortical surfaces in pristine or near-pristine condition. Most remains are complete, unbroken specimens. Looking specifically at bison, the most pressing issue is how the animals died. Here tooth eruption/wear provides critical insight. Analysis of mandibular teeth from younger animals (Dental Age Groups 1–5), indicates the bison died during mid fall through mid winter. Although it is impossible to age the adult animals (and thus determine what time of the year they died), antemortem tooth loss or extreme occlusal wear indicates many of them are relatively old. This observation, coupled with the season-of-death, indicates that most, if not all, of the animals likely died naturally from starvation, an interpretation consistent with the fact that none of the remains display stone tool cutmarks or hammerstone impact fractures.

Bison skeletal representation provides another clue about the taphonomic history of the bonebed. Appendicular elements are relatively far more abundant than axial elements. Experimental and actualistic observations on hydrodynamic sorting (Aslan and Behrensmeyer 1996; Todd 2003) provide the basis for the inference that the excavated faunal assemblage is fundamentally a lag accumulation in which buoyant, slow-settling elements were winnowed from the site by fluvial processes prior to burial. The geoarchaeological setting of the site offers support for this interpretation.

The artifacts deserve brief mention. While the copper pike is extant, the two points, discovered 14 November 1936, apparently were stolen from the crated assemblage prior to being shipped to Madison in early 1938. Fortunately, a plan map, with horizontal and vertical provenience information, from the 1936 excavations leaves no question that the three artifacts were recovered in direct association with the bison remains. Less clear, however, is the temporal relationship between the bison and the artifacts.

Present indications are that the Old Copper Complex dates to ca. 6000–3000 RCYBP (Pleger 2001). Such an age range does imply a temporal overlap with *B. occidentalis*, which passed into extinction ca. 6000–5000 RCYBP (Frison et al. 1976). The same holds true for the missing points. Alonzo Pond photographed two points in the Logan Museum collections (Beloit, Wisconsin) that, in his view, most closely matched the missing specimens from Interstate Park. Based on this photograph, the missing points were small to medium-sized, side-notched forms; one had a bifurcate base, while the other was apparently convex. Temporally, these points are probably assignable to the early- or middle-Archaic tradition. Hopefully, results (pending) of five AMS ^{14}C assays on bison and elk bone from Interstate Park will clarify the temporal relationship between the bison and artifacts.

We have benefited from the input of a great many persons—too numerous to name them all. However, we would like to thank the staff of the Milwaukee Public Museum, Wisconsin Historical Society, and University of Wisconsin-Zoology Museum for access to the faunal assemblage, copper pike, and critical information on the 1936-7 excavations.

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Variability in Morphology and Raw Material Choices in Paleoamerican Projectile Points from Yucca Mountain, Nevada

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The Yucca Mountain (YM) region of southwest Nevada has an abundant Paleoamerican record that contains small to very large lithic assemblages.

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Associated with these assemblages are a variety of Paleoamerican projectile point styles. Morphological variability in these points sheds light on functional and raw material relationships that likely changed through time.

Different raw materials appear to have been chosen for specific Paleoamerican point styles at YM (Table 1). Of the known Clovis-like lanceolates, three are made from cryptocrystalline silicates (CCS) and one from obsidian. Long-stemmed Lake Mohave points (LS-LMO), including elongated bi-points, tend to be made from CCS or welded tuff. Short-stemmed Lake Mohave (SS-LMO), Silver Lake (SVL), and Pinto points all tend to be made from obsidian. These data support the inference that different raw materials were used for different stemmed point styles, even though previous research in the Great Basin indicates that stemmed points tend to be manufactured from obsidian (Amick 1993, 1995). While the use of obsidian at YM for smaller stemmed points may be related to package size (Hartwell et al. 1996), these same point styles could have been made just as easily from local CCS or welded tuff. Clovis-like lanceolates tend to be manufactured from CCS and obsidian throughout the Great Basin (Beck and Jones 1990), and the YM data reflect the same raw material choices. Variation in raw material suggests that substantially different behaviors or functions were associated with lanceolates and LS-LMO points, as opposed to SS-LMO, SVL, and Pinto points.

Table 1. Projectile point data from four Paleoamerican sites near Yucca Mountain (sites 26Ny2603, 26Ny3193, 26Ny7920 and 26Ny8187).

	Obsidian	Cryptocrystalline	Welded Tuff	Totals
Clovis-Like	◆	3		3
LS Lake Mohave	2	6	4	12
SS Lake Mohave	9	1		10
Silver Lake	8			8
Pinto	5			5
Indeterminate	10		2	12
Totals	34	10	6	50

LS long-stemmed; **SS** Short-Stemmed

◆ Only one other Clovis-like point has been found near YM. It was made from obsidian and obtained from a low-density dispersed artifact scatter (Hartwell and Varley 2004:30). All other lanceolates at YM have been found in dense artifact concentrations.

Variation in point morphology and toolstone selection may have changed over time. Beck and Jones (1997:196–197) summarized available morphological and chronological data and hypothesized that Clovis-like lanceolates appeared earlier than stemmed points, although these point types likely overlapped. Jennings also posited much the same chronological relationships, although elongated bi-points preceded shorter-stemmed point styles (1986:Fig. 3, 117). This chronological reconstruction makes sense, given the YM data. There are only four Clovis-like lanceolates known from the YM area, but there are 12 LS-LMO points. The most numerous projectile points, however, are SS-LMO and SVL styles (n = 18), followed by lower numbers of Pinto points (n = 5). If this particular chronological sequence is correct, then Paleoamerican sites at YM were most intensively occupied after the terminal Pleistocene and well into the early Holocene.

Morphological and material variability within point styles at YM has important implications for Great Basin prehistory. The selective manufacture of particular Paleoamerican points with specific raw materials is likely tied to significant changes in the use of weaponry, whether for hunting or processing activities. These technological changes may also be related to changes in overall Paleoamerican mobility patterns and subsistence strategies across the Pleistocene-Holocene boundary.

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Preliminary Evaluation of the Paleoamerican Occupation in the San Augustin Basin, Socorro and Catron Counties, New Mexico

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This paper presents some preliminary results of a multi-year project designed to understand the Paleoamerican occupation and paleoenvironmental history of the eastern portion of the San Augustin Basin (Holliday et al. 2006). The San Augustin Basin is a high-altitude grassland located in a structural basin in the Datil-Mogollon volcanic field, immediately southeast of the Colorado

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Plateau (Weber 1980, 1994). This work expands on prior research of the late-Quaternary landscape evolution and paleoenvironmental history of the San Augustin Basin (Bryan 1926; Clisby and Sears 1956; Foreman et al. 1959; McFadden et al. 1994; Markgraf et al. 1984; Powers 1939; Stearns 1956; Weber 1994) to develop more robust information on Paleoamerican land use and subsistence strategies.

Earlier Paleoamerican archaeological research in the project area included unsystematic pedestrian survey and limited excavations (Beckett 1980; Hurt and McKnight 1949), but recent work has been limited primarily to analysis of Folsom projectile points and preforms from privately owned artifact collections (Amick 1994, 1995, 2002; LeTourneau and Weber 2004). In this paper, we summarize results from two undertakings: (1) an inventory of the entire Paleoamerican artifact collection recovered from the Plains of San Augustin by Robert Weber, and (2) a systematic pedestrian survey of 965 acres in the eastern portion (White Lake and C-N Lake) of the basin.

Weber began collecting artifacts from the project area in late 1950s and made repeated (often annual or more frequent) visits to the eastern portion of the San Augustin Basin. He identified 75 archaeological and 20 paleontological localities. Each locality was mapped on a 7.5-minute quadrangle map; associated diagnostic surface artifacts were systematically collected, and each artifact was assigned a catalogue number associated with a specific find locality. Occasionally non-diagnostic artifacts were also recovered at these localities, although most were not assigned a catalogue number. Despite multiple visits to sites, the majority (81 percent; n = 61) of Weber's Paleoamerican localities consisted only of an isolated projectile point or small number of diagnostic artifacts. Just 14 (19 percent) localities produced evidence for multiple Paleoamerican artifacts, including diagnostic points, preforms, channel flakes, and other tools.

Our inventory of Weber's Paleoamerican artifact collection identified 87 projectile points and preforms, 23 scrapers, 5 gravers/drills, 3 bifaces, 25 channel flakes, and 67 flakes and flake tools. Various Paleoindian and later diagnostic projectile-point and preform types are represented in the assemblage, including Clovis (n = 13), Folsom (n = 30), Agate Basin/Hell Gap (n = 2), Plainview (n = 7), Cody/Scottsbluff (n = 22), Angostura (n = 1), and unidentified point fragments (n = 10). In addition, eight Archaic points (i.e., Augustin, Bajada, Bat Cave, Chiracahua, Jay, Pinto, San Jose, and San Pedro) and two unidentified non-Paleoamerican points were recovered.

The 2006 pedestrian survey consisted of 12 separate survey blocks. Seven survey areas (645 acres) were selected because they encompassed areas where Weber identified 10 Paleoamerican and 2 paleontological localities. The other five areas (320 acres) were chosen to sample areas containing no previous finds, especially areas around the highest shorelines. Surface artifacts, including Archaic and Formative-period remains, were associated with 6 of the 11 Weber find localities, but only 3 localities produced additional Paleoamerican diagnostics (a Cody point and several channel flakes). A newly identified site (ARF-16) included a possible Paleoamerican projectile-point fragment, and several scrapers and flake tools at this site might represent a kill/butchery locale. All other cultural remains identified during this survey likely related to Archaic (Early and Middle) and Formative-period occupations.

From the 2006 fieldwork in the San Augustin Basin we can draw several preliminary conclusions. First, most Paleoamerican remains in the San Augustin Basin are isolate finds, and the sites with multiple artifacts are multicomponent palimpsest deposits. Second, based on the number of either components or diagnostic artifacts, the most intensive Paleoamerican occupations date to the Folsom and Cody periods. Third, both limited-use (e.g., kill/butchery) and at least seasonal short-term residential localities (e.g., camps) are probably represented in the basin. Finally, our initial raw material analysis suggests that while some long-distance sources (e.g., Edwards, Chuska, Rancheria, and possibly Alibates) were used by site occupants, locally available tuffs, chalcedony, and rhyolites predominate Paleoamerican chipped-stone assemblages. It appears that Paleoindian foragers in the San Augustin Basin practiced a land-use strategy similar to elsewhere in the American Southwest, in which intermountain basins were used as seasonal residences, and groups had moderate mobility and relied heavily on locally available lithic raw materials (Amick 1994, 2002; Judge 1973).

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2006 Investigations at the O. V. Clary Site, Ash Hollow, Garden County, Nebraska

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The O. V. Clary site is one of four late-Paleoindian sites located on the Clary Ranch along a short stretch of Ash Hollow Draw bisecting the property. Limited field investigations in 2005 revealed three stratified late-Paleoindian components (Hill et al. 2006). We returned last summer to further document the geoarchaeological and paleoenvironmental context of the site, focusing on the structure and character of the middle component, which had yielded evidence suggestive of a residential occupation. This work involved geological trenching, paleoecological sampling, and high-resolution excavations of ca. 19 m^2, increasing the total excavated area to ca. 27 m^2.

All four sites occur within the lower portion of an early- to middle-Holocene fill that is at least 16–17 m thick in Ash Hollow Valley. The surface of the fill is

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Terrace 2. Five lithostratigraphic units, from oldest (II) to youngest (VI), have been identified in the lowest several meters of the Terrace 2 fill. Unit V contains late-Paleoindian occupations at both the Clary Ranch and O. V. Clary sites. This unit consists of horizontally laminated brown coarse silt or very fine sandy silt (silt loam) alternating with dark brown or very dark grayish brown silt loam. Thirty-seven AMS radiocarbon assays make it possible to assign ages to the various lithostratigraphic units. For brevity, Unit V dates between 9150 and 8750 yr B.P.

The O. V. Clary site is situated along the axis of the aggrading valley floor in a narrow reach of the valley. Clearly defined channel banks are lacking; apparently occupations occurred on the nearly level, aggrading valley floor, and the entire site was subjected to low-magnitude flooding. Subfossil gastropod species associations suggest that around the time of the occupation, ca. 9100 yr B.P., dense stands of grasses, with perhaps some brush or isolated trees at protected locations, existed in the immediate vicinity.

Congruent artifactual, faunal, and site structural evidence indicates the middle component served as a late-Paleoindian residential base camp. Eruption/wear analysis of two bison calf dentitions and size comparisons of fetal bison remains indicate the material accumulated over the course of a single, continuous occupation stretching from mid/late summer to very late winter/early spring. On-site activities were organized around two hearth areas. Material culture recovered around Hearth 1 includes a spectacular variety of lithic and organic artifacts. The sample of organic artifacts includes 15 bird bone beads (or fragments thereof), 2 bone needles, a bone awl, and an antler billet. Hearth 2, which produced the base of an Allen/Frederick point and an endscraper, was partially destroyed by the backhoe during geological trenching.

The chipped-stone assemblage (n = 9,914) is almost exclusively microdebitage derived from resharpening working edges of unifacial tools and use spalls detached from the edges of these tools during contact with hard materials. Most of the tools (n = 39) are scrapers (n = 11) and utilized flakes (n = 7). Microwear analysis on the scrapers suggests they were held in jam-type hafts and used to process dry hides; the distal ends of six scrapers are impregnated with red ocher that may have been used as a preservative in finishing the hides. Several utilized flakes have microwear signatures consistent with planing antler. Most bifaces are represented by tip, base, and edge fragments from finished weapon tips that are thought to have been introduced to the site in transported meat packages. Four anvils, 2 hammerstones, a shaft abrader, and 4,429 small nodules of red ocher have also been recovered.

Most chipped-stone artifacts are made from White River group silicates (Hoard et al. 1993). Trace amounts of Hartville Uplift chert from southeast Wyoming leads us to infer that the White River group silicates at the O.V. Clary site are derived from Table Mountain (Koch and Miller 1996), located along the North Platte River, some 200 km upstream from the site.

One-third of the faunal assemblage is bison (NISP = 245) and probable bison (NISP = 986) remains. Three thousand small, unidentifiable mammal bone fragments constitute the majority of the difference. The bison and fetal bison (NISP = 20) remains offer insight into late-Paleoindian bison hunting, carcass transport, and provisioning behavior, as well as secondary exploitation of the transported parts at a residential camp.

No fewer than six bison are discernible in the middle component. The age/ sex mix, including two bulls, two cows, and two calves of markedly differing ages, suggests that hunters were not preferentially targeting animals of a particular age or sex, and that the animals were procured singly during encounter-type hunting, not from a multi-animal kill. At least three fetuses were harvested from pregnant cows. This inference is consistent with an extended residential occupation during which hunters provisioned consumers on an apparently regular basis with fresh-food packages. The transported carcass segments were defleshed, disarticulated, and then processed for marrow.

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Test Investigations at the Mockingbird Gap Clovis Site: Results of the 2006 Field Season

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In 2006 (May 19–26) we continued a program of testing at the Mockingbird Gap site initiated in 2005. As noted previously (Huckell et al. 2006), this extensive (ca. 800 m by 150 m) Clovis camp is located about 40 km southeast of Socorro, New Mexico, in the desert grassland at the northern end of the Jornada del Muerto. Discovered in the late 1950s by Weber, who mapped the

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site and conducted controlled surface collections, Mockingbird Gap occupies a long, narrow ridge bordering Chupadera Wash on the southeast. The ridge is divided into northern and southern sections by a shallow erosional gap. Our 2005 testing focused on exploring a portion of the southern ridge segment where Eastern New Mexico University conducted field schools from 1966 to 1968 (Weber 1997; Weber and Agogino 1997). Results of that testing suggested that while potential Clovis debitage was abundant, the artifacts were contained in a pedogenically modified, probably Holocene-age sand that had seen considerable disturbance by eolian processes and bioturbation.

Late in 2005 our attention was drawn to a nearly level plain at the southern foot of the northern ridge segment. Over the years Weber had found a large quantity of Clovis artifacts in this area where wind had removed sand and created shallow depressions down to resistant units. Several bucket auger holes placed in the area revealed fine-grained deposits 10–20 cm below a blanket of younger sand; the fine-grained sediments suggested a depositional environment that had not been subject to eolian erosion. Accordingly, we decided these units should be tested to determine whether they contained Clovis archaeological deposits less disturbed than those on the ridge.

Our 2006 work focused on a portion of this plain that measured approximately 160 m east-west by 75 m north-south. We began by excavating a series of judgmentally selected 1-m^2 test pits adjacent to three auger holes at the west end of this area. Two of these units were rapidly completed and demonstrated that the fine-grained deposit was a well-developed Btb soil horizon underlain by a Bkyb horizon. A younger deposit of sand with a Bw horizon and a very unusual, thin Bg (gley) at its base rested atop the Btb. One unit produced three flake fragments and a unifacially retouched flake fragment, all clay-coated and from within the Btb or Bkyb horizons. While not diagnostic, these artifacts were of materials consistent with those used to manufacture Clovis tools at the site. The other unit failed to produce artifacts but revealed the same stratigraphic sequence.

Some 90 m to the east were areas where Weber had recovered Clovis point fragments and other artifacts. While most were surface finds in deflated areas, we identified one intriguing locale where it appeared that Clovis artifacts had only recently been exposed by erosion; Weber had collected three Clovis point fragments within a 5-m area there. One judgmental 1-m^2 unit 3 m south of those point fragments yielded 48 flaked-stone artifacts, including the basal corner of a Clovis point and a fragment of a flake tool, and one piece of large mammal (bison-sized) tooth enamel. Importantly, the same suite of soil horizons was present in this unit, and 65 percent of the artifacts were recovered from the Btb horizon; they also displayed clay films. The second unit, approximately 7 m upslope of the first, yielded 9 flakes, 4 or 5 from the Btb. Our interpretation of these results is that these units lie within a discrete Clovis occupational locus within the site.

To explore the area lying between the two areas of test excavations, we ran an east-west line of bucket auger holes at 4-m intervals that followed the largely uneroded surface of the plain. These revealed that the Btb horizon was essentially continuous across this plain. Additional randomly placed auger holes south of the line also revealed the Btb; two additional 1-m^2 units served to test those areas. One, 35 m south of the first artifact-producing unit at the west end of the plain, yielded three flakes, two at the top of or within the Btb. These results strongly suggest that this level plain south of the northern ridge was the scene of considerable Clovis activity, and that shallowly buried but minimally disturbed archaeological deposits exist here. We found no evidence of younger occupations. The areal extent of Clovis occupation within this large area is uncertain, but potentially is extensive. This plain appears to have been geomorphically relatively stable since the late Pleistocene, in contrast to areas of Clovis occupation on the ridge.

The 2006 investigations were supported by funds from the Maxwell Museum of Anthropology, University of New Mexico. Crew members from UNM included Christina Sinkovec, Marcus Hamilton, and David Kilby; crew members from the University of Arizona included Bill Reitze, Matt Hill, Lisa Janz, and Andrew Kowler. We are grateful to the New Mexico State Land Office and the New Mexico Historic Preservation Division for their continuing support our work (permit SE-239).

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Update on Wisconsin's Silver Beach Elk Site (47BA526)

Jean Hudson

The discovery and initial reporting of the Silver Beach Elk site called attention to the unusual association of a fluted point with much of a well-preserved elk skeleton (*Cervus elaphus*) in northern Wisconsin (Hudson 2006). Two samples of the elk bone have since been radiocarbon-dated, yielding dates much younger than the associated Gainey-style fluted point would suggest. Apparently the elk kill occurred in a separate and far more recent hunting event than did the loss of the fluted point, and the two items came to rest near each other on the bottom of the Middle Eau Claire Lake by independent means.

The first radiocarbon sample was taken from an elk rib that exhibited

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butchering marks. It was submitted to Beta Analytic and AMS-dated to 380 ± 40 RCYBP (Beta-215798). Given the recentness of this date, and the documented difficulty of accurately dating ancient bone, a second sample was submitted. The second sample was taken from the interior of the elk skull, which is still attached to the antlers, providing an especially secure taxonomic identification of the source bone. The second sample was submitted to the Stafford Research Lab. Stafford's collagen-extraction protocols help to eliminate potential modern contaminants at the molecular level, and these techniques have proven successful in the past in dating late-Pleistocene faunal material. The Stafford sample was AMS-dated to 360 ± 15 RCYBP (UCIAMS-29115). The two dates show strong overlap and place the elk in protohistoric or early historic times.

Underwater test excavation in the summer of 2006 confirmed the stratigraphic context of the site as proglacial outwash sand and gravel, as indicated by Clayton's (1984, 1985) geologic mapping of the area. Clayton's regional reconstructions of glacial advances and retreats suggest that the site area could have been an active proglacial outwash zone, in the form of shallow braided streams, as early as the Airport Advance (about 12,300 RCYBP), with increasing amounts of dry land available to Paleoamerican hunters by the Lake Ruth Advance (about 11,500 RCYBP). This time frame and ecological setting matches reasonably well that hypothesized for other groups using Gainey-style fluted points across northeastern North America. The fluted point shows no signs of water-rolling, and to date no additional lithic materials have been recovered from the site; the point may represent an isolate lost during a hunt.

The spatial association of the elk and the fluted point remains somewhat puzzling. The fluted point was found in 2005 less than 1 m south of the elk remains; soil tests in 2006 showed no stratigraphic distinctions in substrate across this meter span. Additional elk remains were recovered in situ during controlled excavation in 2006. These included the left mandible and part of the hyoid, both firmly embedded in the surface of the sand and gravel stratum. Most of the elk remains were recovered in approximate anatomical position, suggesting the carcass became embedded in the sediments while still largely intact. Wounding and butchering marks on the skeleton suggest the animal was killed by stone weaponry that penetrated the left scapula and entered the rib cage, nicking two ribs on the way, and that butchery focused on dismembering the limbs. The location of a partially intact elk skeleton with wounding and butchering marks on a lake bottom that is now approximately 1.5 m under water and roughly 30 m from the modern shoreline is somewhat problematic. Given that the antlers are well developed and still firmly attached, the animal may represent a winter kill butchered on the frozen lake, which subsequently fell through the ice and came to rest on the bottom. At present the spatial association of the elk and the fluted point is best explained as accidental. Given the underwater location of the point, it is unlikely it would have been discovered had not the more visible elk skeleton attracted attention to the spot. Perhaps other such fluted points lie waiting to be found in similar submerged proglacial sediments.

Dating of sample UCIAMS-29115 was funded by the local community through contributions to the Barnes Area Historical Association.

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Paleoindian-age Artifacts Recovered from a Buried Alluvial Soil in Northeastern Kansas

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Site 14RY6175 was recorded by R. D. Mandel (Mandel 1999) when flakes were recovered from a buried soil at 2- to 3-m depth within high-terrace fill of the Kansas River on Fort Riley, Kansas. The deep-testing approach responsible for this discovery was dictated by fortuitous recommendations derived from previous subsurface geoarchaeological exploration throughout the military installation (D. Johnson 1998; W. Johnson 1997; Zeidler 2001). To access the Paleoindian component, a 12-by-12-by-2.3-m pit was excavated to within 20 cm of the buried soil. Seven 1-m^2 test pits were then excavated in the floor of the pit, and a 3.5-m-high profile was prepared in the west wall for geoarchaeological study.

The 205 objects recovered from the Paleoindian zone consisted of debitage (98), chipped-stone tools (4), faunal remains (31) and miscellaneous items likely representing thermally altered sediments (72). Of these objects, two are noteworthy. One, the only bifacial tool recovered from the site, is a large preform (Figure 1A) discovered during preparation of the geoarchaeological profile. Comparisons to reference material indicate that the material type is Permian-age Wreford B chert, described by Stein (2006:271) as “blue-gray to gray and commonly mottled. It is medium- to fine-grained and may contain white fossil fragments. . . [and] is common throughout the Flint Hills.” The

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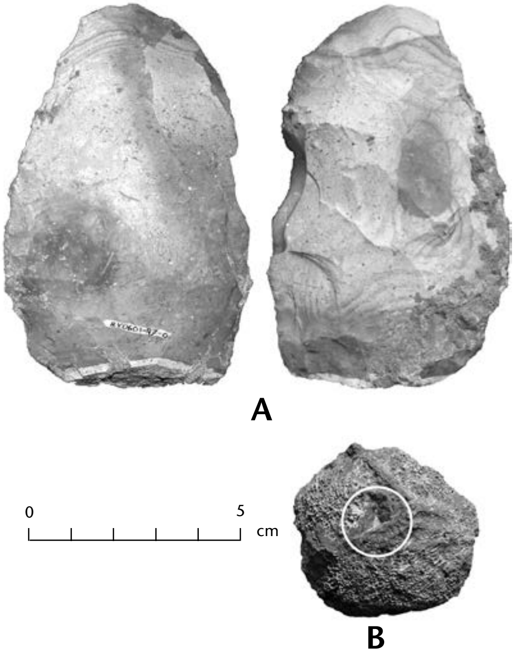

Figure 1. **A,** early-stage bifacial preform; **B,** modified bone with an embedded chert fragment (encircled). Both were recovered within the upper A horizon of the buried soil at 14RY6175.

chert of this artifact is banded as to resemble tree rings and exhibits unpatinated primary and secondary colors of 5Y 6/1 light olive gray and 5Y 4/1 olive gray, respectively, and a patinated color of 5B 9/1 bluish white (Geological Society of America 1991). The proximal end retains some of the source material's cortex. There is no indication of use wear.

The other noteworthy object is a modified bone specimen containing an embedded chert fragment from either a butchery tool or projectile point (Figure 1B). It is fragmentary, spongy bone, possibly a proximal humerus or distal femur from a bison. Other bone recovered consisted of either small, unidentifiable fragments or rodent-size elements, most of which were prairie dog (*Cynomys* sp.) and ground squirrel (*Spermophilus* sp.). These are considered intrusive and, though not radiocarbon-dated, likely date to the middle Holocene (Altithermal).

Both the biface and modified bone were retrieved from the upper Ab horizon of the Paleoindian-age paleosol approximately 4 m apart. A suite of AMS radiocarbon ages, obtained on soil organic carbon from the buried soil, indicates that the two artifacts were deposited within that part of the Ab horizon that dated to 9950 ± 55 RCYBP (OS-55626; 11,350 CALYBP), correlative with latest-Plainview or late-Dalton Paleoindian cultures (Blackmar and Hofman 2006).

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A Clovis Point from the High Sierra, Fresno County, California

Sarah E. Johnston, Jeanne Day Binning, and Alan P. Garfinkel

A bifacially fluted Clovis point of Queen/Truman Meadows obsidian was discovered as an isolate at 2490 m above sea level near Courtright Reservoir, east of Fresno, California (Price and Johnston 2002; Hughes 2004) (Figure 1). The discovery, 96 km west of the Nevada toolstone source, is the first fully reported Clovis find from the high Sierra (Moratto 2000; Dillon 2002; Rondeau 2004). Figure 1 shows the artifact and its discovery location (map ref: National Geophysical Data Center website 2007). Six hydration measurements (base, 4.9/5.0; blade, 4.9/4.9; tip, 4.9/4.8; all measurements ± 0.2 microns) demonstrate that manufacture, use, reworking, and discard occurred over a brief period, with the discovery site being the original discard location (Origer 2005).

The point measures 63.45 x 32.55 x 9.10 mm, weighs 17.95 g, and has a basal indention of 4.1 mm. These metrics are well within the range of other fluted Clovis bifaces from the central and western United States. The point manifests grinding of the basal lateral margins to prevent breakage (cf. Titmus and Woods 1991). Typical of used Clovis points, microscopic and macroscopic striations from hafting preparation or damage from the pressure of the haft binding during use (cf. Kay 1996:328–31) are present on both faces. Tip

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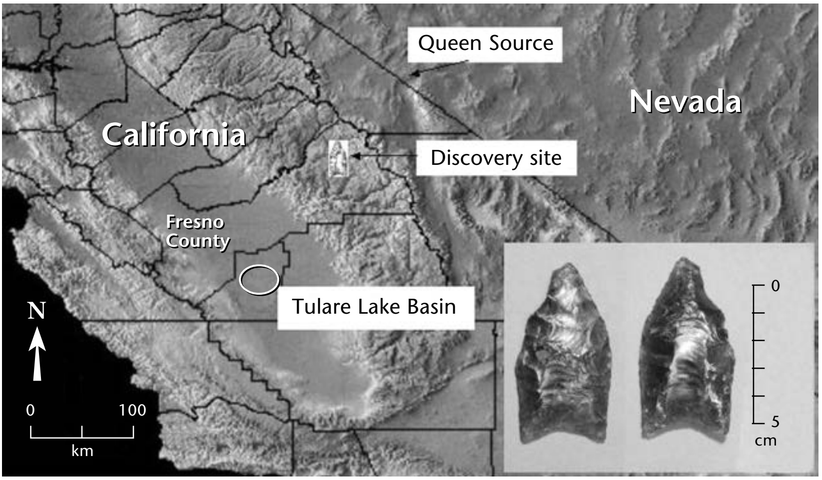

Figure 1. Clovis point from Courtright Reservoir and its location in the Sierra Nevada Mountains, California.

damage and reworking are also present and are responsible for the current morphology of the tip and diminished length of the point.

Chronology and typology of California fluted points are controversial. Direct dates are rare (Dillon 2002; Moratto 2007) and age determinations rely mostly on cross dating (Bouldurian and Cotter 1999). The Courtright Clovis averages 4.9 microns of hydration (Origer 2005). The Queen hydration rate produces dates in RCYBP, using the formula Age = 82.74 $(x)^{2.06}$, where x is the micron measurement (Basgall and Giambastiani 1995:44).

Since the rate was developed for a lower elevation, EHT adjustment was necessary. This refinement provides us with a projected 11.1 ± .2 microns. The adjusted reading translates into 11,778 ± 250 RCYBP, or ca. 13,500 CALYBP (Stuiver and Reimer 1993; Stuiver et al. 1998). That age is commensurate with the earliest inception of Clovis in interior North America as estimated via the recently revised dates at 11,050 RCYBP (Morrow and Morrow 1999:225; Waters and Stafford 2007).

Like the fluted points in the southeastern United States, those of the Far West, particularly California, are seen by some as being outside of the Clovis morphological mainstream and not deserving of the label "Clovis" (e.g., Rondeau and Taylor 2007:46; Rondeau et al. 2007:63-69). Others see these fluted bifaces as well within the morphological variability of Clovis points found farther east (Willig and Aikens 1988:17). Clovis variability is evident, regardless of the extent of the geographic area considered. Clovis points found in discard contexts are different from those found in manufacturing or cache contexts. Within any site or context such as Naco (Haury 1953:8-9), Dietz (Fagan 1988:395-402), or Gault (Collins 2002:Figure 3), there is variability in Clovis point morphology. The wide geographic distribution and different contexts of these points, as well as undue emphasis on differences rather than similarities, have made systematic morphological comparison difficult. If not for the fact that the Courtright Clovis is made of obsidian from western Nevada, morphologically it could be a used and discarded Clovis point from the Plains or the Southwest.

Less controversial than whether or not there are Clovis points in California is the dating of such points. California Clovis-like fluted points are considered to be contemporaneous with those from other parts of the United States (Dillon 2002:112). Clovis points, when well dated, have a relatively short time span wherever they occur (Taylor et al. 1996; Fiedel 1999; Morrow and Morrow 1999:224–27). The Courtright Clovis point date of 13,500 CALYBP does not contradict this observation. This date puts the Courtright Clovis at the beginning of the Clovis phenomenon, contemporaneous with its earliest occurrence in interior North American (Morrow and Morrow 1999:225). However, this fluted point does not shed light on whether people living in the Far West at the same time or earlier and lacking Clovis points (e.g., at the Arlington Springs site) were or were not of the Clovis tradition (cf. Waters and Stafford 2007a:1122–26; Haynes et al. 2007:320b; Waters and Stafford 2007b:320c).

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A New Date for the James Allen Site, Laramie Basin, Wyoming

Ruthann Knudson and Marcel Kornfeld

The James Allen site (48AB4) (Mulloy 1959; Wormington 1957:144–46) is a bison butchering station in the southern Laramie Basin, Wyoming, 23 km south of Laramie and 16 km north of Colorado. Burned bison bone from the site was radiocarbon-dated at 7900 ± 400 RCYBP [M-304; Crane and Griffin 1958:1102) in the early days of ^{14}C analysis. The James Allen bifacial points' distinctive oblique parallel flaking (Figure 1) has been labeled the "Allen," "Jimmy Allen," and "James Allen" point type.

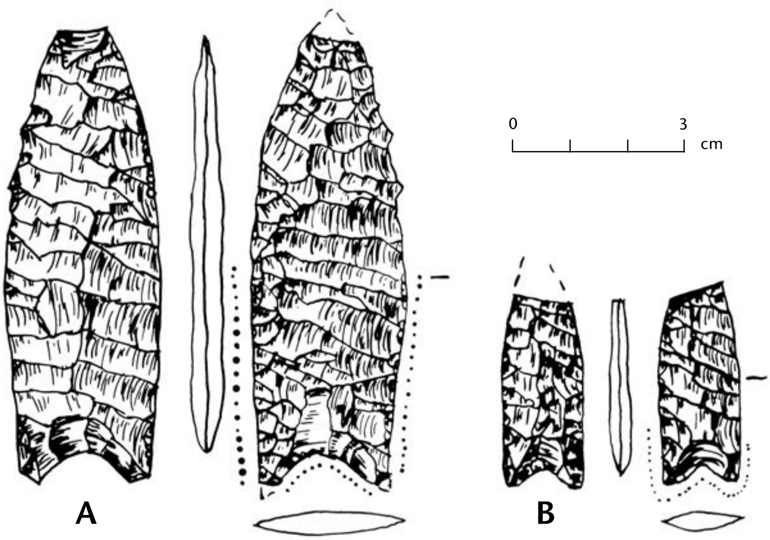

Figure 1. Points 60436 (**A**) and 60434 (**B**) from the James Allen site (48AB4), Wyoming.

The site was excavated by William Mulloy and a University of Wyoming archaeological field school in 1951. The site, a single 50-foot-square component in a shallow soil resting on shale later covered by windblown sand, was completely excavated. It is in open country, with sparse grass and sagebrush, on a slope below a ridge with several permanent springs in the vicinity. There was no evidence of an enclosure or hearths. Remains of about 15 bison were discovered, most disarticulated but with some whole or partial leg or vertebral units and only fragments of skulls. Mulloy (1959) and Berman (1959) interpreted this as a single kill/butchering event.

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Mulloy collected 30 bifacial point fragments, 6 plano-convex scrapers, one unifacial and one bifacial knife/scraper, and 60 pieces of debitage from the excavation. Avocational archaeologist Jim Duguid collected 25 flaked-lithic artifacts from the site in the early 1960s, and George Frison of the University of Wyoming has collected bone and 15 artifacts from it over the past half century. There are 61 tools (at least 41 points, 2 drills, 8 unifacial scrapers, several indeterminate fragments, and a couple of pieces of debitage) represented in the extant collection.

Mulloy destroyed all his records before he died and did not collect any of the James Allen site bone. Frison, however, collected bone from backdirt in the 1960s. One was a bison long bone fragment recently ^{14}C-dated at 8405 ± 25 RCYBP (UCIAMS-19330; Stafford 2005). This falls within one standard deviation of the charcoal date (8600 ± 380 RCYBP [A-501; Haynes et al. 1966:15]) that Haynes uses to date both the Frederick (Byrnes 2003) and Scottsbluff components at the Hell Gap site. Two new bone dates for the Scottsbluff site (Hill and Knudson 2005) are 8680 ± 85 RCYBP (AA67442) and 8939 ± 85 RCYBP (AA67443). Two obliquely flaked points from Red Smoke (Knudson 2002) are associated with ^{14}C dates around 9000 RCYBP, as are oblique parallel points from Clary Ranch (Hill et al. 2002, 2006; Myers 1997). Oblique parallel flaking appears to be relatively persistent.

Knudson initiated this research in 2004 as a Senior Fellow recipient of a George C. Frison Institute of Archaeology and Anthropology grant, and the ^{14}C date was provided by the Frison Institute. The authors are deeply indebted to George C. Frison for preserving information and materials from the James Allen site.

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The Dilts Site (48CA4718): Goshen and Bison in Eastern Wyoming

Jason M. LaBelle

The Dilts site (48CA4718) consists of a Goshen projectile point exposed with a scatter of bison bone in a tributary arroyo of Spring Creek, southern Campbell County, Wyoming. The site was documented in 2003 during a routine CRM inventory for coal-bed methane energy development (LaBelle 2004).

The projectile point is nearly complete, missing a portion of an ear (Figure 1). It is lanceolate in form, with a concave base, and minimal (if any) resharpening. It is made of a brown fine-grained orthoquartzite (probably from the Black Hills or Bighorn Mountains) and measures 82.3 mm in maximum length, 26.4 mm in maximum width, and 6.1 mm in maximum thickness. The point is comparable to Goshen forms from regional sites such as Upper Twin Mountain (Kornfeld et. al 1999) and Mill Iron (Frison 1996). The point does not match the "classic" forms from these sites; however, it is often more difficult to typologically classify isolated projectile points than projectile-point assemblages acquired from mass kills (Bamforth 1991).

In all, 67 bone fragments larger than 1 cm were mapped from the site surface, scattered across the sloping bank. Smaller fragments were noted but omitted from analysis. A cranial fragment and a complete sacrum were recorded in situ. The surface bones are small, averaging 28.6 mm in maximum length and 1.8 g in weight, dominated by cancellous and cortical bone, weathered and root-etched. Identifiable bones include the sacrum, cranial fragments, long bones (femur and tibia), ribs, and teeth. The bones represent a single bison and/or large ungulate. An unburned cranial fragment was submitted for AMS ^{14}C dating to Lawrence Livermore National Laboratory, with pretreatment by Paul Matheus of the University of Alaska–Fairbanks. The sample returned an uncorrected date of 10,170 ± 50 RCYBP (CAMS-105766), similar to those from the Goshen component at the Jim Pitts site in western South Dakota, where six bonebed dates gave a weighted mean of 10,160 ± 50 RCYBP (Donohue and Sellet 2002). A late persistence of Goshen is also documented at the Upper Twin Mountain site (Kornfeld et al. 1999).

Dilts is possibly an arroyo kill of a single bison, based on the assemblage and context. The site represents a common predation strategy of Paleoamerican

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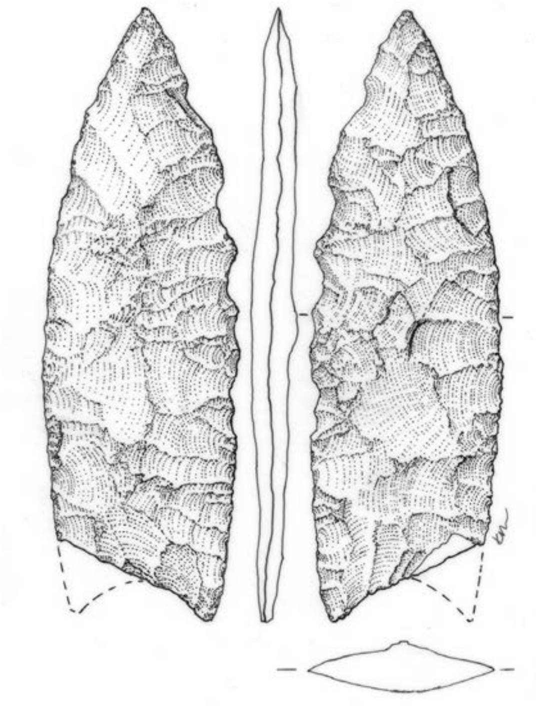

Figure 1. Goshen point from the Dilts site (48CA4718), Campbell County, Wyoming. Maximum length is 82.3 mm. Illustration by Katherine Monigal.

hunters of the Great Plains and Rocky Mountains, where small bison kills probably occurred much more frequently than the well-documented communal mass kills. Portions of the site remain buried and are presently preserved; additional fieldwork may well change this present interpretation.

The project was sponsored by Lance Oil and Gas, in advance of energy development, and was completed by archaeologists from Western Land Services. The Quest Archaeological Research Fund at Southern Methodist University funded the ^{14}C date. Special thanks to Allen Aksamit, Donald Anderson, Pete Bostrom, Laura Carter, Jerry Dilts, Sam Drucker, Jason Garber, Ryan Garber, Matthew G. Hill, Paul Matheus, David Meltzer, Juanita Mines, Katherine Monigal, and Western Land Services for their help and support with this project.

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A Midland Point from a Folsom Context at Blackwater Locality No. 1

Philippe D. LeTourneau

Midland points are found in greatest numbers on the Llano Estacado, yet the absence of firm stratigraphic associations between Folsom and Midland points in that region has led to continued debate about the relationship between the two point types (Holliday 1997:187–188). Reported here is a Midland point in secure stratigraphic association with Folsom points from the El Llano Archaeological Society's (ELAS) "El Llano No. 1" excavation at the North Bank of the Blackwater Draw (Clovis) site.

ELAS worked at the North Bank in 1962–1963 (Warnica 1966:345, pers. comm. 1995), with Museum of New Mexico (Hester 1972:71) and Eastern New Mexico University (Hester 1972:86; Stevens 1973:6–14) assisting. F. E. Green also excavated at the North Bank in 1963–1964 (Condon 2005; Green 1992:331–32).

The Midland point (catalog # EL-220) (Figure 1) is one of about 50 Folsom/Midland artifacts that ELAS excavated below the "Agate Basin Unit of the White Sand Lens" (Warnica, pers. comm. 1995). Diagnostic Folsom artifacts

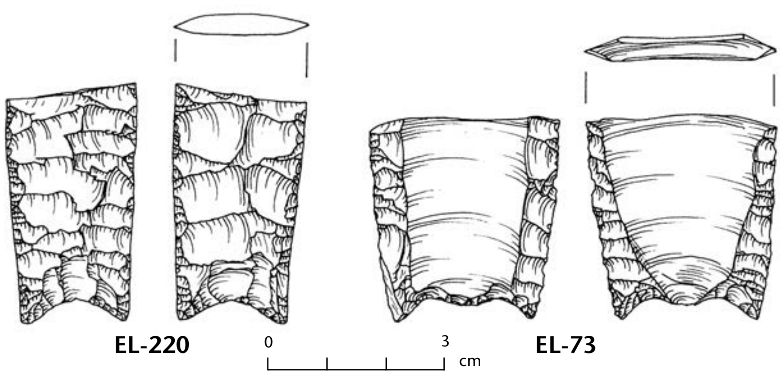

Figure 1. Midland Point (catalog # **EL-220**) and Folsom point preform (**EL-73**) from El Llano No. 1.

consist of two fluted Folsom point preforms (EL-73, EL-214) (Figure 1). These artifacts were from Unit D_{1a} spring-laid sand (Green 1992:Figure 3; Haynes and Agogino 1966). Unit D_{1a} was bounded on the top by D_{1b}, which contained Agate Basin artifacts (the Agate Basin Unit of the White Sand Lens mentioned above), and on the bottom by C_1, a facies of C_0, which contained mammoths and Clovis artifacts (Haynes and Agogino 1966). Unit D_{1a} is the same as Warnica's Bed 4b (Haynes and Agogino 1966:820; Warnica 1966:Figure 2) and

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was part of Sellards' (1952) Brown Sand Wedge and was a facies equivalent of Sellards' Diatomaceous Earth (Haynes and Agogino 1966).

The Midland point is a base/midsection made of opaque, light gray and yellow Alibates silicified dolomite with dark reddish brown mottling. The point is 40.19 mm long, 22.28 mm wide, and 4.97 mm thick. Basal width is 17.94 mm. The cross section is biconvex, the base is concave, and the lateral margins expand from the base after a very slight contraction near the base. Facial flaking is generally collateral and comedial to transmedial. Marginal flaking is moderately regular. The basal margin is lightly ground, and both lateral margins are moderately ground from the base to the break. The break is a bend fracture.

The El Llano No. 1 Midland point is one of the best-documented and most secure Folsom-Midland associations on the Southern High Plains. Although D_{1a} sediments originated in springs, the El Llano No. 1 artifacts appear to have been deposited after deposition of those sediments, since none of the artifacts have the distinctive polish exhibited by many of the artifacts excavated from spring contexts at the site (Boldurian 1981; Haynes and Agogino 1966:813; LeTourneau 2000:Appendix C). Also, although D_{1a} is part of the Brown Sand Wedge, which contained artifacts from Clovis to late-Paleoindian age (Haynes and Agogino 1966:318; Hester 1972:65–66; LeTourneau 2000, 2002), Clovis, Folsom, and Agate Basin artifacts were stratigraphically separate at the North Bank. The ELAS excavations at the North Bank provided the first solid evidence for the contemporaneity of Folsom and Midland points.

Jim Warnica generously provided access to the El Llano No. 1 artifacts in 1995 and again in 2005 and shared his extensive knowledge of the Blackwater Locality No. 1 excavations. Warnica subsequently donated the El Llano No. 1 artifacts to the Blackwater Draw Museum in 2005. Sarah Moore drew the artifacts.

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A Survey of Wisconsin Fluted Points

Thomas J. Loebel

Nearly 40 years have elapsed since the last major distributional study of Wisconsin fluted points (Stoltman and Workman 1969). As part of a regional effort to document fluted points in Wisconsin, I report on archival research and study of public and private collections conducted over the last decade (Amick et al. 1999; Hill et al. 1998; Loebel 2005). To date, 401 fluted points, including 48 Folsom and Midland points, have been recorded. The majority (n = 353) fall within the typological range of variation displayed by Clovis/Gainey complex fluted points. Notable is the absence of Parkhill (Barnes) and Crowfield complex points well-documented in the eastern Great Lakes.

Although Stoltman and Workman (1969) partially equated distribution of fluted points across the state with sample bias, this study, using county-level or better provenience (n = 323), confirms some of their observations regarding patterns of geographic distribution. Clovis-complex points are concentrated in the southern half of the state with heavier concentrations towards the southeast, suggesting Clovis-age land use was of unequal intensity across the region (Figure 1). Other concentrations result from the Withington, Aebischer, and Morrow-Hensel sites, and finds reported from lithic source areas (Amick et al. 1999; Hill 1994; Loebel 2005). The lack of fluted points in northern counties may result from modern biases; however, late-Paleoindian occupations are well known within these portions of the state (Dudzik 1991; Meinholz and Kuehn 1996), suggesting this area was avoided by earlier fluted-point groups. This suggests a general south-to-north movement over time as well as regional patterns of raw material use.

A variety of lithic sources are represented within the Clovis sample: 128 (37 percent) are Hixton Silicified Sandstone from Silver Mound, 43 (12.4 percent) are PDC or Platteville/Galena cherts from southwest Wisconsin or northwest Illinois, 39 (11.3 percent) are Moline chert from Illinois, 25 (7.2 percent) are Burlington chert, and 13 (3.8 percent) are Cochrane chert. Lesser amounts of Taconite (n = 8), Knife River Flint (n = 2), and miscellaneous sources constitute the remainder (n = 6). Eighty-two previously recorded specimens lacked detailed raw material descriptions, although I suspect most are Platteville/Galena or Burlington cherts. Strong northward patterns of movement, particularly along the Rock River corridor, are indicated by long-distance transport (300–

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Figure 1. Distribution of Clovis points in Wisconsin by county.

400 km) of Illinois cherts. In fact, more Moline fluted points are known in Wisconsin than Illinois (Loebel 2005). This likely reflects redundant seasonal patterns of mobility and northward range extension over time in response to changing late-Pleistocene resource structure.

I wish to thank Jeff Behm, R. P. Mason, Jim Stoltman, Ernie Boszhardt, and Dillon Carr, for freely sharing data over the years, as well as the many private individuals who contributed to this study. Special recognition is due to the late Harris Palmer, who, in the early 1960's had the foresight to recognize the importance of recording fluted points.

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A Clovis Occupation along Swift Run Gap, Virginia

Douglas H. MacDonald

Recent excavations at the McDaniel site (44GN115) produced evidence of the only known Clovis site in Greene County, Virginia. The site is along Swift Run at the base of the Blue Ridge Mountains and Shenandoah National Park (MacDonald et al. 2005). Excavation of 12 test units at the site yielded 433 lithic artifacts, including a Clovis point and associated artifacts (Figure 1). The point is produced from an opaque, waxy, fine-grained gray-black chert with light gray mottles. The material is most likely Helderberg chert from the North Fork Shenandoah Valley, although this identification is tentative.

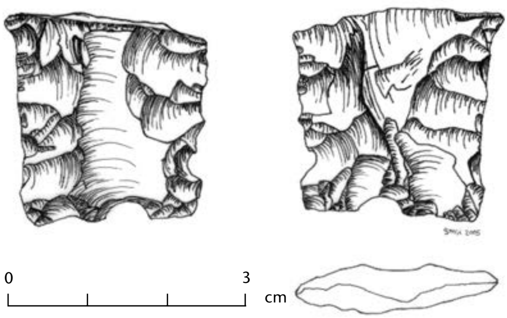

Figure 1. Clovis point from 44GN115 (illustration by Susanne Haney).

The Clovis point measures 25.3 mm wide and 5.1 mm thick, and is 4.2 mm thick within the channel flake portion of the point. The width-to-thickness (W:T) ratio for the point is 6.02 within the channel flake and 4.96 otherwise. A Clovis point from the nearby Flint Run site had a very low W:T ratio of 3.84 (Gardner 1974). Most complete Clovis points have W:T ratios of between 5 and 10 (Callahan 1979:156); thus, the ratios of 4.96 and 6.02 for the point from site 44GN115 are within the expected range.

Other artifacts at the site support the presence of a Clovis occupation. A late-stage biface of Onondaga chert possesses an intact lateral edge with several parallel flakes typical of stage 2–4 Clovis point preforms (Callahan 1979:93). Excavations also yielded a jasper retouched flake and a Corriganville chert utilized flake produced on blades, a typical Clovis technology. The jasper blade exhibits extensive retouch and use wear on both lateral edges and across both faces. The jasper likely originated at the Flint Run quarries near the Clovis-period Thunderbird site, 80 km north of the site on the opposite side of the Blue Ridge.

The McDaniel site indicates use of Swift Run as a travel corridor across the Blue Ridge into the Shenandoah River Valley for at least 11,000 years. Gardner (1977:259) and others (McAvoy 1992: 151–60) have suggested that Clovis

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groups in Virginia oriented settlement patterns primarily along the coast and within major river valleys, with only occasional use of major ridges owing to their hostile (glacial?) climate and limited resource potential (Eaton et al. 2003: 151; Stingelin 1965:39). New evidence from the McDaniel site, however, as well as possible Clovis points in nearby Madison County (Nash 1998), suggest that early Americans occasionally crossed major ridges at well-known gaps instead of traversing around them and along their edges.

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A Fluted Point from East Bearskin Lake, Minnesota

Susan C. Mulholland, A. D. Romano, and Stephen L. Mulholland

Excavations at the Bearskin Point site in northeastern Minnesota yielded a projectile-point base of Knife Lake siltstone. Preliminary description as Holcombe-like (Okstad 1990:48) has been uncritically cited (Florin 1996:50; Higginbottom 1996:8; Mulholland et al. 1997:389; Okstad et al. 2000:24). Reexamination indicates a different identification.

The point base is 30 mm long, expanding from 19.8 mm wide at the basal tips to 29.5 mm at the break (about 10 mm in 30 mm). This shape best fits the divergent type of fluted-point blade forms (Stoltman 1991:247, Figure 1f). The point is bi-convex in cross section with a deep basal concavity (5.2 mm); the thickness at the break is 6.25 mm. The lateral edges are very heavily

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ground to just below the break (29 mm), but the basal edge is extremely sharp. The surface of the blade has well-defined collateral flake scars meeting to form a medial ridge. The obverse face (Figure 1A) exhibits a single clear but short fluting scar extending ear to ear across the point base and ending at an imperfection in the material. The reverse face (Figure 1B) has a shorter fluting scar that still extends ear to ear; the basal platform area collapsed, forming many step fractures.

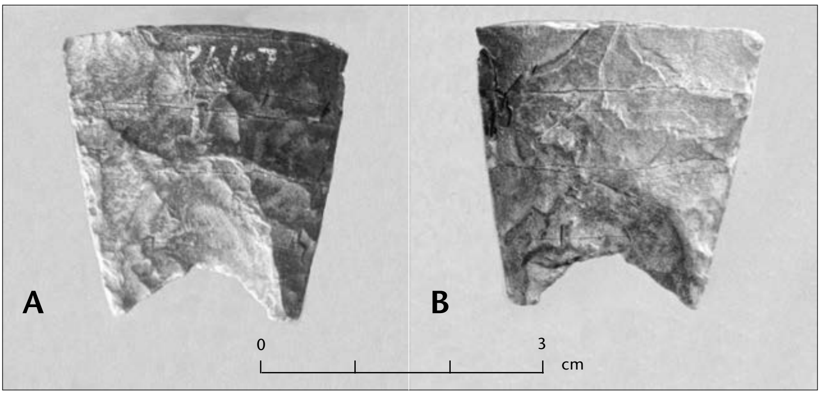

Figure 1. The Bearskin Point fluted point.

Smaller flake scars superimposed on the obverse fluting scar extend at an angle from the basal edge to the inner edge of the fluting scar. The flake scars lack negative bulbs of percussion and were therefore truncated by the flute on the reverse face. These flake scars are not an example of true basal thinning, which produces longer flakes parallel to the long axis of the point (Hester 1972:91; Morrow 1984:10, Figure 1.10B) Instead, they reflect intentional basal platform preparation for fluting the reverse face. The reverse face does not show similar flake scars, which were probably obliterated during fluting.

The heavily ground lateral edges could suggest the point was finished and prepared for use, as grinding is often considered the last step before hafting. However, the extremely sharp basal edge indicates it could not have been hafted effectively, nor therefore broken during use. The point probably broke during the second (reverse) fluting attempt when shock waves snapped the blade.

Initial identification as Holcombe-like was based on two characteristics. The divergent shape (expanding from the base) is definitely characteristic of Holcombe. However, the small flake scars at the base of the obverse face only superficially resemble basal thinning flakes, while the larger and wider (ear-to-ear) scars resulted from fluting. Holcombe points exhibit a range of basal treatments including flutes on one side but most commonly dominated by basal thinning (Wahla and Devisscher 1969). This point illustrates an attempt at bifacial fluting rather than unifacial fluting or basal thinning.

Fluted point types in the western Great Lakes region include both Plains (Clovis *sensu stricto*, Folsom) and eastern (Gainey, Barnes, Crowfield, Holcombe) variations. This point base does not clearly fit into any type. Gainey and Clovis are bifacially fluted, but tend to have parallel lateral edges (Stoltman 1991:246–48). Folsom is extremely finely flaked and distinctively fluted (Morrow 1984:14); Barnes has fishtail-shaped ears (Deller and Ellis 1988:255–58). Holcombe is unifacially fluted and/or basally thinned, and is thinner and narrower with a shallower basal concavity (Fitting et al. 1966:55–58; Woodley 2004:187). Crowfield, while bifacially fluted, is even thinner than Holcombe and with less deeply indented basal concavities (Deller and Ellis 1988:258).

Two factors complicate type identification, the incomplete condition of the point and the material type (Knife Lake siltstone is difficult to flake, much less flute). Gainey might fit best in terms of overall dimensions, cross section, and basal concavity (London Chapter of the Ontario Archaeological Society, n.d.). However, Clovis is similar, and isolated points can be indistinguishable (Stoltman 1991:248). In any case, the point appears to be bifacially fluted and therefore earlier than a Holcombe-like designation suggests.

The presence of a fluted point in far northeastern Minnesota is notable, given the scarcity of fluted points in the region (Mulholland et al. 1997:386–90; Mulholland 2000:1). It could indicate ice-free conditions in the area even earlier than has been postulated (Phillips and Hill 2004:296; Hill 2007:38). Additional work is needed to establish the nature and extent of a fluted-point presence in northeastern Minnesota.

The excavations on the Bearskin Point site were conducted by Gordon Peters, Forest Archaeologist for the Superior National Forest, U.S.D.A. Forest Service, in 1988 and 1989 with the assistance of numerous Passport in Time volunteers. Access to the projectile point was granted by Walter Okstad, Forest Historian for the Superior National Forest, U.S.D.A. Forest Service.

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Technological Remarks on the Folsom Bifacial Artifacts from the Baker Site, New Mexico

Hugo G. Nami and Dennis J. Stanford

As a part of a long-term project directed towards experimental and comparative technological research on diverse Paleoindian lithic assemblages from the Americas, this paper reports observations made on bifacial artifacts from the Baker site, New Mexico. These specimens were recovered during fieldwork conducted during the 1960s in the central Rio Grande Valley. The artifacts are curated at the National Museum of Natural History. This collection has significant potential for understanding aspects of Paleoindian lithic technology in the region (Amick 1996; Judge 1973).

The site yielded a remarkable number of artifacts useful for understanding the Folsom biface-reduction sequence. The analyzed sample considered only those pieces with significant attributes of early bifacial stages of manufacture, preforms, and finished products. Most are made of chert and fine-grain quartzite locally available in the Santa Fe gravels. Non-local sources include Chuska (Nabrona) chert from Arizona and felsite from Las Vegas, New

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Mexico. Six bifaces were broken during the early stage of their manufacture (Callahan 1979). Flake scars indicate percussion flaking using a bone or soft stone. Their width/thickness ratio and average angles indicate that the bifaces failed during stages 3 and 4 in a proposed bifacial thinning model based on the Folsom projectile points manufactured at Lindenmeier (Nami 1999). Three preforms exhibit fractures that occurred during fluting, suggesting that preparation for fluting occasionally started during early stages of reduction. Five specimens were broken during removal of the first flute. These examples indicate that the side to be fluted was prepared by pressure applied on platforms produced by beveling the edge of the biface. Spacing the pressure flaking at about 5- to 10-mm intervals created the convexity to carry the fluting force and control the width of the channel in the first attempt. The opposite face still has remnants of early-stage reduction when the preform breaks. If the fluting was successful, knappers prepared the second face for fluting in a manner similar to the first. Another five examples were broken during second fluting. In this step, one of them was fractured in at least four parts (one lacking). Three pieces have been refitted to both channel flakes in a process similar to that at the Hanson site (Frison and Bradley 1980: Fig. 35). Another specimen was successfully fluted on one face and carefully prepared for the second, but failed because it detached only a 1.5-cm flute. However, the preform broke near the tip where the raw material was flawed. As usual, isolated nipples were prepared for fluting platforms. A number of preforms (more evident in those of Pedernales chert) exhibited heat-treatment attributes in later stages (Crabtree and Butler 1964) suggesting they were treated, probably after successful bifacial thinning. In fact, preforms exhibit luster, change of texture, and heavy ripples in the pressure flake scars, and are shinier than early stages. Four completed basal fragments were apparently carried to the site in the foreshafts and replaced by new points. These points show that finishing was accomplished by small regularized retouched flakes and the edges were carefully abraded.

The biface-reduction sequence shares many similarities with other Folsom localities. Comparable biface stages and preforms are present in several sites across North America, including Hanson (Frison and Bradley 1980), Lindenmeier (Nami 1999; Wilmsen and Roberts 1978), Bobtail Wolf (Root et al. 2000), and Big Black (William 2000). The Baker specimens exhibit preparation for fluting identical to many preforms from Lindenmeier. In fact, these artifacts demonstrate that the fluted face was prepared for pressure flaking by using beveled platforms. The reverse face still has flake scars remaining from previous bifacial thinning (Nami 1999:Figure 6A–B). Differences between the early-stage bifaces and preforms suggest that heat treatment was applied after successful bifacial thinning.

In summary, Folsom artifacts from Baker indicate that the projectile-point manufacturing sequence in the Rio Grande Valley is basically similar to other Folsom sites. Specifically, the entire sequence has a similar manufacturing pattern of bifacial thinning in the early stages, including probable heat treatment, preparing the first face for fluting, retouching the other face and second fluting, and final retouch after fluting.

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Paleoindian Settlement in the Southeastern United States: Insights from Examining Regional Databases

Jason O'Donoughue

Regional distributional studies can inform many aspects of Paleoindian archaeology, including processes of colonizing the Americas, settlement patterning, and development of regional cultures (Anderson 1996, 2004; Anderson and Faught 2000; Anderson and Gillam 2000). In the eastern U.S. these studies have derived almost exclusively from the Paleoindian Database of the Americas (PIDBA; http://pidba.utk.edu/). PIDBA contains spatial and metric information for fluted points recorded by researchers throughout North America. The data are presented at the county level as counts of diagnostic points, with information on individual points presented where available. This

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repository, which is constantly expanding and evolving, presents ample opportunities for research (Anderson et al. 2005).

State archaeological site file databases present an alternative source of regional Paleoindian data. These databases store information, including spatial location and temporal-cultural affiliation, on recorded archaeological sites in each state. While acknowledging that certain biases exist in both PIDBA and state site files (e.g., inter-observer variability in typological assessment and differential survey coverage), utilizing both resources should mitigate these biases and increase confidence in our conclusions. To this end, site file data were obtained from Alabama (Office of Archaeological Research), Florida (Bureau of Historic Preservation), Georgia (University of Georgia Laboratory of Archaeology), South Carolina (South Carolina Institute of Archaeology and Anthropology), and Tennessee (Tennessee Division of Archaeology). The relevant PIDBA data were extracted for comparison. Examination of these data at the regional scale reveals several patterns of interest (Figure 1).

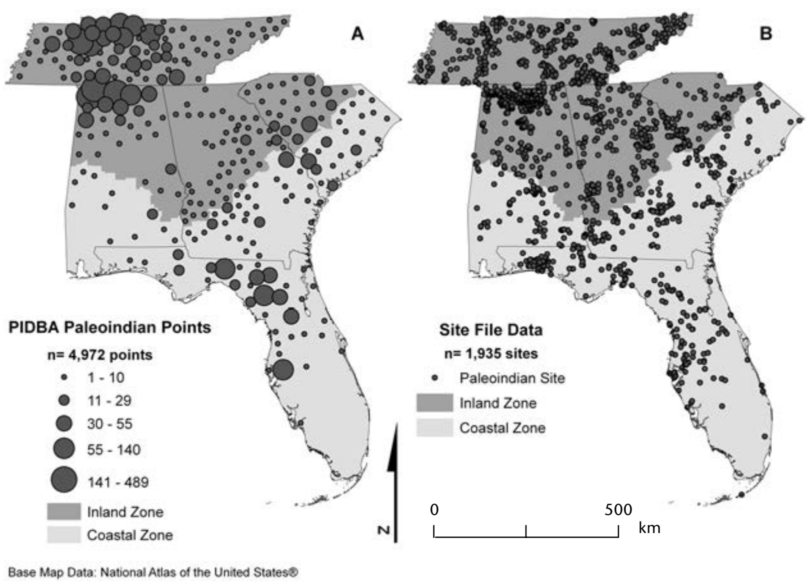

Figure 1: The Paleoindian archaeological record of the southeastern U.S. **A,** distribution of Paleoindian points from PIDBA; **B,** distribution of Paleoindian sites from state site files.

The densest area of Paleoindian sites and points is in the Midsouth, between the Cumberland River in Tennessee and Middle Tennessee River in Alabama. This corresponds with Anderson's (1990, 1996) hypothesized staging areas in the region. Other lesser concentrations occur along most of the rivers and reservoirs of the region, illustrating the potentially biasing influence of survey intensity. Of particular note is the relative paucity of the Paleoindian material record in the vicinity of the coastal plain compared with the interior.

To further explore this pattern the research area was divided into interior and coastal zones. This was done at the county level to facilitate analysis and comparison between PIDBA and the site files. The coastal zone comprises those counties located below the Fall Line Hills physiographic province (Fenneman 1938). This zone is almost exclusively below 100 m amsl, save for portions of southeast Alabama and southwest Georgia. The land area and number of Paleoindian points and sites were calculated for each zone.

Both PIDBA and the site files exhibit significantly higher density in the interior than the coastal zone. The distribution of Paleoindian points from PIDBA displays densities of 13.30 points per 1000 km^2 in the interior (3930 points over 295,568 km^2), and 3.36 points per 1000 km^2 in the coastal zone (1042 points over 310,239 km^2). Similarly, the site file data exhibit densities of 4.83 sites per 1000 km^2 in the interior (1428 sites over 295,568 km^2), and 1.63 sites per 1000 km^2 along the coast (507 sites over 310,239 km^2). Thus in the interior the density of sites is approximately three times that of the coastal area, while the density of points is nearly four times greater.

Several possibilities are suggested by this apparent sparse occupation in the coastal plain. There could be systematic survey bias precluding site discovery in the area, or depositional or preservational processes at work that obscure the Paleoindian archaeological record. However, if we accept that the pattern is real, then two explanations present themselves. First, Paleoindian peoples may have been adapted to the Piedmont uplands and made little use of what is today the coastal plain beyond the immediate vicinity of the Fall Line Hills. Alternatively, these groups may have exploited both the Piedmont and coast, perhaps seasonally, but spent little time on the intervening coastal plain. In this scenario the coastal plain represents a sparsely inhabited or little-utilized "no man's land" between more productive ecological habitats. The Paleoindian coastal record has since been inundated by rising sea water, thus obscuring evidence for occupation (Gillam et al. 2006; Lambeck et al. 2002).

This analysis illustrates the potential for large-scale datasets in addressing questions of Paleoindian archaeology. The results of this analysis are enticing, but much additional data and research are needed to explain Paleoindian coastal settlement in the southeastern U.S. The development of underwater archaeology and emergence of a submerged Paleoindian record is quickly expanding our understanding of coastal settlement, and should prove fruitful in the future (Faught 2004).

Special thanks must go to the archaeological site file curators who facilitated access to their data. Thanks also to all of those involved in the creation and maintenance of PIDBA.

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New Evidence of Microblade Technology in the Nenana Complex Type Site at Dry Creek, Central Alaska

Daniel Odess and Scott Shirar

In 1989, Powers and Hoffecker tentatively proposed a new late-Pleistocene culture complex based on over a decade of "early man" research on the north side of the Alaska Range in Central Alaska. The newly defined Nenana complex was identified at several sites and confirmed on the basis of apparent stratigraphic separation from overlying Denali-complex materials at Dry Creek. Its most salient attribute, according to Powers and Hoffecker, is a complete absence of microblade technology (1989:278). Absence of evidence for the production and use of microblades was considered significant because that technology is ubiquitous in Denali-complex sites (West 1967, 1981), including the overlying Dry Creek component II, and in Siberian Dyuktai sites from which Denali is thought to derive (Dumond 1980; Yi and Clark 1985).

The distinction between Nenana and Denali took on added significance two years later when Goebel et al. (1991) proposed the Nenana complex as a Clovis progenitor. Defining Nenana as "pre-microblade" is important because one of the principal difficulties in deriving Clovis from the archaeological record of central Alaska is that prior to the definition of Nenana, culture

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complexes from that area were all characterized by extensive microblade use, a practice not seen in Clovis. Thus defining a late-Pleistocene Alaskan complex as "pre-microblade" effectively returned the focus of the search for Clovis origins to Beringia (Goebel 1999, 2004; Hoffecker et al. 1993). Despite the avowedly provisional nature of the Nenana complex (Powers and Hoffecker 1989:278), it has become reified through use.

During the course of reanalyzing the cultural material from Dry Creek, one of the type sites for the Nenana complex, we discovered a core tablet from a wedge-shaped microblade core in the debitage from component I, the Nenana-complex material at the site (Figure 1). The tablet was point-plotted and catalogued at the time of excavation, but was incorrectly identified as non-

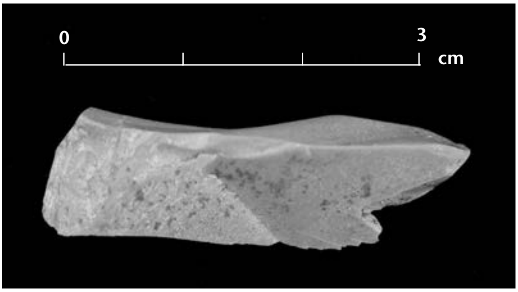

Figure 1. The core tablet from component I, Dry Creek. (Photo by Sarah Meitl.)

diagnostic debitage. Field notes indicate it was found at a depth of 161 cm, well below the overlying Denali-complex material, which ends at 150 cm in this part of the site, and well within the deposit termed component I. It is made from brown siliceous stone, a common material attributed to both components I (Nenana) and II (Denali). It has been burinated from the distal end, a practice often seen in Denali-complex material from other sites.

Leaving aside the possibility that its location was simply recorded incorrectly at the time of excavation, the presence of this object in the Nenana complex component at Dry Creek can be interpreted in two ways. It might be explained as having been reworked from the overlying component II deposit. Alternatively, the core tablet may in fact have originally been deposited with component I, suggesting that component I is part of the Denali rather than the Nenana complex to which it has been ascribed.

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Evidence for Shifts between Clovis Biface and Blade Production at the Gault Site (41BL323), Texas

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In the last 15 years, it has become clear that blade manufacture is an important component of Clovis technology in certain regions of the continental U.S. (Broster and Norton 1993; Collins 1998, 1999, 2007; Collins and Lohse 2004; Dickens 2005, Ferring 2001; Goodyear and Steffy 2003; Haynes and Huckell 2007; Kilby and Huckell 2004; Sanders 1990). A contextually secure quarry/ campsite like Gault provides a good opportunity to examine whether that importance altered through time.

In 2000 and 2001, Texas A&M University excavated 42 1-m^2 units at the Gault site, Texas (Collins and Hester 1998). Clovis sites with good stratigraphic context are few in number; Gault is unparalleled with two stratigraphically separate Clovis components, designated as Unit 3a (lower; 4.04 m^3) and Unit 3b (upper; 3.55 m^3) (Waters and Shafer 2002), which produced approximately 66,000 artifacts. Although there were no observable differences in the technological traits between the early and late components at Gault, Dickens's (2005; this volume) analyses of the biface and blade assemblages concluded that early stages of both reduction trajectories employed comparable flaking techniques usually associated with blade production. Both trajectories began with locally available rectangular or sub-rectangular Edwards chert; early-stage reduction in both trajectories incorporated corner and lateral blade detachment as well as cresting to prepare arrises (Collins and Lohse 2004:163-165; Dickens 2005:254-259). Therefore, initial by-products of biface and blade manufacture—primary and secondary cortical blades and crested blades—are indistinguishable.

The first author conducted individual attribute analysis of debitage greater than 2.54 cm in size (n = 3,403) to determine if biface and blade manufacture

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covary within either component. The products (bifaces and interior blades) and by-products (exhausted cores, biface thinning flakes, etc.) included here are those definitively assigned to either blade or biface manufacture (Table 1).

Table 1. Blade and biface data generated from Unit 3a and Unit 3b Clovis components at the Gault site.

Blade by-products

Unit	Interior blades	Blade cores	Sequential flakes	Core-tablet flakes	Total blade by-products
3a	39	15	13	21	49
3b	12	13	6	16	35
Totals	51				84

Biface by-products

Unit	Bifaces	Biface thinning flakes	Overshot flakes	End-thinning flakes	Edge bite flakes	Total biface by-products
3a	32	231	59	10	12	312
3b	13	63	30	1	4	98
Totals	45					410

We calculated a test of association for Units 3a and 3b using the Chi-Square statistic and four contingency tables: (1) blades:bifaces, (2) blade by-products:biface by-products, (3) blades:blade by-products, and (4) bifaces:biface by-products. The significance level was set at 0.05. The Chi-Square statistic proved significant for the blade by-products:biface by-products table ($\chi^2 = 11.1821$; df = 1; p = 0.0008) and blade and blade by-products table ($\chi^2 = 4.5999$; df = 1; p = 0.0320). While Unit 3a has 1.3 blade by-products per blade, Unit 3b has 2.9 blade by-products per blade. In addition, Unit 3a has 6.4 biface by-products per blade by-product, but Unit 3b has only 2.8 biface by-products per blade by-product. Viewed in conjunction with the inversely related variables blade product and biface by-product (Table 1), these ratios suggest several possibilities:

1) Blade production was more efficient in Unit 3a;
2) Relatively more blades were removed from the site during the 3b occupancy;
3) Blade and biface production occurred in separate parts of the site and the excavation block intersected different portions of those areas.

Ongoing spatial analysis may help discriminate between these outcomes. In summary, although approximately 14 percent more volume was excavated in Unit 3a than Unit 3b, in Unit 3a the density of blades, bifaces, and biface by-products is approximately three times higher, whereas in Unit 3b blade by-products are only 40 percent higher.

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AD-ICP-MS vs. LA-ICP-MS Analysis of Quartzite Sources, Gunnison Basin, Colorado

Bonnie L. Pitblado, Hector Neff, Stephen T. Nelson, and Carol M. Dehler

In *CRP* volume 23, we reported the results of a pilot study comparing five analytical techniques with potential to source quartzites from the 8000-year-old Chance Gulch site, Gunnison Basin, Colorado (Pitblado et al. 2006). We determined that petrography, instrumental neutron activation, and acid-di-

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gestion inductively coupled plasma mass spectrometry (AD-ICP-MS) can all discriminate among our sources, with the geochemical technique AD-ICP-MS performing the task most accurately.

Unfortunately, AD-ICP-MS requires sample pulverization. This is fine for geologic specimens, but problematic for Paleoamerican artifacts. Therefore, in January 2007, we added a sixth component to our sourcing pilot study: laser ablation-ICP-MS (LA-ICP-MS). This technique uses a laser beam just a few tens of microns in diameter to ablate a minute spot (or multiple spots, or lines) for trace-element analysis using a mass spectrometer.

For each of 12 samples representing 6 Gunnison Basin quartzite sources, we conducted 4 ablations and then averaged the results to increase the accuracy of trace-element detection. LA-ICP-MS detected 15 fewer elements than AD-ICP-MS (45 versus 60 of a possible 90). The questions for us became whether, as has been the case for others who have compared the two techniques (Habicht-Mauche 2002; Rockman 2003), our LA-ICP-MS data suggest an interpretive picture similar to our AD-ICP-MS data and whether the loss of 15 elements significantly compromised our ability to discriminate among sources using LA-ICP-MS.

We explored these issues various ways, one of which entailed plotting pairs of elements measured using both forms of ICP-MS, including rubidium and manganese (Figure 1). From this exercise, we concluded the following:

1. The structures of our AD- and LA-ICP-MS data *are* parallel;
2. At least some Gunnison Basin sources (e.g., Quarry 4) are somewhat homogeneous and distinct from others as demonstrated by both AD- and LA-ICP-MS data;
3. Replicate analyses of samples (3-6 and 5-1) yield similar results, with predictably greater spread in the LA-ICP-MS data;
4. The extremes in the LA-ICP-MS data are more extreme than in the AD-ICP-MS data, a function of sample micro-variation.

Our results suggest that AD-ICP-MS data have the greatest potential to discriminate among sources, because crushing samples ensures that *all* trace elements will be represented in their profiles. However, the crushing that produces the most accurate results destroys samples. LA-ICP-MS impacts only the tiniest bit of sample, virtually invisibly. This means that even a Clovis point can be profiled without compromising artifact integrity, but it also means that trace elements will not register if the laser misses the accessory mineral that contains them. That said, Figure 1 shows that even with just four ablations, LA-ICP-MS may yield data sufficiently resolved that crushing samples for AD-ICP-MS will not produce substantially more useful results. Future experiments will test this proposition, possibly resulting in the ability to source our quartzite and preserve it, too.

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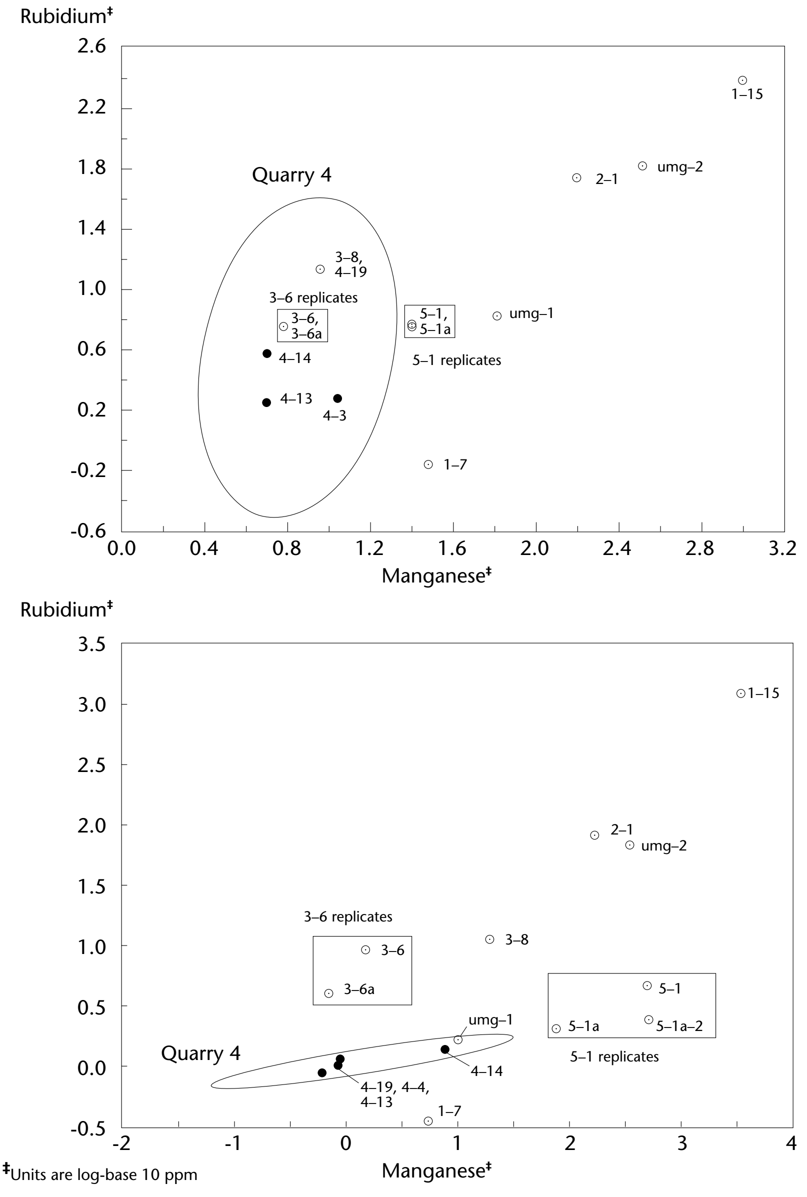

Figure 1. Bivariate plots of rubidium and manganese as measured by AD-ICP-MS (top) and LA-ICP-MS (bottom). Numbers to the left of hyphens indicate source locality (1, 2, 3, 4, 5 or UMG). Samples with "a" after them are replicates (the same samples tested more than once). These results have been enclosed in rectangles.

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Clovis Occupation of the Central Colorado High Country

Mary M. Prasciunas and Allen Denoyer

The Black Dumps site (5CF1573) is located in the San Isabel National Forest in central Colorado, in a high-altitude (2950 m asl) mountain park setting near a large perennial spring. The site was discovered by locals who found two heavily patinated and impact-fractured Clovis projectile-point bases and a probable Clovis midsection/distal fragment on the surface of the site. Recording and testing of the site by the United States Forest Service and the University of Wyoming's George C. Frison Institute of Archaeology and Anthropology in 2003 resulted in the discovery of artifacts ranging from the early Paleoindian through historic periods (Prasciunas and Denoyer 2005). The vast majority of the artifacts were found on the surface of the site, and subsurface testing did not reveal buried components. An AMS ^{14}C date on charcoal recovered just above bedrock roughly 2 m below modern ground surface in alluvium yielded an age of 5820 ± 40 RCYBP (Beta-200110), suggesting a lack of late-Pleistocene deposits.

In addition to the Clovis points discovered prior to the recording and testing of the site (Figure 1A–C), we identified a lateral fragment of a fluted projectile point, possibly Clovis or Folsom, with a portion of the edge reworked into a spokeshave (Figure 1D). Because the Clovis points are heavily patinated, raw material identification is difficult. However, a small nick along the margin of the largest point base suggests manufacture from local Trout Creek chert. The fluted lateral fragment is macroscopically similar to Troublesome chert from Middle Park (Black 2000).

Compared with other regions in the state, Clovis sites are relatively rare in the Colorado high country (Colorado OAHP site file database; Gilmore et al. 1999; Lipe et al. 1999; Martorano et al. 1999; Reed and Metcalf 1999; Zier and Kalasz 1999), as well as throughout the Rocky Mountain region in general (Frison 1991, 1992). While surface finds of isolated points do occur frequently enough to suggest the utilization of this ecological zone by Clovis people (Pitblado 1998; Brunswig 2003), the nature of Clovis mountain occupation remains unclear.

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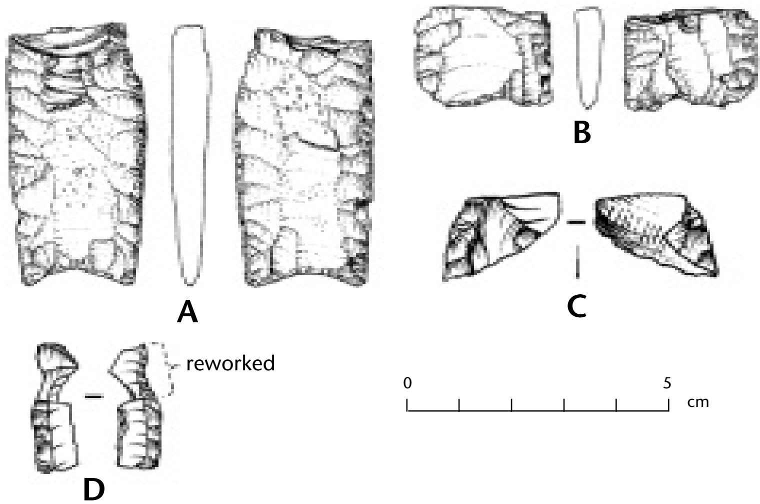

Figure 1. Clovis point bases (**A, B**), midsection fragment (**C**), and fluted and reworked lateral fragment (**D**) discovered on the surface of the Black Dumps site.

There are several possible explanations for the lack of Clovis sites in high-altitude settings. As traditionally argued, Clovis subsistence and land-use strategies could have revolved around resources more widely available on the Plains (Husted 1974). Another possibility is differential site visibility, either due to survey bias or geologic activity that resulted in a lack of intact late-Pleistocene surfaces (Pitblado 1998). Finally, glacial-induced environmental restrictions could also explain the lack of abundant Clovis sites in mountain settings (Brunswig 1992). Because the details and timing of late-Pleistocene/early-Holocene climatic events vary on a local scale (Reed and Metcalfe 1999), the accumulation of fine-grained paleoenvironmental data is crucial for distinguishing among these hypotheses. Conversely, paleoclimatic reconstruction efforts can benefit from the discovery of high-altitude early-Paleoindian sites which, even without buried components, provide evidence of habitability in specific locations during a fairly tightly constrained period of time.

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Fluted-Point Variability in the Central Great Basin

Michael F. Rondeau, Ted Goebel, and Mark B. Estes

Explaining typological variability in fluted points has become an issue of current interest in the Far West of North America (Beck et al. 2004; Elston et. al 2006; Rondeau 2006). Here we present results of a comparative analysis of two fluted-point collections from White Pine County, Nevada—one from Jakes Valley (Goebel et al. 2004) and the other from the Sunshine Well locality, Long Valley (Beck et al. 1994). We found significant differences between these two collections (Rondeau 2006).

Our sample consisted of six fragmentary fluted projectile points (5 bases and a mid-section) from Jakes Valley (Figure 1) (Goebel et al. 2004), and 31

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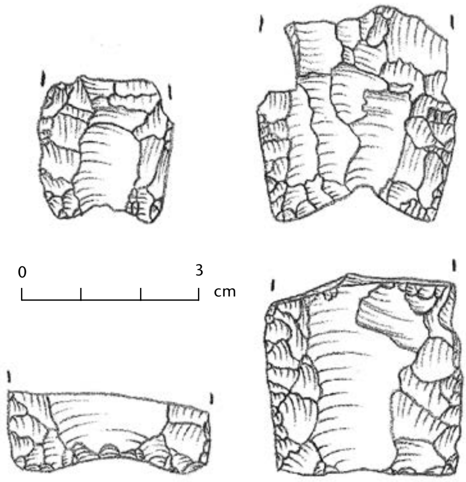

Figure 1. The fluted points from Jakes Valley, Nevada.

fluted or unfluted concave-based projectile points from Sunshine Well, of which 26 were basal fragments and 5 were complete or nearly complete specimens. Of the Jakes Valley specimens, five are from the Jakes Depression site and one is from Illipah Creek-1. The Sunshine Well points were collected and initially described by the late Phil Hutchinson, an avocational archaeologist from Reno, Nevada (Hutchinson 1988). All the points from Jakes and Long valleys described here come from surface contexts.

Compared with the Sunshine Well points, 5 of the 6 Jakes Valley points have greater widths, 6 of 6 have greater thicknesses, and 7 of 13 flute scars have greater widths than the Sunshine Well points. Although all these points have concave bases, depth of concavity measurements on the Sunshine Well points are typically greater than those on the Jakes Valley points.

All six Jakes Valley specimens have pronounced flute scars on both faces. In contrast, Sunshine Well end thinning is much more variable. Eight points have clear fluting, 10 have clear fluting and pressure end thinning, 3 are intermediate with basal thinning transitional in size between obvious flute scars and pressure end thinning, 8 have only pressure end thinning, and one has no end thinning of any kind. Such intermediate and end-thinned forms have not been found in Jakes Valley.

All six Jakes Valley points show moderate lateral edge-grinding, and all five bases show moderate basal grinding. The lateral margins of the Sunshine Well points range from being moderately edge-ground (15), lightly edge-ground (8), to not ground at all (8). Similarly, their basal margins range from being moderately edge-ground (6), lightly edge-ground (11), to not ground at all (13). One Sunshine Well point was too weathered to measure its degree of edge-grinding.

Sunshine Well yielded five specimens with whole or remnant nipple-style fluting platforms inset within a concave base. This feature is reminiscent of remnants occasionally depicted within concave bases of Folsom points (Frison and Bradley 1980, Fig. 31f; Morrow and Morrow 1999, Fig. 5b and 6v). These five Sunshine Well specimens had large, very pronounced multiple flute-like pressure scars that ran in pairs to either side of the nipple remnant, and a sixth point had attributes that suggested such an inset basal element existed at an earlier stage of manufacture. Such features have not been observed on the Jakes Valley points.

The Sunshine Well specimens bear generally smaller and often well-aligned series of scars along their lateral margins, giving them a more refined appearance than the Jakes specimens.

The Jakes Valley points appear closer to Western Clovis points in morphology and technology than those from Sunshine Well. They are typically edge-ground, larger in size, fluted, and have bases that are less concave than most of the Sunshine Well points. Further, their lateral and basal margins do not show signs of having been carefully pressure flaked, as the Sunshine Well points do. Beck et al. (2004) have argued that this fine pressure flaking suggests placement of the Sunshine Well specimens as post-Clovis. We further suggest that the following features can be used to distinguish the Sunshine Well points from Western Clovis forms: (1) pronounced post-flute end thinning that removed nearly all evidence of prior flute scars; (2) apparent grading from fluting to pure end thinning; (3) decline and absence of basal edge grinding; and (4) use of inset fluting platforms.

Since all the Jakes Valley points are from surface contexts, we cannot independently date them; however, during trenching of gravel alluvium at the Sunshine Locality, Beck and Jones (1997:192) found a small fluted-point base loosely associated with charcoal that was ^{14}C-dated to 10,320 ± 50 RCYBP. This point is similar to others described above from Sunshine Well. Although it and the dated charcoal were not from an obvious primary context, this single ^{14}C date as well as the results of our analysis presented here suggest that the specimens from Sunshine Well may represent a post-Clovis variant, while the Jakes Valley points may represent a Far Western Clovis complex.

Our Jakes Valley fieldwork was funded by the Sundance Archaeological Research Fund, University of Nevada Reno. Access to the Sunshine Well collection was provided by Pat Barker and Tom Burke of the Nevada State Office of the Bureau of Land Management. Appreciation is expressed for the help and support of Eugene Hattori and Maggie Brown of the Nevada State Museum. Thanks to Tom Jones and Charlotte Beck who commented on an earlier draft of this paper. Any errors or shortcomings in this report are the responsibility of the authors.

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Use-Wear Analysis of the Clovis Biface Collection from the Gault Site in Central Texas

Ashley M. Smallwood

A collection of 65 Clovis bifaces and biface fragments recovered from the Lindsey Pit of the Gault site, Texas, were analyzed for indications of use wear. The bifaces represent all stages of manufacture, with stage 1 being a blank and stage 7 a finished Clovis point (Dickens 2006). Of the 65 bifaces recovered, 10 specimens (15.38 percent) have evidence of utilization. Of these, one biface is stage 2, one is stage 3, two are stage 5, one is stage 6, and five are stage 7. Here I present results of high-power microscopic use-wear analyses of these Gault bifaces.

As a part of this study, I conducted experiments to facilitate interpreting use wear on the prehistoric assemblage. All specimens were examined on a Leica DMLA compound microscope fitted with Nomarki optics at magnifications of 100x, 200x, and 500x. The images viewed with the Cool SNAP-Pro camera were directly acquired with Image Pro and In-focus 1-60 3-D imaging software. Replica points were manufactured as closely as possible to original forms from a local variant of Edwards chert. A succession of thrusting experiments with the replicas led to diagnostic use wear with a consistent pattern of distribution. Polish elements were concentrated on high arrises and facets at the tip and extend proximally along the center axis; these use units intensified with each stabbing. Linear indicators were oriented in the direction of impact and penetration. The lateral edges of the points developed isolated use units of an ephemeral polish, but traces were by far more apparent and developed along each point's center axis. Furthermore, the point replicas obtained diagnostic traces of use wear after only one series of impact with the animal. Butchering experiments created examples of use-wear traces produced by cutting hide,

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meat, and bone. Use-wear evidence remained strictly ephemeral in development and was distributed in isolated areas along the extreme cutting edge. Diagnostic evidence of butchering includes polished surfaces on proximal facing facets along the lateral edge and perpendicular linear indicators initiating at the cutting edge. An additional series of experiments demonstrated that a tool acquires distinguishable traces of wear from butchering and stabbing, and in agreement with Kay (1998) these distinguishable traces were maintained after consecutive uses. The placement of polished facets and superimposed linear indicators map out changes in tool function over time. Finally, a series of experiments established indications of use caused from chopping and scraping. Polish development remained ephemeral in isolated use areas oriented with the tool's trajectory. These experimental results helped define indications of use, use signatures of different functions, and the rate of use-wear development.

The five Gault Clovis points and point fragments show evidence of use-wear from complicated use histories. All the points acquired linear indicators and polish distributions indicative of their use as projectiles (Kay 1996; Smallwood 2006). Polish is distributed in a linear fashion from the tip to the flute scar along the center axis, and linear indicators incise the microtopography in the same direction parallel to the long axis. Two specimens also have polished surfaces on proximal facing facets along the lateral edge, and perpendicular linear indicators begin at the cutting edge. These patterns are indicative of cutting (Ahler 1979); I infer that the serviceable blade edges were employed as butchering knives. One of these points appears to have been cyclically utilized as a projectile, a butchering tool, and finally as a projectile. Highly developed haft wear on the proximal ends of three of the projectile points helps reconstruct the haft-binding technique. Features including edge grinding, linear indicators oriented with impact, and polish on interior flake arrises around the flute are evidence for a wedge style of foreshaft or mainshaft hafting (Kay 1996).

While there are comparatively more finished tools with evidence of utilization, there are also bifaces in the early stages of manufacture that have traces of use wear. All polish elements, only evident at a 500x magnification, are located strictly on high features of the microtopography at the working edge. Polish elements are ephemeral and remain isolated in a limited distribution on the tool surface. Working edges developed extensive scarring or microflaking, but do not appear to be rounded from use. This use wear indicates these tools were employed for expedient tasks, such as cutting, chopping, and scraping (Ahler 1979).

In conclusion, there is a corresponding relationship between the number of Clovis bifaces in later stages of manufacture and the number of bifaces utilized as tools. The finished points were extensively used, reworked, and recycled, with use wear more intensely developed than the traces of use wear on the experimental points. Unfinished bifaces were employed for expedient tasks, and their use represents site activities beyond quarrying and lithic-tool manufacture. Extensively utilized finished fluted points were discarded, while new bifaces were manufactured and used at various stages of completion. In summary, this use-wear analysis suggests the Gault site was a multi-purpose site, and quarrying was the primary site activity.

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Source Determination of Obsidian Artifacts from Swan Point (XBD-156), Alaska

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Chemical sourcing of obsidian artifacts serves an important role in establishing prehistoric patterns of trade, exchange, and interaction. In Alaska and adjacent areas of British Columbia and the Yukon, more than 1,200 obsidian artifacts and geologic source samples have been analyzed by various analytical techniques (e.g., Cook 1995) resulting in the identification of more than 20 chemically discrete obsidian "sources" throughout this vast region. Despite the numbers of samples analyzed, the chemical profiles for most sources are represented by only a few samples and the geologic sources for many artifacts remain unknown. As part of a larger effort to better understand prehistoric patterns of resource utilization, trade, and social interaction in northeast Asia and Alaska, we geochemically analyzed 29 obsidian artifacts excavated from Swan Point.

Swan Point is a stratified, multi-component site located in the central Tanana

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Valley near Delta Junction, Alaska (Holmes et al. 1996). The site spans more than 14,000 years and is divided into five cultural periods: Late Taiga Period (ca. 3000 CALYBP to historic time; Zone 1a), Middle Taiga Period (ca. 6000 to 3000 CALYBP; Zone 1b), Early Taiga Period (ca. 9500 CALYBP; Zone 2), Transitional Period (ca. 13,000 to 9500 CALYBP; Zone 3), and Beringian Period (>13,000 CALYBP; Zone 4). Although obsidian occurs as a minor raw material throughout the entire Swan Point cultural sequence, it is most prevalent during the Middle and Late Taiga Period (Zone 1, levels 1-6). Obsidian is rare in the Transitional and Beringian Periods, but exists nonetheless.

The Swan Point obsidian was analyzed using a portable benchtop X-ray fluorescence spectrometer in summer 2006 at the National Park Service Curation Facility in Anchorage, Alaska. All analyses were nondestructive. The accuracy of the group assignments was assessed by analyzing known Alaskan obsidian previously analyzed and curated at the University of Missouri and through the routine analyses of Peruvian obsidian samples that served as quality-control samples. Following the analyses, it was possible to assign the Swan Point artifacts to three previously identified compositional groups—Batza Tena (middle Koyukuk river drainage), Wiki Peak (Nutzotin Mountains), and Group H (unknown source locale) (Figure 1). The majority of the obsidian originated from the Batza Tena source (n = 20; 2 from Zone 2, one from Zone 3, the remainder were from Zone 1); 6 samples were from Wiki

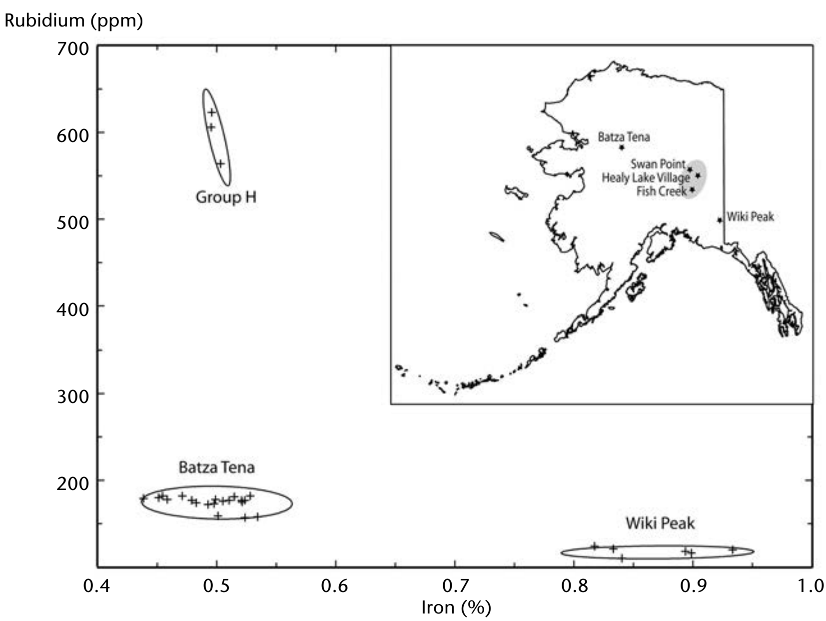

Figure 1. Bivariate plot of iron and rubidium showing the chemical separation of the Wiki Peak, Batza Tena, and Group H sources. Individual analyses of Swan Point artifacts are denoted by pluses. The map of Alaska (inset) shows the locations of the Wiki Peak and Batza Tena obsidian sources relative to the Swan Point, Fish Creek, and Village sites; the shaded area denotes the probable location of the Group H source.

Peak (one from Zone 1a and 5 from Zone 1b), and 3 were assigned to Cook's (1995) Group H (all from Zone 4). Prior to this study, only two other examples of Group H obsidian were known—both from sites located in east-central Alaska (Figure 1)—one from Level 7 of Healy Lake Village (XBD-020; ca. 10,560 CALYBP) and a second from a component at Fish Creek (XMH-219) believed to date to ca. 2070 CALYBP. The occurrence of Group H obsidian at Swan Point Zone 4 and Healy Lake Village may suggest not only the exploitation of a localized and apparently restricted obsidian source, but also that a connection may exist between the inhabitants of Healy Lake Village and Swan Point. Alternatively, if Group H obsidian is non-local, then the question of the origin of Group H obsidian may be important for understanding where late-Pleistocene/early-Holocene migrants to the area originated and what non-local raw material resources they may have had access to. The identification of the Group H obsidian source is therefore critical to furthering our understanding about the earliest inhabitants of Alaska.

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Ongoing Investigations of the Meserve Type Locality in Central Nebraska

Chris Widga

In 1923, two brothers discovered bison bones eroding out of the south bank of the Platte River in Hall County, Nebraska. These remains were brought to the attention of Frank G. Meserve, a biologist at what was then Grand Island College, who revisited the site the following summer. Meserve recovered two bison skulls, numerous postcranial remains, and, notably, a lanceolate projectile point in direct association with the bison. Subsequent correspondence with Erwin Barbour of the University of Nebraska State Museum (UNSM) identified the remains as *Bison bison occidentalis.* A UNSM field party led by C. B.

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Schultz revisited the site in the summer of 1931, recovering additional bison remains, clarifying stratigraphic relationships, and adding to the inventory of cultural materials. Letters between Barbour and Meserve indicate that in November of that year, the Grand Island College and UNSM collections were consolidated prior to publishing a series of brief articles mentioning the Meserve locality (Barbour and Schultz 1932; Meserve and Barbour 1931; Schultz 1933). Since that time, other authors have explored the cultural relationships of people responsible for Meserve-type materials (Davis 1962; Knudson 2002; Myers and Lambert 1982); however, the small faunal collection curated in the UNSM has never been re-analyzed and the type site itself has never been revisited.

In 2004, I undertook an inventory of the Meserve faunal collection curated at the UNSM. Overall, the bone is in good condition, although certain specimens are heavily plastered or landmarks are difficult to identify owing to excessive shellac. Over 40 specimens can be identified to skeletal element. Most are complete or nearly complete elements. Cranial and foot bones are common; however, high-utility limb bones are represented only in the single, mounted individual mentioned in Barbour and Schultz (1932). No butchering marks were observed. Four adult bison of different ages are represented by mandibular rami. It is possible that fragmentary maxillary remains represent an additional individual. A single large older male skull with associated mandibular dentitions shows cranial dimensions similar to other documented *Bison bison occidentalis* specimens (McDonald 1981). No seasonality estimate based on eruption and wear patterns in dentitions is possible at this time.

After inventorying the extant collection, the potential location of the 1931 UNSM excavations was identified through discussions with local landowners and a brief cutbank survey. Despite extensive erosion in the early decades of the 20th century (Barbour and Schultz 1932), the Meserve locality likely experienced significantly less erosion after the construction of Kingsley Dam in 1936. Comparison of aerial photographs from 1938 and 2002 shows an indistinguishable channel configuration, despite dramatic changes in vegetation cover. Even with this reduced erosion regime, the river has maintained a steep 4-m cutbank at the Meserve locality. There is a shallow, steep-sided swale that may represent the remains of the 1931 UNSM quarry, as well as an extensive horizontal exposure of terrace deposits showing a distinct thickened A horizon ca. 2.6 m below the modern surface. A bison 2nd phalanx from the middle of this paleosol was submitted to the University of Arizona AMS laboratory for ^{14}C-dating (purified collagen fraction). The resulting ^{14}C date, 9380 ± 100 RCYBP (AA-68354; δ^{13}C: -10.8‰), represents the first radiometric age estimate for the Meserve-type locality. This age estimate is similar to other dated localities in the central Plains with artifacts showing Dalton-like technological attributes (Hofman and Blackmar 1997; Mandel et al. 2004); however, these age estimates are generally more recent than well-dated Dalton components in the Missouri Ozarks and southeastern United States (Goodyear 1982; McMillan 1976; O'Brien and Wood 1998).

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Maximizing Tool Use: Endscrapers from the Gault Site

James E. Wiederhold

Twelve Clovis endscrapers recovered from the Gault site, Texas, were analyzed for traces of microwear to determine tool function (Wiederhold 2004). These scrapers came from two geologically distinct components excavated during

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the 2000 Texas A&M University excavations at the area known as the Lindsey pit. The Clovis material occurred on the slope of a buried gravel bar, in pond clays, and within overlying floodplain deposits capped by a weak soil and separated from later cultural deposits by an erosional unconformity (Waters and Shafer 2002).

The microwear study was conducted to determine if the endscrapers were used to work animal hides, since hide working is often the inferred function of these tools in the archaeological literature (Brink 1978; Hayden 1979, 1986; Keeley 1980; Schultz 1992; Shott 1995; Vaughan 1985). The analysis included extensive actualistic and goal-oriented experiments dealing with the use of endscrapers. In this way, the analyst experimentally creates a situation that will produce, as closely as possible, a suite of use-wear characteristics analogous to those found on tools from archaeological sites. The experimental endscrapers, both hafted and unhafted, were used to perform a range of scraping activities including all of the tasks necessary for dressing bison hide (Wiederhold 2004) as well working wood, antler, bone, and horn.

Two Leica microscopes were used to examine the bit edges of both the archaeological and experimental sets of endscrapers and to photograph any use-wear characteristics. Microflaking and rounding were observed with an MZ 12.5 motorized stereomicroscope with an imaging capability of 1 to 160 magnifications. A DMLA compound microscope fitted with Nomarski optics was used to examine polish and striae at 100, 200, and 500 magnifications.

The 12 Gault endscrapers are a fairly homogeneous group in terms of size, morphology, and function. They are small, averaging 44 mm in length. Edge angles of the bits are relatively steep with an average of 84.5°. Microscopic examination of the bits reveals a great deal of damage from stacks of step fractures due to microflaking during use (Figure 1). Although they were originally hafted, by the time of discard they had been removed from their hafts because their reduced length and steep edge angle made them inefficient hafted tools.

Nine of the 12 have “spurs” on one or both sides. These spurs are acute projections that occur at the junction of the lateral edge of the hafting element and the base of the bit. They are very likely remnants of the final resharpening before the scraper was removed from the haft. After the scrapers were taken from the haft, but before they were discarded, the spurs saw use as graving or scoring tools. Microscopic examination further indicated that in some cases lateral edges were used during this time.

These factors indicate that the endscrapers were at the end of their use lives and although possibly used for working hide earlier in their use lives, the final tasks they performed were on a much harder material. This assemblage of endscrapers exhibits extensive use represented here by use of the bit through several resharpenings and continued use of the bit, spurs, and lateral edges after removal from the haft.

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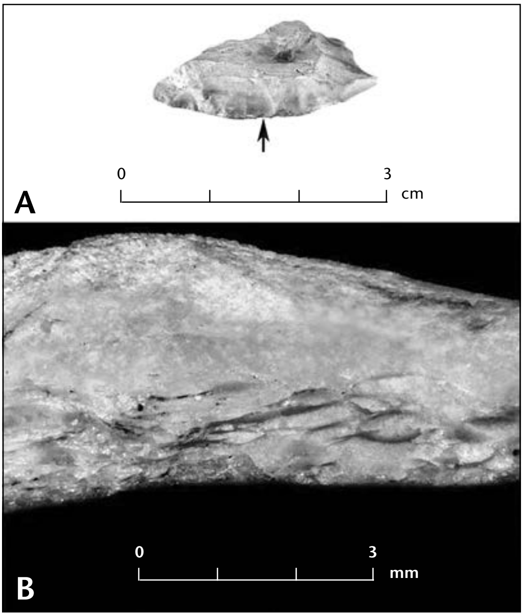

Figure 1. A, Gault endscraper 227. **B,** image taken at 16X showing intensive microflake edge damage at the center of the bit as evidenced by stacks of step-fracture terminations.

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A Discussion of Two Early Headland Sites on the Southern Oregon Coast

Samuel C. Willis and Loren G. Davis

Late-Quaternary marine transgression has greatly skewed archaeological perspectives on early coastal adaptive patterns along the Northwest Coast. Because of this, early coastal sites are more likely to be found in portions of the modern landscape that were much more distal to what was the late-Pleistocene to early-Holocene Pacific shoreline. Along Oregon's southern coast, these types of early cultural occupations are known as "bluff sites" owing to their preservation on tectonically uplifted headlands and absence of marine resources (Lyman 1991; Ross 1984). To date, late-Pleistocene and early-Holocene bluff sites from this region include Indian Sands (35CU67C), a multicomponent site with evidence of human occupation dating from 10,430 ± 150 RCYBP (Beta-170406, charcoal) to 6440 ± 670 CALYBP (thermoluminescence) (Davis 2006; Davis et al. 2004), and Devil's Kitchen (35CS9), which contains a stratified record of human occupation that begins sometime after 11,000 ± 140 RCYBP but before 5900 ± 80 RCYBP (all dates on charcoal) (Davis et al. 2006; Hall et al. 2005). A brief examination of the role that these sites played in an early coastal lifeway is afforded through a comparison of their technological patterns and environmental context. Only brief descriptions of the lithic assemblages are provided here, as they are discussed at length elsewhere (Hall et al. 2005; Willis 2004, 2005).

Both sites contain significant quantities of Jurassic Otter Point (JOP) chert in naturally uncorticated nodules or corticated alluvial cobbles. Although similar raw materials were reduced in very similar ways at both sites, the resulting tool assemblages are quite different.

The Indian Sands site shows a focus on the production of early-stage bifaces, facilitated by the creation of large, thick, lenticular flakes from multidirectional chert cores. The large flake (or core-on-flake [Hovers 2007]), was then reduced by percussion in a multidirectional fashion in order to produce a large early-stage biface. These early-stage bifaces retain the original single faceted platform of the core-on-flake. Linear dimensions of non-formal modified flakes are consistent with the larger negative scars of the cores-on-flakes. Two basal fragments of finished foliate bifaces were also recovered, indicating refurbishment of hafted biface systems. Cobble tools are absent in the early component.

The lithic assemblage from the Devil's Kitchen site is represented by a lower frequency of early-stage biface manufacture in the middle- and early-Holocene deposits (17 percent of all tools). Instead, core preparation for macroflake production seems to have been the main goal at Devil's Kitchen (42 percent). Furthermore, core design was highly variable as reflected in the

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use of unidirectional, bifacial, and multidirectional forms, some made on rounded cobbles. Hafted bifaces appear in serrated foliate and stemmed forms (8 percent). Modified flakes constitute a large percentage (33 percent) of lithic tools recovered. The Devil's Kitchen assemblage fits fairly well into the Pebble Tool Tradition of the Pacific Northwest (Carlson 1990, 1996).

To summarize, the lithic assemblage and debitage patterns from Indian Sands show an emphasis on manufacturing lithic bifaces for transport elsewhere and the repair and retooling of hafted-biface systems from local JOP chert nodules. The Devil's Kitchen assemblage shows an emphasis on creating and applying a generalized toolkit dominated by modified macroflakes produced from cores made on locally available JOP chert present in rounded cobble form.

Not surprising, bluff sites do not reflect a single pattern of cultural activity. Contextually, the Indian Sands and Devil's Kitchen sites occupy different headland environments. Indian Sands is found in a paleosol developed in an aeolian depositional setting upon a high headland. The Devil's Kitchen site is contained in alluvial deposits that would have been part of a riparian zone during the late Pleistocene and early Holocene (Hall et al. 2005; Punke and Davis 2006). In both cases, the lithic assemblages reflect early hunter-gatherers pursuing activities related to different inland resources; however, the specific technological focus differs at each location. Because the available sample of late-Pleistocene to early-Holocene assemblages is limited along the southern Northwest Coast, we can offer two interpretations of these technological patterns at this time. First, early coastal peoples may have employed a generalized approach to technological organization; variations of toolkit manufacture and composition were therefore synchronously applied at different parts of what was an inland landscape. Alternatively, the bifacial emphasis seen at Indian Sands may temporally precede the macroflake industry recovered at the Devil's Kitchen site; however, the reasons behind such a technological shift are not clear. Greater chronometric control on the different lithic industries is needed to fully evaluate which of these interpretations is the correct one.

By demonstrating that bluff sites differ in their content and structure, and that the technological basis for these differences may be related to the late-Pleistocene, early-Holocene, and middle-Holocene environmental contexts in which associated technological behaviors were applied, we offer productive avenues toward elucidating early Northwest Coastal adaptive patterns. Moreover, by studying the technological links between specific environmental contexts we can apply these associations in a broader search for other early sites in comparable places.

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Late-Paleoindian Use of Antlers Formation Toolstone at Pumpkin Creek, Southern Oklahoma

Don G. Wyckoff and Mike Waller

This brief report documents ongoing studies of early Holocene artifacts and their clues to Antlers Formation chert and silicified sandstone use in southern Oklahoma. The Antlers Formation is early Cretaceous (120 mya) beach sand and deltaic deposits that now constitute a narrow (50 to 130 km) outcrop arching from southeast Oklahoma to south-central Texas (Hart and Davis 1981; Hill 1901). In Texas the formation is part of the Trinity Group and its important aquifer.

In Oklahoma, the Antlers Formation lies south of the Ouachita Mountains and extends west over 250 km to south of the Arbuckle Mountains. Today, the formation is mapped north and south of the east-flowing Red River. In early Cretaceous times, however, the drainages ran northeast-southwest from such uplands as the Ozark Plateau, the Ouachita Mountains, and the Arbuckles. These ancient streams carried fine and coarse sediments south where, upon reaching the grade of the Cretaceous sea level, these fluvial materials became incorporated in deltas and fine sandy shorelines. Among the coarse sediments

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are gravels that contain clasts of high-quality cherts and quartzite. Intriguingly, the lithologies of these materials seldom resemble those known for today's Ozarks and Ouachitas. South of the Arbuckles, pebble- to fist-size cobbles are manifest in the Antlers Formation because Quaternary erosion trends west to east, thus cutting across the linear alignments of the Cretaceous drainages. South of the Arbuckles the Antlers Formation is identifiable as a glaringly white, slightly calcareous, fine sand. The gravel clasts here are frequently cryptocrystalline cherts of diverse colors (black, tan, red, and blue gray) and fine- to medium-textured, silicified sandstone. Some 30 percent of the chert clasts manifest sponge spicules and fusilinid-like fossils; these do not resemble the fossil-bearing cherts common to the Permian limestones in the Flint Hills across the state to the north. All knappable clasts are subangular to well rounded and have cortex that is thin and nearly polished.

Late-Paleoindian use of Antlers Formation cherts and quartzites was first documented at the Pumpkin Creek site in Love County, Oklahoma (Wyckoff and Taylor 1971). The few diagnostic projectiles available for that study included forms attributable to Plainview, Meserve, and Scottsbluff. Since 1971, numerous additional surface finds at this site include lanceolate forms with attributes of both Dalton and Plainview, side-notched early Archaic forms, and a slightly constricted stemmed lanceolate form. Examples are shown in Figure 1. Broken early-stage bifaces and varied sizes of bifacial thinning flakes attest to people collecting cobbles in the vicinity and process-

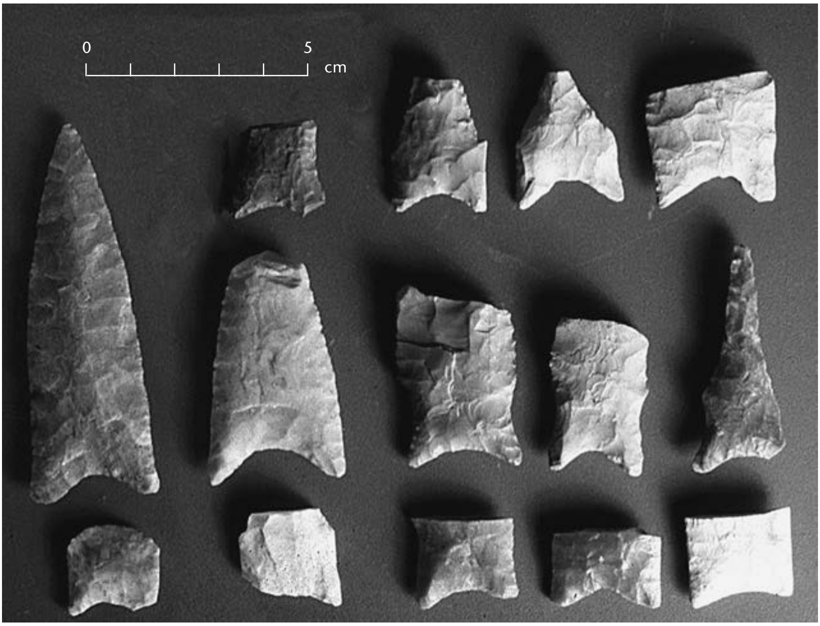

Figure 1. Examples of diverse lanceolate forms recently recovered from the Pumpkin Creek site (34Lv49) in Love County, Oklahoma. All are of cherts believed to have come from the Antlers Formation.

ing them into various stages of bifaces. Although the surface collection (flakes and tools) from this site exceeds 3,000 pieces, few other formal tools or utilized flakes are represented. A minimum analytical nodule study of materials was conducted several years ago (Neustadt 2000), but sufficient new materials merit another application of this kind of study, especially one involving more detail about products being made from individual cobbles.

Currently, our attention is increasingly on tools, flakes, and sources of a very fine textured, silicified sand. Once thought to be clasts in the gravels, the discovery of segments of a substantial, angular slab of this material at Pumpkin Creek suggests a different genesis and source. This slab appears to have weathered out of the Antlers Formation. Thus, it may have formed from and within the fine sand of this formation. Field searches thus far indicate such material is rarely manifest, yet the material was highly favored by people making San Patrice and Plainview-like bifaces in this locality. Further, this may be the white quartzite reported for the Aubrey Clovis site some 80 km to the south (Ferring 1995).

We deeply appreciate the help of Larry Allen and Neil Suneson (Oklahoma Geological Survey) in our study of Antlers Formation materials. Also, Larry Banks and Bob Patten have provided useful comments and insight to our attempts to understand the Antlers Formation "silicified sandstone."

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A Fluted Projectile-Point Base from Bering Land Bridge National Preserve, Northwest Alaska

Christopher Young and Sabra Gilbert-Young

In July 2005, the National Park Service, Western Arctic National Parklands, conducted an archaeological reconnaissance near Serpentine Hot Springs

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within the Bering Land Bridge National Preserve on the Seward Peninsula. This investigation located the basal portion of a fluted projectile point (Figure 1) found on the surface of a large dispersed site consisting of at least six distinct concentrations of chipped-stone debris and tools. The site is located along the edge of a granite outcrop approximately 1.3 km north of Serpentine Hot Springs. This is the first fluted point found in situ on the Seward Peninsula.

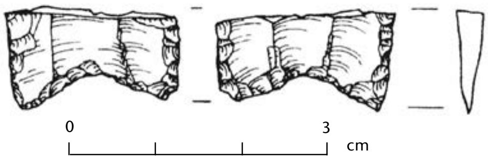

Figure 1. The fluted point from Serpentine Hot Springs, Alaska.

The point is made of a brown cryptocrystalline silicate most likely originating from a source in the Brooks Range approximately 320 km to the north. The point fragment is 12 mm long and has a proximal end terminating in a snap fracture. Maximum thickness is 4 mm; it is 20 mm wide at the point of fracture and 17 mm wide at the base. On both faces, edges are continuously microflaked, and lateral and basal edges are ground. The base of each face has three longitudinal flake scars including a single deep channel-flake scar removed from the centerline and shallower longitudinal flake scars removed on either side. The flute scars range between 4 and 7 mm, with the center flute widest on both faces.

Two 50-by-50-cm test units placed within 1.5 m of the point base yielded seven flakes in association with small flecks of charcoal. No faunal material was encountered. The proximal end of a parallel-edged channel flake was recovered at 5 cm below the surface and is made from a different material (slightly transparent chalcedony) from the point base. It has a length of 17 mm, a width of 10 mm, and a thickness of 1.5 mm. Four flakes came from depths between 25–47 cm below the surface. Four charcoal samples (two identified as *Salix* sp.) were recovered and submitted for AMS ^{14}C dating. Resulting dates are 10,060 ± 40 RCYBP (Beta-208367), 10,250 ± 60 RCYBP (Beta-208368), 10,250 ± 60 RCYBP (Beta-208370), and 9480 ± 40 RCYBP (Beta-208369) (this last sample was too small for a $^{13}C/^{12}C$ ratio measurement). The charcoal specimens were recovered from 37, 36, 39, and 30–32 cm below the surface, respectively. Test unit profiles indicate only a moderate amount of cryoturbation likely due to good drainage provided by a fairly coarse soil column and regolith substrate.

The majority of northern fluted points exhibit the unique technological adaptation of double or triple fluting. Most northern fluted points are surface finds; very few are recovered from excavated contexts. All suffer from the inconsistencies of dating methods and/or poor associations to dated material, leaving the age of fluted points in Alaska very much in question (Clark 1991; Reanier 1995). The nascent investigations at this site illustrate the potential for it to become the oldest site on the Seward Peninsula as well to demonstrate the antiquity of fluted points in Beringia.

The authors wish to acknowledge Claire Alix for the wood charcoal identifications and Sarah Moore for the artifact illustrations.

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Paleoenvironments: Plants

A Late-Glacial/Early-Holocene Pollen and Nonsiliceous Algae Spectrum from Five Island Lake, Northcentral Iowa

James K. Huber, E. Arthur Bettis III, and Deborah J. Quade

We report on pollen and nonsiliceous algae of a sediment sample collected 762–790 cm below the floor of Five Island Lake, Palo Alto County, Iowa, during a cultural resource assessment program associated with lake dredging. Five Island Lake is located on the northeast edge of Emmetsburg, Iowa (43° 09.35′ N, 94° 39.01′ W). The lake originated as part of a subglacial drainage system during the time the Des Moines Lobe glacier was at the Algona Moraine. The sampled interval is composed of black mucky peat, bracketed by an upper ^{14}C age of 9360 ± 40 RCYBP (Beta-168947) and two basal ages of 12,620 ± 80 (Beta-168945) and 12,540 ± 40 RCYBP (Beta-168946).

The pollen sample was processed using a modified Faegri and Iverson (1975) technique addition of KOH, HCl, HF, and acetolysis), stained with safranin and stored in silicone oil for counting. One standard *Eucalyptus* tablet was added to the sample to estimate pollen concentration values (Maher 1972). The pollen sum consists of 440 grains of trees, shrubs, herbs, and vascular cryptogams.

The pollen spectrum is 73.6 percent arboreal pollen (AP). *Picea* (spruce) is the most dominant pollen type (15.9 percent), followed by *Betula* (birch, 14.1 percent), *Alnus* (alder, 12.5 percent), *Fraxinus* (ash, 7.3 percent), *Quercus* (oak, 6.1 percent), *Ulmus* (elm, 5.0 percent), and *Ostrya/Carpinus* (hop hornbeam/hornbeam, 3.6 percent). The value of *Pinus* (pine) is low (1.0 percent). Other AP types occurring in amounts of less than 2 percent are *Populus* (aspen/cottonwood), Cupressaceae (cedar), *Larix* (tamarack), *Pinus banksiana/P. resinosa* (jack/red pine), *Abies* (fir), *Tilia* (basswood), *Acer* (maple), *Salix* (willow), and *Corylus* (hazelnut).

Nonarboreal pollen (NAP) makes up 26.4 percent of the pollen sum and is

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dominated by Cyperaceae (sedge, 7.3 percent), *Artemisia* (wormwood, 6.6 percent), Poaceae (grass, 3.6 percent), and *Ambrosia* (ragweed, 1.6 percent). Other NAP comprising less than 2 percent of the pollen sum includes Chenopodiaceae/Amaranthaceae (Goosefoot/Amaranth families), Tubuliflorae (subfamily of Asteraceae), Caryophyllaceae (Pink Family), Apiaceae (Parsley Family), *Dryopteris*-type (shield fern), *Equisetum* (horsetail), and *Pteridium*-type (bracken fern). Aquatic/wetland pollen is represented by *Lycopus*-type (bugle weed), *Nuphar* (yellow pond lily), and *Sagittaria* (arrowhead) in trace amounts. Also occurring is the moss *Sphagnum* (sphagnum).

Nonsiliceous algae associated with the pollen record include *Gloeotrichia*-type (6.7 percent), a blue-green algae (Cyanochloronta) and seven taxa of green algae (Chlorophycophyta). The green algae *Botryococcus, Scenedesmus, Pediastrum* undifferentiated, *P. araneosum* var. *rugulosum, P. Boryanum, P. duplex,* and *P. integrum* are present with values of 2.2 percent or less. The relative abundance of *Gloeotrichia*-type, an algae that fixes atmospheric nitrogen (Lee 1980; Van Geel et al. 1989) and the low concentration of nonsiliceous green algae in the sample suggest nutrient-poor conditions at Five Island Lake at the Pleistocene/Holocene transition.

The pollen assemblage from Five Island Lake correlates well with the *Betula-Alnus* Pollen-Assemblage Zone, dated to 11,800 ± 110 RCYBP at Lake West Okoboji, located 45 km to the northwest in Dickinson County, Iowa (Van Zant 1979). Van Zant (1979) interprets this zone as representing a mixed coniferous-deciduous forest that marks climatic amelioration in this area and the end of the late glacial. Cool moist conditions are indicated by the abundance of *Ulmus, Ostrya/Carpinus,* and other thermophilous deciduous trees. The moderate abundance of NAP types (24.6 percent) suggests the presence of an open mixed coniferous-deciduous forest or a mixed coniferous-deciduous forest with openings in the vicinity of Five Island Lake approximately 12,000 RCYBP.

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Paleoenvironments: Vertebrates and Invertebrates

Parasitism as a Potential Factor in Reduced Genetic Variability in Late-Quaternary Musk Ox (*Ovibos moschatus*)

Barry W. Baker

Recent studies have documented low genetic variation in modern musk ox populations (*Ovibos moschatus*) (Fleishman 1986; Groves 1997; Holm et al. 1999, MacPhee et al. 2005; Mikko et al. 1999). MacPhee et al. (2005) analyzed ancient DNA from dated fossil musk ox samples and provisionally suggested this reduction occurred sometime after the Last Glacial Maximum but before the mid-Holocene (18,000–4000 RCYBP). Here I draw from ongoing research by parasitologists and speculate that parasites played a role in this reduced genetic variability. This has implications for understanding the causes of late-Pleistocene megafaunal extinctions and population declines. It also echoes the work of MacPhee and Marx (1997) in suggesting that research in paleomicrobiology might provide insights on these declines (Hecht 2001).

Several studies have shown that modern musk ox exhibit low genetic variation. Fleischman (1986) reported only one polymorphic allozyme locus for Canadian musk ox. Groves (1997) documented low mitochondrial DNA variation in musk ox. Mikko et al. (1999) found an apparent lack of variation in the *Mhc DRB* gene in several musk ox populations. Finally, Holm et al. (1999) found a lack of variation in musk ox–specific microsatellites. More recently, Van Coeverden de Groot and Boag (2004) identified higher microsatellite diversity than Holm et al. (1999), although the identification of extinct haplotypes in Pleistocene *Ovibos moschatus* by MacPhee, et al. (2005) shows diversity in this species has been reduced through time. The latter research focused on mitochondrial sequence data and identified extinct haplotypes not seen in modern musk ox. Overall, the results show that musk ox were more genetically diverse in the late Pleistocene than today.

At the same time that geneticists have studied musk ox diversity, parasitologists have documented the effects of modern climate change on musk ox parasites (Hoberg, et al. 1995, 1999, 2002; Kutz et al. 2001, 2002, 2004a, 2004b,

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2005; Webster and Rowell 1980). It is noteworthy that since MacPhee and Marx (1997) first suggested that microbes may have played a role in late-Pleistocene megafaunal extinctions, several studies have shown that current climate change has the potential to impact microbial communities and their vertebrate hosts (Bradley et al. 2005; Dobson et al. 2003; Harvell et al. 2002; Kutz et al. 2004b, 2005; Pounds et al. 2006).

As examples, I review three parasites recently studied in musk ox herds. First, *Protostrongylus stilesi*, a lung nematode, was recently described for the first time in musk ox (Hoberg et al. 2002). This parasite is characteristic of sheep (*Ovis* spp.) in the Nearctic and has been considered a potential factor in pneumonia outbreaks in bighorn sheep (*Ovis canadensis*) (Spraker et al. 1984). Hoberg et al. (2002) note that contemporary musk oxen appear to acquire parasites when in sympatry with infected bovid or cervid hosts (see also Alendal and Helle 1983), and point out that during the Pleistocene, sympatry between musk ox and other ungulates was likely even more extensive than today. The implication is that musk oxen may have been exposed to novel parasites from cervids and other bovids as Pleistocene ecosystems and vertebrate communities fluctuated with climate change.

A second parasite of interest is *Umingmakstrongylus pallikuukensis*, a nematode lungworm of musk oxen recently described as a new genus and species (Hoberg et al. 1995). Circumstantial evidence suggests it may be one of the driving factors in musk ox population decline (Kutz et al. 2004b). Infected animals have been observed with nasal bleeding and pulmonary compromise (Kutz et al. 2004b). This parasite may result in reduced ability to fight or flee, increased predation by bears, and reduced fecundity and herd recruitment (Kutz et al. 2004b).

A third parasite recently studied is *Teladorsagia boreoarcticus*, an abomasal nematode first described as a new species in 1999 (Hoberg et al. 1999). This parasite has caused severe abomasal disease in musk oxen and may impact fecundity and musk ox population fluctuations (Kutz et al. 2004b). Climate warming and high population densities have been proposed as driving factors in the emergence of *T. boreoarcticus* (Kutz et al. 2004b).

Recent research has shown that modern climate change and parasitism may be contributing factors in musk ox population declines. Average summer temperature increases as small as 1–2 degrees Centigrade may cause clinical disease outbreaks in Arctic faunas resulting from parasitism (Kutz et al. 2002; Kutz et al. 2004b). It is likely that similar processes occurred in the Pleistocene. While researchers have discussed in detail the potential evolution of musk ox parasites in the late Pleistocene (Hoberg et al. 1995, 2002), it appears no one has yet suggested that parasitism played a role in prehistoric musk ox declines. Here I speculate that parasitism, driven by and in conjunction with climate change, contributed to population declines in prehistoric musk ox herds, thus contributing to the reduced genetic variability recently observed in this species.

Numerous questions remain unaddressed here, including why musk oxen survived even warmer periods of the Holocene when the effects of parasites and climate changes could have been even worse than they are today, or why they survived late-Pleistocene stresses at all? At the very least however, an interdisciplinary approach to questions of parasite-driven wildlife declines (as suggested by Pedersen et al. 2007) focusing on paleontological and archaeological issues could prove insightful.

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Fossil Birds of the Ardis Local Fauna, Late Pleistocene, South Carolina

Robert M. Chandler and Curtis C. Bentley

In April 1991, the junior author and Mr. Vance McCollum discovered a rich deposit in a large open-pit mine operated by the Giant Cement Plant located 5 km NNE of Harleyville, Dorchester County, South Carolina. Quarry operations removed overlying Plio-Pleistocene surficial deposits and clay-rich, late-Eocene Harleyville Formation to expose and mine late-Eocene-age limestone of the Tupelo Bay Formation (Bentley et al. 1994; Geisler et al., 2005). Locally, groundwater differentially dissolved the Tupelo Bay Formation creating interconnected solution cavities that contacted and penetrated the Harleyville Formation opening the solution cavities to the Pleistocene surface. Fossils were collected from highly differentiated sands within the solution cavities that appear to represent various hydrological flows often resulting in the rapid burial and exquisite preservation of some specimens. The Ardis local fauna is a diverse latest-Pleistocene (dated between 18,940 ± 760 and 18,530 ± 725 RCYBP) vertebrate fauna of fish, amphibians, reptiles, birds, and mammals; it is the largest Rancholabrean fauna reported from South Carolina (Bentley et al. 1994). The turtle fauna of the Ardis local fauna, consisting of 14 species,

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includes the earliest record of the spotted turtle (*Clemmys guttata*) reported to date in North America (Bentley and Knight 1993). Mammals are represented by 43 taxa of an edge community ("disharmonious fauna") not represented in the region today (Bentley et al. 1994). Since discovery of the Ardis local fauna, mining has continued at the Giant Cement Plant and all sediments yielding local fauna specimens have now been completely removed. This paper is a report on the preliminary identification of the avian component of the Ardis local fauna.

Our preliminary identification of the paleo-avifauna includes 7 orders with a minimum of 9 families and at least 13 species. Represented are the following orders, families, subfamilies, and species: Pelecaniformes, Phalacrocoracidae, *Phalacrocorax* cf. *P. auritus* (double-crested cormorant); Ciconiiformes, Ciconiidae, *Ciconia maltha* (extinct stork); Anseriformes, Anatidae, Anatinae (3 or more species of true ducks); Galliformes, Phasianidae, Tetraoninae, *Tympanuchus* sp. (prairie grouse); Meleagridinae, *Meleagris gallopavo* (wild turkey); Odontophoridae, *Colinus* sp. (bobwhite); Charadriiformes, cf. Scolopacidae (small shorebird); Laridae (small tern); Strigiformes, Strigidae, *Strix varia* (barred owl); and Passeriformes, cf. Emberizidae (2 species of sparrows and/or their relatives).

The "disharmonious fauna" hypothesis (Bentley et al. 1994) is supported by the species diversity and the ecological requirements of the fossil birds. Of note is the first record in South Carolina of *Tympanuchus* sp. (prairie grouse) that today has a greatly reduced relictual distribution in the Plains states from its late-Pleistocene distribution that included Alabama, Florida, Georgia, and Tennessee. Also, the first record of the extinct stork (*Ciconia maltha*) is an important eastern North American record outside Florida (Brodkorb 1963).

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A Pleistocene Bird in El Peñon de los Baños Locality (D.F., Mexico)

Eduardo Corona-M., José Concepción Jiménez-López, and José Antonio Pompa y Padilla

In the Basin of México, animal remains associated with early human settlements are scarce, even though animals should have been readily available and were probably used extensively as a resource by the first peoples. For example, of 215 mammoth localities that have been studied, only 9 have clear evidence of cultural relationship (Arroyo-Cabrales et al. 2006). From the same basin, seven Pleistocene localities have produced bird bones, and four of these localities have yielded evidence of early humans; however, none of these bird remains show signs of cultural modification (Corona-M. 2006).

In this paper our aim is to identify the only bird bone retrieved with human remains found at the locality known as El Peñon de los Baños. It is remarkable that this bone remained unidentified for decades; it is currently in the DAF-INAH Collection. The hill named Peñon de los Baños is located in the middle of the former Lake Texcoco, Mexico City, one of the original five lakes that constituted the Basin of México. The hill was originally surrounded by springs; however, the water of the lake was brackish because it was located at the lowest point of the internally draining basin.

The Peñon de los Baños is an emblematic place for research on the prehistory of México, since the first ancient human bones retrieved there in the 19th century were assigned to the late Pleistocene, causing some controversy (Bárcena 1885; Bárcena and Del Castillo 1886; Newberry 1886). Other discoveries at this locality were made in 1957, 1959, and 1962 (Romano 1974).

The bird bone described here was retrieved in 1959 with the remains of a woman named Peñon III (Mooser and González Rul 1961). This original find was accidental and occurred when a water well was excavated by local inhabitants. Data on the position of the body and depositional context were not reported. Recently, the human cranium was dated by AMS to 10,755 ± 75 RCYBP (González et al. 2003). This date makes these the oldest human remains known in México and among the oldest known in North America.

Associated with the human remains were the bird bone and some unidentified botanical remains. However, with the available evidence it is hard to know if these remains are part of a burial. Further studies are necessary to clarify this situation. In any case, the evidence suggests that all the remains were found in aquatic sediments with volcanic tuff, and were sealed by a thick layer of travertine (Mooser and González Rul 1961). These data suggest that the bird

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remains are the same geological age as the woman and could be conservatively attributed to the late Pleistocene.

The bird bone, identified as an ulna, is covered by a superficial layer of preservative and is in good condition. The diaphysis is almost complete, with a double line of quill knobs; both epiphyses are broken. Nevertheless, a partial *brachialis anticus* muscular groove could be observed. To document the size of the specimen, some measurements (in mm) were taken: maximum length: 198.5, breadth of proximal epiphysis: 15, and breadth of distal epiphysis: 13.

The bone resembles specimens in the osteological collection of the Laboratorio de Arqueozoología at INAH and is identified as a white pelican (Pelecanidae: *Pelecanus erythrorhynchos*). This bird is a common winter visitor, with a wide distribution from the north of Mexico to the Isthmus of Tehuantepec, and inhabits almost all the Transversal Volcanic Belt (Howell and Webb 1995).

The species was previously recorded in two late-Pleistocene localities, San Marcos, Jalisco, and Tlapacoya in the Basin of Mexico (Corona-M. 2002). However, those reports did not include a formal identification and number of remains.

In any case, this record confirms the presence of this species in the late Pleistocene of central Mexico. However, at this time we cannot unequivocally demonstrate any cultural relationship for this specimen.

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Diverse Avifaunas from Coastal Caves in Southeast Alaska

Timothy H. Heaton

Three significant avifaunas have been discovered in coastal caves of southeast Alaska: a late-Pleistocene fauna from On Your Knees Cave, Prince of Wales Island (described by Heaton and Grady 2003); and modern faunas from Kit 'n' Kaboodle Cave, Dall Island, and Birds Bounty Sea Cave on Coronation Island (Table 1).

Table 1. Faunal remains from southeast Alaskan coastal caves.

	Species	Common name	NISP
Kit 'n' Kaboodle Cave, Dall Island			
	Gavia stellata	Red-throated loon	4
	Podiceps grisegena	Red-necked grebe	7
	Phalacrocorax pelagicus	Pelagic cormorant	51
	Clangula hyemalis	Long-tailed duck	1
	Melanitta perspicillata	Surf scoter	39
	Melanitta fusca	White-winged scoter	1
	Bucephala clangula	Common goldeneye	5
	Larus canus	Mew gull	3
	Larus glaucescens	Glaucous-winged gull	11
	Uria aalge	Common murre	91
	Brachyramphus marmoratus	Marbled murrelet	1
	Corvus caurinus	Northwestern crow	2
	Ixoreus naevius	Varied thrush	1
Bird's Bounty Sea Cave, Coronation Island			
	Fulmarus glacialis	Northern fulmar	22
	Puffinus griseus	Sooty shearwater	46
	Puffinus tenuirostris	Short-tailed shearwater	73
	Phalacrocorax pelagicus	Pelagic cormorant	7
	Clangula hyemalis	Long-tailed duck	1
	Melanitta perspicillata	Surf scoter	7
	Melanitta fusca	White-winged scoter	2
	Dendragapus obscurus	Blue grouse	1
	Heteroscelus incanus	Wandering tattler	1
	Aphriza virgata	Surfbird	1
	Larus canus	Mew gull	9
	Larus glaucescens	Glaucous-winged gull	3
	Uria aalge	Common murre	61
	Cepphus columba	Pigeon guillemot	3
	Brachyramphus marmoratus	Marbled murrelet	5
	Cyclorrhynchus psittacula	Parakeet auklet	1
	Cerorhinca monocerata	Rhinoceros auklet	11
	Ptychoramphus aleuticus	Cassin's auklet	3
	Fratercula cirrhata	Tufted puffin	18
	Surnia ulula	Northern hawk owl	1
	Corvus caurinus	Northwestern crow	3

All three faunas have abundant and diverse alcids (murres, puffins, etc.), diving ducks, cormorants, and gulls, as well as a few terrestrial birds (passerines, grouse, etc.). Of the three faunas, On Your Knees and Kit 'n' Kaboodle

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caves are most similar in abundance of bird families (although the species differ considerably). Birds Bounty Sea Cave, with the most distinct fauna, is dominated by procellariids (fulmars and shearwaters) that are completely absent from the other two sites.

Kit 'n' Kaboodle and Birds Bounty caves are both coastal, not far above high tide, whereas On Your Knees Cave is 1 km from the ocean. Location, therefore, does not explain the difference. Of the three, only Birds Bounty Sea Cave has a large entrance visible from a distance, but the procellariids and alcids that dominate the fauna rarely come ashore and do not roost there.

The difference in the faunas must be related to the carnivores that accumulated them. Foxes (*Alopex lagopus* and *Vulpes vulpes*) probably accumulated most of the birds at On Your Knees Cave, but foxes no longer live on these islands (Heaton and Grady 2003). The Kit 'n' Kaboodle fauna was probably accumulated by mink (*Mustela vison*). Otters (*Lontra canadensis*) frequent both caves as well, but they eat mostly fish and accumulate few bird bones. By contrast, Birds Bounty Sea Cave is a bald eagle (*Haliaeetus leucocephalus*) roost that shows no evidence of bone accumulation by mammals.

Eagles have an advantage over mammals in bird hunting because they can catch prey in offshore waters. Alaska's procellariids do not breed in southeast Alaska and rarely enter sheltered waters where mammals could catch them (Gabrielson and Lincoln 1959), but their great numbers and habit of gorging themselves at sea could make them easy targets for eagles. This comparison illustrates the importance of knowing the habits of predators and prey in understanding fossil collections.

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Indications of Butchering on a Late-Pleistocene *Bison antiquus* from the Maritime Pacific Northwest

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Since 1957, skeletal remains of at least 10 bison have been documented from peat bogs on Orcas Island (Harington1975; Kenady 1990; Rensberger and

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Barnosky 1978; Wilson et al. 2007), the largest of the San Juan Islands in maritime northwest Washington State. Only one of the bison is represented by more than a few bone fragments or partial horn cores. This animal, a male *Bison antiquus*, is represented by a large well-preserved skull dated by ^{14}C to 11,760 ± 70 RCYBP (Beta 216160), and nearly 100 postcranial specimens, including complete elements and fragments, beneath 3 m of peat in Ayer Pond. The 3-acre pond was created artificially in a headwater wetland in a large topographic trough. Workmen excavating the pond made the discovery in basal pond silts atop glaciomarine sediments and beneath the overlying peat deposit. They stopped work and carefully collected the bones by hand across a 10 m^2 surface. The site is now under 3 m of water.

Kenady learned of the discovery a year later in 2005 and obtained the collection for study and curation at the local museum. A radiocarbon sample was taken from the horn core and submitted immediately. Since then, 98 specimens have been identified, inspected, labeled, and catalogued. The skeletal elements represented are shown in Figure 1A in articulated positions and in their discovered configuration described by the workmen in Figure 1B. During the initial recording and cataloguing procedure, modifications were recognized that include 30 green-bone fractures, 2 sets of rodent gnaw marks, 3 polished fractured edges, 8 points of impact, 3 sets of parallel scratches, and at least 2 deep V-section cut marks as shown in Figure 1C-1. Over 60 bones, mostly lower limb, were whole and unmodified. Significantly, no canid or other carnivore U-section gnawing marks were found. Because the modifications suggested human butchering, the location was registered as archaeological site 45SJ454.

The Ayer Pond finds and others from Orcas demonstrate that during early

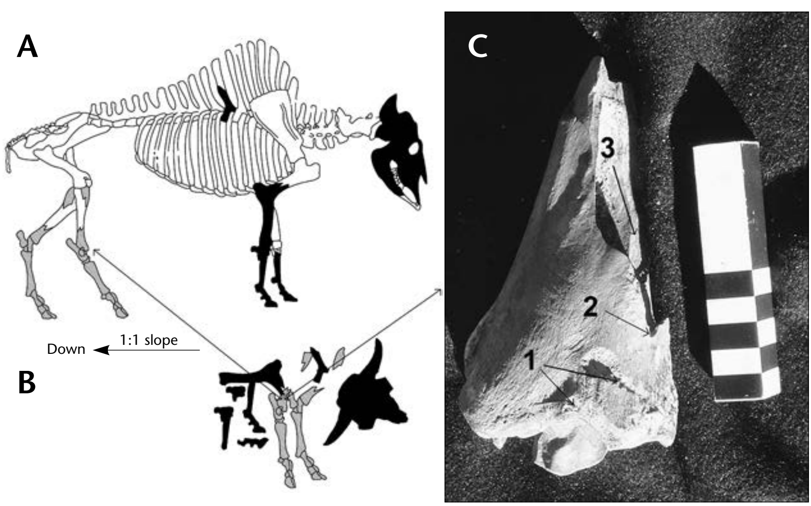

Figure 1. Bison skeleton with discovered bones shaded or filled and photograph of apparently butchered tibia. **A,** anatomically correct articulation; **B,** relative positions as found; **C,** right distal tibia with scale in centimeters (**1,** cut marks; **2,** point of impact; **3,** green bone spiral fracture).

postglacial times a thriving population of megafauna existed on the island and persisted for at least 1000 years. A bison phalanx from a similar peat excavation on the island at Jacobson Pond has been radiocarbon-dated to 11,180 ± 60 RCYBP (Beta 231168), and another bison horn core discovered in a Victorian Valley bog has been dated to 10,800 ± 60 RCYBP (Beta 231169). These dates together with the oldest date from Ayer Pond span a millennium.

The grasslands that first colonized the newly emergent, nutrient-rich marine sediments during that period provided ideal grazing habitat that was part of an extensive landscape nearly connecting the mainland with Vancouver Island (Wilson et al. 2007). The attractive grazing lands and the relatively long, 1000-year existence of bison on the island raise the possibility of a contemporary human presence in the area related to the hunting opportunities. Green-bone fractures on most of the reported Orcas bison, and the absence of any carnivore gnawing, hint at possible human involvement.

In contrast to these inconclusive finds the larger, more complete Ayer Pond bison bones exhibit multiple green-bone spiral fractures, impact scars, a few cutmarks, abrasion or polish, and in situ spatial relationships suggestive of human “gourmet” butchering. These characteristics, together with anatomical parts representation skewed toward lower-value cranial and distal limb elements, warrant additional analysis given the site’s age and potential relevance to New World colonization hypotheses. Fracturing of massive bones might have been accomplished by a large predator such as the widespread giant short-faced bear *(Arctodus simus)*, now considered a hyena-like scavenger (Matheus 2007), but the cutmarks cannot be explained by this agent. Both fracturing and cutmarks could be explained as the result of post-depositional trampling and “trampling-skid”, but that explanation cannot account for the selective bone element representation. These observations considered together suggest butchering of the Ayer Pond bison along the margins of what was a pond and discard of the scrap into the pond where it remained until this recent discovery.

Although the Orcas Island bison discoveries have not yet been directly associated with artifacts, none of these peat bogs have been the subject of systematic archaeological investigations and previous archaeological research in the region has focused almost exclusively on the modern shoreline. An undated lithic assemblage from the DeStaffany site on nearby San Juan Island contains projectile-point forms that have been dated to late-Pleistocene age on the Columbia Plateau but this site lacked associated faunal remains (Kenady et al. 2002). At least eight isolated Clovis points have been found in the Puget Sound region, the nearest on Whidbey Island, 44 km southeast of Orcas (Meatte 2006). The new evidence reported here contributes to an emerging body of data that suggests a terrestrial ecosystem considerably more productive than usually envisioned by archaeologists (Schalk et al., this volume) and underscores this region’s significant potential to yield important data bearing on Clovis and pre-Clovis populations.

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Full-Glacial Gastropods and Rodents from Kulas Quarry, Wisconsin

Matt Kuchta, Richard Slaughter, and Dana Geary

Kulas Quarry, a newly discovered fossil site in west central Wisconsin, has yielded several microtine rodent teeth and thousands of terrestrial gastropod shells from species with alpine, boreal, and/or arctic affinities (Figure 1). The gastropod fauna includes *Columella columella alticola, Vertigo modesta modesta, Pupilla muscorum, Catinella* cf. *gelida,* and the first record of *Discus shimeki* from the state. Vertebrate remains are scarce, but include four molars of *Dicrostonyx* sp., a tundra-dwelling lemming.

The quarry is located in the Latch River Valley, a tributary of the Mississippi River, in Trempeleau County, Wisconsin. It contains a 6-m exposure of late-Wisconsinan alluvium with multiple fossiliferous lenses. Remains from the taxa listed above were recovered from a lens 2 m below a late-Pleistocene

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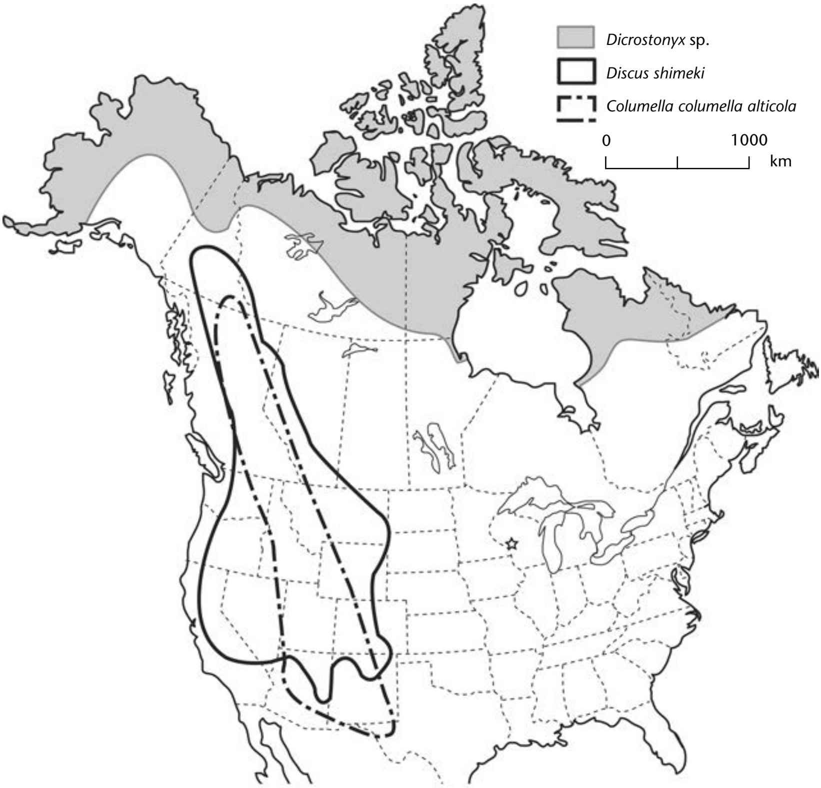

Figure 1. Map showing the modern ranges of *Discus shimeki*, *Columella columella alticola*, and *Dicrostonyx* sp. in relationship to the location of Kulas Quarry.

terrace surface. A 4.65-kg sediment sample was collected, water-screened, and analyzed for biotic material. Shell carbonate from this lens, named Kulas Quarry -1 (KQ-1), produced an age of 16,670 ± 60 RCYBP (Beta-223641).

At present, *D. shimeki* and *C. c. alticola* are high-altitude alpine species with distributions that are centered on the Rocky Mountains. *V. m. modesta* and *P. muscorum* also occur throughout the Rocky Mountains as well as in southern Canada (Leonard, 1952). Gastropod faunas at Elkader and Conklin Quarry, two full-glacial sites in eastern Iowa, also contain these four taxa, as well as species that feed on deciduous leaves. For example, *Hendersonia occulta* is common at both Iowa localities and *Discus macclintocki* is also present at Elkader (Baker et al., 1986; Woodman et al., 1996). These latter two species currently live in algific habitats within the Upper Mississippi River Valley and typically are associated with oak-maple woodlands. Shells of *H. occulta* and *D. macclintocki* are not known from KQ-1. Their absence may be the result of taphonomic factors; sample size is not likely the cause, since more than 2,000 shells have been identified from this lens.

Kulas Quarry, approximately 100 km south of the ice margin during the last glacial maximum, harbors the northernmost full-glacial fauna in the Midwestern United States. Despite these geographic attributes, the KQ-1 gastropods suggest there was a significant amount of boreal forest vegetation in west-central Wisconsin at the end of the full-glacial period. Jore-1, a full-glacial site in southeastern Minnesota, contained abundant tundra plant macrofossils such as *Polygonium viviparum* and *Dryas integrifolia,* indicating the presence of tundra plants in the Upper Mississippi River Valley ca. 18,000 RCYBP (Baker et al., 1999). The numerous dental elements of *Dicrostonyx* in Kulas Quarry sediments indicate there was likely tundra or tundra-like habitats in the local area as well.

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A Cautionary Note on North American Late-Quaternary Biogeography

Richard S. Laub

In 2001, the deciduous premolar of a peccary was found in Pleistocene strata of the Hiscock site, western New York State (Laub et al. 1988, Laub 2003a). It proved to be one of the most significant finds of that field season as it belonged to *Mylohyus* sp., a taxon usually associated with more southerly latitudes (Laub 2003b). This small tooth, BMS no. E27500, represents the first and only *Mylohyus* remains reported from New York, and a certain coincidence (below) begs the question: Did this animal actually inhabit western New York?

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I am suggesting here a distinction between the *objective* fact that a fossil occurs at a particular site, and the *subjective* inference that its owner lived at or near that site. Few would argue that a rhinoceros herd whose articulated skeletons were found in a bed of Miocene volcanic ash (Voorhies 1985) had not been resident where found. At Hiscock, however, the bones of Pleistocene animals co-occur with Paleoindian artifacts, both lithic (Ellis et al. 2003) and osseous (Tomenchuk 2003), reminding us that in late-Quaternary North American paleontology a new taphonomic agency, humans, must be considered.

Previously, the northernmost occurrences of *Mylohyus* were in southern and eastern Pennsylvania, the nearest to Hiscock being Frankstown Cave in Blair County, and New Paris No. 4 in Bedford County, respectively 300 and 375 km south of Hiscock (FAUNMAP Working Group 1994:432; Kurten & Anderson 1980:296-297). In this regard it is noteworthy that, besides the peccary, there are two archaeological links between Hiscock and southern Pennsylvania. First, in a typological comparison of the Hiscock fluted bifaces with those of major sites in the Northeast, Ellis et al. (2003) found the closest similarity with the Shoop site of Dauphin Co., southeastern Pennsylvania. Shoop lies between the eastern and western *Mylohyus* localities. Second, the Shoop lithic assemblage is predominantly (about 98 percent) made of a variety of Onondaga chert most similar to that from western New York and the Ontario Peninsula (Cox 1986:108; Fogelman 1986:3; Witthoft 1952:471). A major Paleoindian quarry, Divers Lake (Prisch 1976), lies about 30 km from Hiscock. In contrast, fluted-point collections in eastern Pennsylvania are predominantly of Pennsylvania jasper and fine-grained black "flint" from nearby sources (Witthoft 1952:470). While Onondaga chert pebbles occur in Susquehanna River gravels reaching to the Shoop vicinity, the Shoop assemblage displays nodule rather than clastic surfaces (Witthoft 1952:471), and only one Onondaga cobble was found at the site (Fogelman 1986:3). This implies that the source was quarried material rather than erratics (Gramly 1988:267), and this Onondaga connection led both Witthoft and Cox to see a close relationship between Shoop and the western New York region that includes the Hiscock site. It should be noted, however, that not all workers agree with this conclusion. Instead, some view nearby river gravel clastics as the probable provenience of the Shoop lithics (John D. Holland, pers. comm., 2007).

The foregoing attests to Paleoindians as agents for transporting objects across great distances. Haynes (1980:118) observed that 300 km is a common figure cited for maximum distance of Clovis sites from lithic sources. Gramly (1999) found a fluted biface made on North Dakota Knife River chert at the Lamb site in western New York. Haynes (1980) mentioned surface wear on lithics from the Simon site (Idaho) as suggestive of their rubbing against each other while being carried in a bag. So, if Paleoindians introduced exotic lithic material to their sites, is it not likely that they occasionally did the same with animal parts?

There is evidence that Paleoindians attributed importance to some objects. At the Wilsall (Anzick) site, Paleoindian artifacts and a contemporary human cranium had been ocher-stained (Lahren & Bonnichsen 1974:148; Stafford et al. 1991:54). Apparent ritual breakage of objects in a lithic assemblage has been reported from southern Ontario (Deller and Ellis 2001). North American Indians are known to have carried objects of significance, including bones and teeth, in medicine bags or bundles (e.g., Helm 1981:353, Lowie 1982; Tooker and White 1968), and some continue this practice. Charlie Bourque (pers. comm., 2006), a Northwest Territories Meti, reports that some of his First Nations acquaintances include animal teeth in their medicine bags. The Yukaghir of northeast Siberia similarly carry animal parts in leather bags (Jochelson 1924:146, 164), posing the possibility that this is an ancient Holarctic practice.

My purpose is not to argue that Paleoindians used medicine bags or to attribute to them the practices of more recent people. Rather, I am urging a conservative approach to paleobiogeography where humans may be involved. I will feel more confident about extending the range of *Mylohyus* into western New York when additional specimens are found in this area.

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Extinct Faunal Remains in Exokarstic Deposits from the Late Pleistocene in Calama (II Region, Chile)

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The paleontological sites of Betecsa 1 (68° 54′ 44″W, 22° 26′ 30″ S) and Kamac Mayu (68° 54′ 40″ W, 22° 26′ 20″ S), discovered in the Atacama Desert (II Region, Chile), have yielded two of the most well preserved assemblages of extinct mammals in Chile. Both sites are located in Calama, in an alluvial basin containing sandy gravel and sand deposits, 100–300 m from the Loa River.

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According to Chong Díaz and Jensen (2004), four stages of deposition can be distinguished at the Kamac Mayu site: (1) a lacustrine stage, represented by a stratified unit of disintegrated marl with diatomite lenses of Plio-Pleistocene age; (2) a second stage characterized by karstic erosion, represented by an eroded surface formed by dissolution cavities; (3) a third stage of fluvial origin represented by sandy gravel and sand deposits that form the fill of multiple channels formed above the karstic horizon; (4) a fourth stage of calcareous cementation (precipitation of calcite in intergranular spaces leading to cementation of clasts). Stage 3 formed prior to the formation of the Loa River canyon and corresponds to the interval in which the fossil remains were deposited. The deposits with fossil remains reach a maximum depth of approximately 1.80 m.

In the Betecsa 1 site, the faunal assemblage was found in a former basin, located approximately 100 m from the current bed of the Loa River, in sandy gravel and sand deposits analogous to the fluvial stage described above by Chong Díaz and Jensen (2004) for the Kamac Mayu site (López and Labarca 2005).

The fossil record of Kamac Mayu is diverse and includes remains of *Macrauchenia* sp. (Litopterna), *Hippidion saldiasi* (Equidae), Xenarthra indet., and Camelidae indet. (Alberdi et al. 2007; López and Labarca 2005). The Camelidae bones are smaller than would be expected for guanaco (*Lama guanicoe*) but larger than vicuña *(Vicugna vicugna*). In addition, the metapodials are very gracile. The incisors recovered at this site exhibit traits similar to the extinct species *Lama gracilis* described for the middle- and late-Pleistoscene Pampean regions of Argentinean and Chilean Patagonia (Menégaz and Ortiz-Jaureguizar 1995). This assemblage differs from the only other record of fossil camelids in Chile (Casamiquela 1999; López et al. 2005).

At the Betecsa 1 site an almost complete *Hippidion saldiasi* (Equidae) skeleton was recovered, including the first cranium that has been described (Alberdi and Prieto 2000; Alberdi et al. 2007). Two AMS ^{14}C dates were obtained for this horse at the Centrum voor Isotopen Onderzoek laboratory in Groningen, Netherlands. The first sample consisted of enamel from a right M^3 and yielded a date of 21,070 ± 100 RCYBP (GrA-29389); a cranium fragment from the same skeleton was dated to 21,380 ± 100 RCYBP (GrA-29388). The samples from the Kamac Mayu site did not have enough collagen for dating. Nevertheless, stratigraphic correlations between both sites and the geological analyses of the Calama basin suggest that the Kamac Mayu fossils are late Pleistocene (Chong-Díaz and Jensen 2004; May et al. 2005).

On the other hand, $\delta^{13}C$ analyses of material from Betecsa 1 have yielded typical values for mammals that fed strictly on C_3 grasses. The $\delta^{13}C$ value was -15.45 for bone and -16.68 for tooth enamel. These relatively negative values are related to the high altitude of the Calama basin (2,250 m above sea level) and an intermittent dry, possibly cold period at the time close to the last glacial maximum (40,000–22,000 RCYBP), a time during which C_3 plants could thrive at an altitude above 1,000 m (Latorre et al. 2002).

This information adds to the previously fragmentary paleontological data on the extreme north of Chile, confirming the close relation between these faunas and those recorded from southern portions of Bolivia (Marshall and Sempere 1991). These observations enhance our predictions for the locations of early archaeological sites, which are likely to be recognized through discovery of remains of mammals that went extinct during the latest Pleistocene (Núñez et al. 2002).

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The Late-Glacial Wenas Creek Mammoth Site (45YA1083) in Central Washington

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During construction of a private road in 2005, a mammoth (*Mammuthus* sp.) left humerus was uncovered near Selah, central Washington State. Finds of isolated mammoth elements are common on the Columbia Plateau, many of them in late-Pleistocene Missoula Flood slackwater deposits (Barton 1998, 1999; Lillquist et al. 2005; Waitt 1980). The Wenas Creek find appeared somewhat unusual because it was well preserved and elevationally above these deposits, thus potentially representing an in situ mammoth. Owing to its unusual topographic setting and the potential for finding additional material at the site, Central Washington University initiated an ongoing investigation with annual summer field schools starting summer 2005 (Barton et al. 2005; Lubinski et al. 2006). The goals of the project from the outset were to recover additional mammoth remains, plus associated faunas and paleoenvironmental data, and place these in geological context. Excavation methods were designed to yield data that could reveal taphonomic relationships between finds and recover evidence of human involvement, if any, with the site.

Field investigations began with a ground-penetrating radar survey, followed by excavating 37 m of backhoe trench, both parallel and perpendicular to the find location, to document the depositional history of the site. More than 46 m^2 has been excavated by hand in units 2 by 2 m or smaller; 95 percent of the matrix was dry-screened through 1/8″ (3.175 mm) mesh, and a 5-percent sample was water-screened through 1-mm mesh to recover any associated microfauna or small artifacts. All finds and geological strata have been mapped with a total-station theodolite for evaluation of spatial relationships. Bones have been consolidated with Butvar B-76 (polyvinyl butyral resin), except for those intended for ^{14}C dating or chemical analyses.

In the first two seasons, we have exposed nearly complete and fragmentary remains of left and right mammoth humeri, and mammoth-size scapula, metapodial, phalanx, and vertebrae. All element epiphyses are fully fused and can be accounted for by a single individual. The humeri are consistent in size

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with Columbian (*M. columbi*) or woolly (*M. primigenius*) mammoths, based on data in Madden (1981), and data compiled independently by Barton. The animal is more likely a Columbian mammoth given the absence of reliably identified woolly mammoths west of the Rocky Mountains (Barton 1998; Lillquist et al. 2005; Madden 1981; Pasenko 2006). Within the same stratum and closely associated with the mammoth bones we recovered a left metatarsal cannon bone and left fused 2nd/3rd tarsal from a bovid, most likely *Bison antiquus*, although this identification has not yet been confirmed. A single human artifact, a cryptocrystalline flake, was recovered about 15 cm above one of the mammoth bones. We have also recovered pollen and opal phytoliths within the mammoth-bearing stratum, and rodent remains in less intimate proximity.

Four bone samples have been submitted to three laboratories for ^{14}C dating, three from the mammoth left humerus and one from the bovid metatarsal. These have so far returned two plausible age estimates, 13,398 ± 58 (Wk-18064) and 13,788 ± 70 RCYBP (Wk-20117). When taken in conjunction with bracketing infrared-stimulated luminescence dates on sediment adjacent to the right humerus (13,920 ± 1190 [UIC-1688] and 18,230 ± 1580 CALYBP [UIC-1203]), ages of about 13,000–14,000 RCYBP or 15,500–17,000 CALYBP are inferred for both the mammoth and bovid. We are awaiting corroborating radiocarbon assays before we can have full confidence in these estimates.

The site lies on a laterally discontinuous bench on an Ellensburg Formation-cored interfluve lying between Wenas Creek and the Naches River. The northeast-facing bench is approximately 170 m below the top of the interfluve and 21 m above the Wenas Creek floodplain. As such, it is ca. 95 m above and roughly 10 km northwest of the furthermost reaches of the Missoula outburst flood deposits as mapped by Waitt (1980) and extended by Lillquist et al. (2005). The site has three principal strata: a basal gravelly sand/sandy gravel; stratified alluvium; a middle matrix-supported diamict interpreted as a colluvium; and a fine-textured loess cap. The origin of the bench has not yet been determined.

Laboratory analyses are underway, including examination of spatial distributions, bone taphonomy, and taxonomy. Excavations at the site will continue with summer field schools for several more seasons.

The Wenas Creek Mammoth Project has been partially supported by the Office of Continuing Education, Faculty Research Fund, and Office of Graduate Studies and Research at Central Washington University in Ellensburg. The landowners, Nancy, Doug, and Bronwyn Mayo of Mayo Ranches, Inc., have been instrumental in initiating the research and their unwavering support has been essential to the project. The contribution of the 2005 and 2006 field school students and volunteers is gratefully acknowledged.

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Spatial Distribution of *Mammuthus columbi* in North America

Michael R. Pasenko

Mammuthus columbi (Proboscidea, Elephantidae) is a Pleistocene mammoth found only in North America. *M. columbi* is considered a direct descendant of *M. meridionalis* (Agenbroad 1984; Webb et al. 1989), or as evolving from an intermediate form called *M. imperator* (Madden 1981; Maglio 1973; Graham 1986). Agenbroad (1984) showed that *M. columbi* could be found in much of North America, but was more common in the Plains area, parts of Texas, the Southwest, and Florida. Saunders (1970:Figure 5) observed that mammoths in Arizona were found in elevations of 152–1981 m above sea level, but more commonly at an elevation of approximately 1372 m above sea level. To expand on these reports I review data on 73 sites with reported occurrences of *M. columbi* and test the hypothesis that there was a relationship between latitude, longitude, and elevation for the Columbian mammoth during the Pleistocene. A previous paper by the author showed there was some correlation for these parameters and *M. primigenius* (Pasenko 2006).

Figure 1 contains a scatterplot and r-squared values for a comparison of longitude-latitude. Data for sites in the United States were acquired primarily through the FAUNMAP (1994) database; data for sites from Canada and Mexico were added. Topographic maps were used to add missing elevations. All identifications of taxa were assumed to be correct.

There was no correlation between latitude and elevation, and no correlation between longitude and elevation. However there was some correlation

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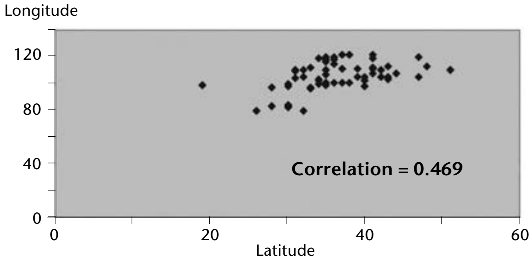

Figure 1. Scatterplot of latitude vs. longitude for *Mammuthus columbi* in North America.

between latitude and longitude (r-squared = 0.47), with a clustering between 30º–50º latitude and 100°–120° longitude. This suggests there is a tendency for *M. columbi* sites to be further west the more north they are, which agrees with Agenbroad's (1984) distributional pattern for *M. columbi* showing little or no sites in the deciduous or boreal forests of the east (except for Florida). These data contrast with *M. primigenius*, which had a strong correlation between elevation and longitude (Pasenko 2006), showing a trend to be higher in elevation the further west they were found. According to these data *M. columbi* was less restricted longitudinally and had a greater range in elevation than *M. primigenius*. The greater range for *M. columbi* may be a result of the more "equable climatic conditions" at lower elevations and latitudes during the late Pleistocene that created an overlap of ranges for organisms (Harris 1985:119–120). The only restriction for the Columbian mammoth appears to be latitude, with fewer sites in Canada. Considering that the enamel thickness for *M. columbi* is greater and of a wider range than *M. primigenius*, and the lamellar frequency is lower (Agenbroad, et al 1994; Madden 1981), it is possible that *M. columbi* was less restricted in diet than *M. primigenius*. Isotopic studies on *M. columbi* show the percentages of C_3 and C_4 grasses consumed varied between regions (Hoppe 2004). It is also possible that since *M. primigenius* was an immigrant to North America with an already preferred habitat and existing derived morphology, the indigenous Columbian mammoth more readily adapted to diverse habitats in Pleistocene North America.

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Early Post-Glacial Ungulates on the Northwest Coast: Implications for Hunter-Gatherer Ecological Niches

Randall F. Schalk, Stephen M. Kenady, and Michael C. Wilson

North America's Northwest Coast has been the focus of increasing scrutiny as a possible route of late-Pleistocene (LP) colonization of the New World (Dixon 1999; Erlandson and Moss 1996; Fedje and Josenhans 2000; Fladmark 1979). Proponents of a coastal-migration model maintain that maritime-adapted populations entered the continent along unglaciated refugia of the outer coastal margin of the Cordilleran Ice Sheet. An expanding faunal record (Gustafson et al. 1979; Heaton and Grady 2003; Ramsey et al. 2004; Wigen 2005; Wilson et al. 2003; Wilson et al. 2007) demonstrating an early postglacial presence of high-value, open-country ungulates along the glaciated coast suggests an alternative ecological niche model in which marine dependence may not have been obligate.

Herb and dwarf-shrub tundra were widespread along this entire coast before 12,500 RCYBP (Lacourse and Mathewes 2005:51) and would have provided extensive forage for ungulates during early deglaciation. Rapid colonization of newly emergent landscapes by open-country ungulates is consistent with the predictions of ecological theory; for example, early stages of ecosys-

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tem succession are characterized by the highest ratios of animal to plant biomass (Margalef 1968). Pulse-stabilized periglacial ecosystems produce complex habitat mosaics with extensive areas of early seral vegetation that can support a diversity of large herbivores (Geist 1978:194–207). Major perturbations that interrupt forest succession and create habitats for ungulates in coastal glacier-marginal environments include isostatic rebound, exposure of new land surfaces by melting ice, annual flooding of broad areas and creation of large areas of poorly drained sediments, deposition of massive amounts of sediment in glacial outwash plains, fan and delta complexes, glacial outburst floods, and drainage of proglacial lakes.

Modern acidic coniferous rainforest soils are nearly ubiquitous in this region and result in extremely poor faunal preservation and a scarcity of data for early postglacial ungulates. Exceptions seem to be limited to areas where acidity is buffered by carbonates (e.g., caves in areas of karst or calcareous rocks, or presence of shellfish or marl). These rare taphonomic windows are yielding important glimpses into this region's LP biogeography.

The most recent discoveries include a series of *Bison antiquus* finds in peat bogs on Orcas and Vancouver islands (Wilson et al. 2003, 2007). This rainshadow area, which has the lowest annual precipitation on this coast, is also characterized by calcareous bedrock and/or shelly glaciomarine drift; these conditions may account for the region's exceptional bone preservation and high density of LP faunal sites. At least 10 individual bison have been recovered from 5 different sites on Orcas Island. On nearby southeastern Vancouver Island, three other sites have also yielded bison remains. A large series of ^{14}C dates on shellfish in uplifted glaciomarine deposits from the San Juan Islands documents that emergent conditions beyond modern sea level were reached around 12,000–11,800 RCYBP and lasted to ca. 8000 RCYBP, with maximum emergence soon after the start (given high isostatic-rebound rate). AMS ^{14}C dates of 11,760, 11,750, 11,180, and 10,800 RCYBP on bison bones from bogs on Orcas and Vancouver islands suggest breeding populations of bison quickly expanded into these areas of early seral vegetation (Kenady et al., this volume; Wilson et al. 2003, 2007).

Limestone caves on Prince of Wales Island document an open-country fauna including caribou, brown bear, arctic fox, and red fox between deglaciation and extensive forest development (12,700–10,000 RCYBP; Heaton and Grady 2003). After 10,000 RCYBP, these species were replaced by a modern forest community fauna. A karst cave in the Queen Charlotte Islands (Graham Island) yielded ungulate, brown bear, and black bear dating about 12,000 RCYBP, and artiodactyl bones dated at 10,900 RCYBP (Ramsey et al. 2004; Wigen 2005). Caribou survived here through the Holocene (Wigen 2005:115), indicating presence in the LP prior to the loss of a mainland connection. On northern Vancouver Island, mountain goat remains have been dated to 12,000 RCYBP in limestone caves (Nagorsen and Keddie 2000:669) and 12,400 RCYBP in carbonate-rich sea caves (Al-Suwaidi et al. 2006). The Manis site, a peat bog on the northwestern Olympic Peninsula, yielded multiple bison as well as mastodon and caribou dating between 11,800 and 12,000 RCYBP (Gustafson et al. 1979).

Prior to major habitat loss caused by forest expansion and eustatic sea level rise after 10,800 RCYBP, tundra and parkland fauna were present in periglacial coastal environments from northwest Washington northward through southeast Alaska. Caribou may have had a broad distribution along the glaciated coast, but distributions of other ungulates such as bison within the area are as yet unknown owing to the heavily taphonomically mediated faunal record. Hunter-gatherers entering this region between 13,500 and 10,800 RCYBP would have encountered a terrestrial ecosystem more productive than at any time after forest closure. The existence of terrestrial environments capable of supporting large ungulates in this interval suggests the potential for an early postglacial ungulate-hunting ecological niche.

In contrast to the maritime model which has focused on the *outer* Northwest Coast and especially its unglaciated refugia, a terrestrial-hunting model suggests that the greatest LP archaeological potentials may be found on the heavily glaciated *inner* coast, where isostatic rebound dominated postglacial sea levels. Finding the archaeological record associated with such adaptations may require a search image that views the coastal landscape in terms of the ecological requirements of large terrestrial herbivores rather than fish, shellfish, and sea mammals. While LP archaeological evidence is as yet extremely limited for this entire coast, the Ayer Pond site (Kenady et al., this volume; Wilson et al. 2007), the Manis site (Gustafson et al. 1979), and several isolated Clovis point finds in the Puget Sound region (Meatte 2006) are consistent with the terrestrial-hunting model.

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Notes on the Late-Pleistocene Vertebrate Fauna from Guy Wilson Cave, Northeastern Tennessee

Blaine W. Schubert and Steven C. Wallace

Faunal remains were discovered in Guy Wilson Cave (36° 27′ N, 82° 13′ W) by S. D. Dean January 28, 1969. Dean contacted John Guilday, who sent Harold Hamilton and Alan McCrady to sample the deposit that summer. This collection is curated at the Carnegie Museum. Of particular interest are three extralimital taxa, caribou (*Rangifer tarandus*), heather vole (*Phenacomys* sp.), and northern bog lemming (*Synaptomys borealis*), and two extinct species, dire wolf (*Canis dirus*) and flat-headed peccary (*Platygonus compressus*). The most abundant taxon is the peccary, and the only date from the site (19,700 ± 600 RCYBP [I-4163]) is on this species (Buckley and Willis 1972). Another sample from the cave was taken by Charles Coney in the 1970s, and this material was donated to the McClung Museum, University of Tennessee, Knoxville. With this sample mammoth (*Mammuthus* sp.), ground sloth (*Megalonyx* sp.), and tapir (*Tapirus* sp.) were added to the fauna. Publications resulting from the

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two samples above focused on the caribou (Guilday et al. 1975) and heather vole (Guilday and Parmalee 1972).

A third excavation of the site was brought to light in Corgan and Breitburg's (1996) review of Tennessee fossil vertebrates. In this report, a sample called the Taylor Collection is reported to be housed in the Biology Department at East Tennessee State University (ETSU), and a drawing of a peccary jaw from this collection is included (p. 42, fig. 33B). In an attempt to find this material, current and retired biology faculty members were interviewed; however, none, including faculty that were present through the 1970s, knew anything about this collection.

In the fall of 2004, Kay Zuber, a volunteer in the ETSU paleontology lab, notified us that one of her friends had just purchased property containing "some old bones" in a shed. This collection was assessed and subsequently donated to the East Tennessee Museum of Natural History collections by the new property owners, John and Amy Blumberg. (The collection is now termed the Blumberg Collection.) The wealth of extinct Pleistocene taxa and some fragments of speleothems led us to believe that this might be the lost Taylor Collection. The Blumbergs contacted the previous owner, Nina Jones, who said the bones were from a cave near Bluff City and were collected by Sammy Taylor and her late husband, Ronnie Jones. Mr. Taylor was then located, shown the collection, and interviewed. He confirmed that the material was from Guy Wilson Cave and that he and Ronnie collected it in the early 1970s. However, he noted that they both had collections and this was not the so-called Taylor Collection that he left with a faculty member in the Biology Department in the mid or late 1970s. At this point, it appears that the Taylor Collection is still lost, but the Blumberg Collection alone represents the largest single sample from the cave.

The Blumberg Collection is remarkable in its extent and diversity. Extinct taxa include the flat-headed peccary, long-nosed peccary (*Mylohyus* sp.), horse (*Equus* sp.), tapir, ground sloth, mastodon (*Mammut americanum*), and dire wolf. The long-nosed peccary and horse were first reported by Schubert (2005), and the mastodon is a new addition to the fauna. Undifferentiated musk ox and large cervid remains are also represented. Deer (*Odocoileus* sp.) and peccary bones are the most common elements, and many show signs of carnivore damage. A well-preserved piece of carnivore scat with visible bone fragments further attests to carnivore activity in the cave. When all the curated collections are considered together, at least eight late-Pleistocene extinct species are represented from Guy Wilson Cave. This is an exceedingly high number for one site, and thus may provide a rare opportunity to look at ecosystem dynamics for late-Pleistocene megafauna. AMS ^{14}C dates to test the temporal overlap among taxa, and stable isotope analyses to infer diets, are pending. Unfortunately, additional sampling in the cave is not possible at this time because access has been denied.

We would like to thank Kay Zuber for bringing these remains to our attention and John and Amy Blumberg for graciously donating the collection. April Nye, Wendi Shaver, and Dawn Coleman spent many hours cleaning hair spray off the specimens and preserving them with Butvar. S. D. Dean, Sammy Taylor and Nina Jones provided helpful historical information about the collection.

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Late-Pleistocene Bivalves from the Kanorado Locality, Northwestern Kansas

Robert E. Warren and Steven R. Holen

Kansas is home to 66 native species of freshwater bivalves, including 47 unionoid mussels and 19 sphaeriid clams (Couch 1997; Mackie and Huggins 1983; Mulhern et al. 2002). Each of these mollusks is adapted to a specific range of environments in which it can live and reproduce. Historically, Kansas has experienced widespread declines in bivalve diversity in response to pollution, siltation, and other human impacts. Ancient shells from archaeological and geological sites can document natural environmental changes that occurred thousands of years ago.

In 2002–2006, the Denver Museum of Nature & Science and the University of Kansas recovered Paleoindian artifacts and fossil bones and shells near the town of Kanorado in Sherman County, northwestern Kansas (Mandel et al. 2004, 2005). The Kanorado locality consists of three archaeological sites (14SN101, 14SN105, and 14SN106) located along a 1.5-km stretch of Middle Beaver Creek, a normally dry stream channel that only carries water after heavy rains.

Artifacts and fossils from the Kanorado locality date to the late Pleistocene. Clovis and Folsom-age lithic artifacts and large-mammal remains were recovered from a buried paleosol that dates about 11,000 RCYBP (Mandel et al. 2005). Older deposits contain mammoth (*Mammuthus* sp.) and camel (*Camelops* sp.) fossils excavated from two sediment horizons at 14SN105. The deepest is at a zone of contact between a horizon of alluvial sand and gravel and an overlying horizon of fine alluvial silt. Fossil bivalve shells are common at this contact and are present but less common in the overlying silt. Mam-

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moth bones from the deep faunal deposits at 14SN105 have been radiocarbon-dated to 12,215 ± 35 and 12,375 ± 35 RCYBP (Mandel et al. 2005). The shells probably represent bivalves that lived and died in an ancient channel of Middle Beaver Creek and were deposited there by natural processes about 14,000 CALYBP. Two bivalve species are represented at the Kanorado sites, a unionoid mussel, *Lampsilis siliquoidea* (the fatmucket), and a sphaeriid clam, *Sphaerium simile* (= *S. sulcatum*; the grooved fingernailclam).

The sample includes three *Lampsilis siliquoidea* shells, one complete left valve (14SN106) and fragments of two right valves (14SN101). The complete specimen is in good condition, with minimal erosion and well-preserved beak sculpture. A fourth shell fragment may be this species, but it lacks beak sculpture and is identified only to genus (*Lampsilis* sp.).

Lampsilis siliquoidea has an extensive distribution in North America, ranging north-south from the Northwest Territories to Louisiana and east-west from Quebec to Montana. In Kansas, most historical collections are in the eastern third of the state in the Kansas, Big Blue, Marais des Cygnes, Neosho, Verdigris, and Arkansas river systems (Hoke 1997, 2005; Murray and Leonard 1962; Warren 2007). The westernmost record is an individual that Miller and Hibbard (1972) found living in a tributary of the Smoky Hill River in central Kansas. The fatmucket lives in a variety of habitats, including large and small perennial streams and permanent lakes of various sizes. It is commonly found in standing or slowly moving water in muddy, sandy, or gravelly substrates. Mussel surveys in North Dakota indicate it does not live in intermittent ponds or streams (Cvancara 1983).

Of 28 *Sphaerium simile* shells recovered, a majority are complete and in good condition (14SN101, 14SN105). Diagnostic characteristics include anterior beak position, evenly spaced coarse striae, and relatively large shells (length = 9.3-15.8 mm).

Sphaerium simile is widespread in North America, extending across southern Canada from Nova Scotia to British Columbia and southward in the United States to Wyoming, Kansas, Arkansas, Kentucky, and Virginia. In Kansas, Mackie and Huggins (1983) have documented it statewide in the Kansas and Arkansas river systems, including two records in the Beaver Creek drainage system in Rawlins County, Kansas. This species lives in a variety of permanent-water habitats, including perennial streams, ponds, and lakes. In Kansas it occurs in standing water or in slow to swift currents on mud, sand-mud, or boulder bottoms (Mackie and Huggins 1983).

Neither bivalve species found at the Kanorado sites lives in the area today. *Lampsilis siliquoidea* and *Sphaerium simile* require permanent-water habitats not available in intermittent streams like Middle Beaver Creek. When bivalves inhabited the area 14,000 CALYBP, the creek probably flowed year-round. Assuming the catchment basin of Beaver Creek has not changed, the effective precipitation (precipitation reaching stream channels as direct runoff) of western Kansas must have been greater in the late Pleistocene than it is now.

This conclusion may be inconsistent with a computer model of climate change in the central Great Plains during the last deglaciation of North America (Kutzbach et al. 1998). The model predicts that annual moisture (precipitation minus evaporation) was at or below modern levels in western Kansas 14,000 CALYBP. However, the Kanorado shells suggest that moisture levels were actually greater than present or suitable habitat for these bivalves would not have existed in Middle Beaver Creek. Mismatches between climate models and fossil-derived estimates are important for testing model accuracy (Webb et al. 1998).

We would like to thank Dr. Gerry L. Mackie (University of Guelph) for corroborating our identifications of *Sphaerium simile* shells.

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Paleoenvironments: Geosciences

Magnetic Susceptibility Signals from the Fuller Farm Site, a Late-Pleistocene and Middle-Holocene Alluvial Sequence in the Central Great Plains

Dane G. Bailey and William C. Johnson

Sedimentary packages of high-terrace fill in the central Great Plains typically contain intercalated buried soils ranging in age from latest Pleistocene to middle Holocene (Johnson and Logan 1990). The basal soil or complex of soils often dates to the late-Pleistocene/early-Holocene transition about 10,000 RCYBP, making it a target in the search for Paleoindian cultural remains (Sherman and Johnson 2006). A technique in the geoarchaeologist's toolkit useful for exploring sediments of this nature is magnetic susceptibility, a relatively quick and inexpensive procedure routinely used in studies of archaeological sites (Dalan and Banerjee 1998).

Here we present the results of magnetic-susceptibility analysis at the Fuller Farm site in northwestern Kansas. Contiguous 2.5-cm samples collected within an 8-m long, 6-cm-diameter core extracted from the high terrace of Prairie Dog Creek were measured for low-frequency magnetic susceptibility (χ_{lf}) to determine concentration of magnetic minerals (e.g., magnetite, maghemite) and for frequency dependence of susceptibility (χ_{fd}) to determine the percentage of magnetic material that is very fine clay-sized (ca. 20 nm). In addition, two ^{14}C assays dated the uppermost Ab horizon of two well-expressed buried soils. The upper soil dated to 5850 ± 70 RCYBP (ISGS-5856; 6579–6741 CALYBP), the lower to 10,150 ± 40 RCYBP (OS-57862; 11,724–11,913 CALYBP) (ages calibrated using http://radiocarbon.ldeo.columbia.edu/research/radcarbcal.htm; Fairbanks et al. 2005). Late-Pleistocene/early-Holocene and middle-Holocene pedogenesis recorded at this locality has been documented throughout the central Great Plains (Mandel 1995; May 2003), indicating climatic forcing (Knox 1983).

The χ_{lf} curve produces a unique signature for each soil horizon or stratigraphic unit captured within the core (Figure 1). Down-core magnetic enhancement, resulting from differences in both the native signal of the

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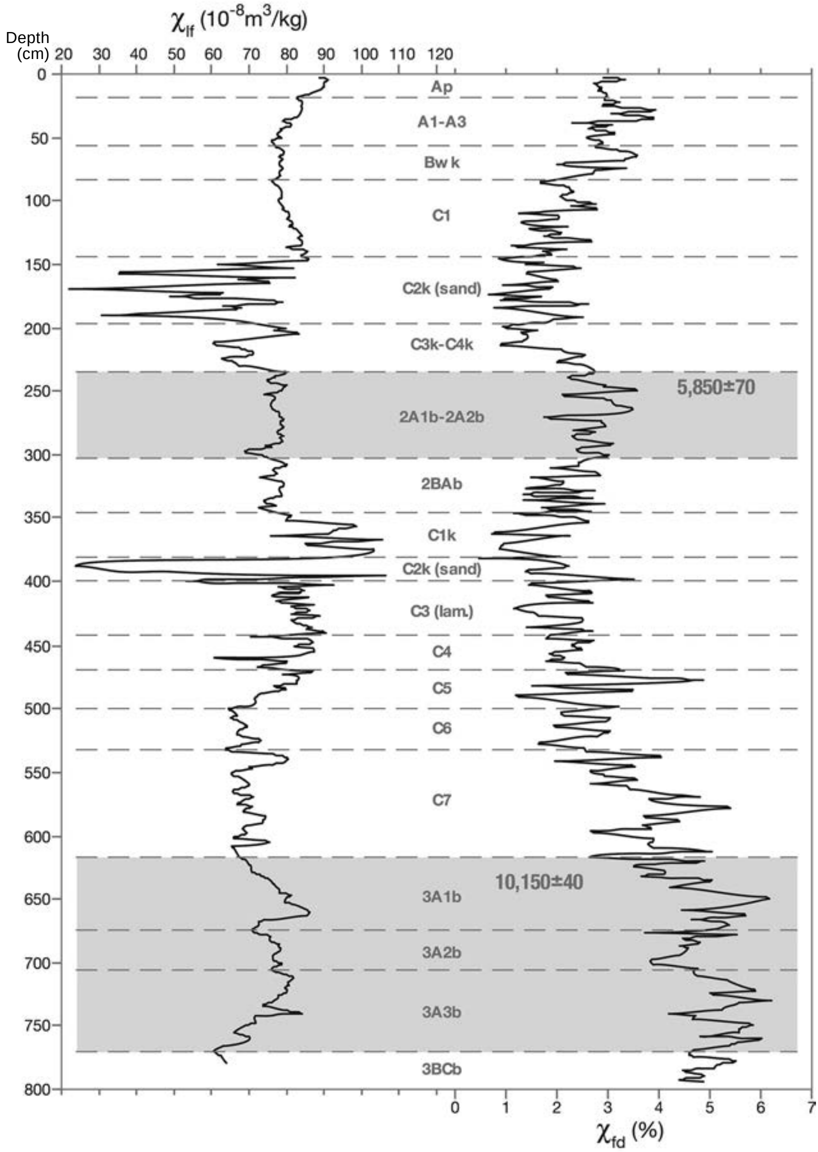

Figure 1. Magnetic susceptibility (χ_{lf}), frequency dependence of susceptibility (χ_{fd}), soil horizons and radiocarbon ages (RCYBP) derived from the core extracted at the Fuller Farm site. Shading indicates buried soil A horizons.

sediments and post-depositional pedogenesis, demarcates individual units. For example, high variance at 150–200 cm and 375–400 cm reflects sand splay deposits, while the basal paleosol exhibits an array of Ab horizons.

Though χ_{fd} data typically display high variance (Figure 1), low-frequency features and trends are discernible. The curve exhibits (1) enhancement of the surface soil, upper paleosol and especially the lower paleosol, and (2) increasing enhancement with depth below the upper paleosol. Elevated χ_{fd} values within the soils likely reflect both accumulation of pedogenic clay and biogenically created magnetite (Evans and Heller 2003). The trend between the two paleosols appears to be due to an upwardly increasing rate of aggradation until relative stability resulted in middle-Holocene pedogenesis.

Magnetic signals from Paleoindian-age soils in alluvium of the central Great Plains display regional similarities that can be employed to identify the soil in the absence of ^{14}C dating (Sherman and Johnson 2006). Notably, the Paleoindian-age soil or soil complex usually produces χ_{lf} signals that are enhanced over at least a 1-m depth, and χ_{fd} signals show higher percentages than any other buried soil in the Holocene sequence. At this site, the bimodal nature of both parameter signals indicates that two soils are welded.

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Ehmke Playa: Relationship between Playas of the Central High Plains and Potential Paleoindian Archaeology

Joshua S. Campbell, William C. Johnson, and Mark W. Bowen

Playa-lunette systems are ubiquitous features of the southern and central High Plains (Holliday et al. 1996; Johnson and Campbell 2005), serving to recharge groundwater within the Ogallala and other aquifers and to provide wetland habitat for wildlife (Smith 2003). In addition, these systems have demonstrated multiple landscape characteristics relevant to the search for records of early human occupations in the central North American continent and have yielded evidence of Paleoindian occupation (LaBelle et al. 2003). The Ehmke playa (Figure 1) in west-central Kansas contains an extensive archaeological site (14LA311) located on the downwind (southeastern) side of the lunette. This site has yielded a long cultural record, likely reaching back to the Paleoindian period. Such a south-facing location would have offered protection from north-northwesterly winds and full exposure to winter insolation. A bulk sample from a buried soil at the site, submitted by R. Timberlake of the Kansas State Historical Society, yielded a ^{14}C age of 9960 ± 120 RCYBP (Tx-6088; 11,420 CALYBP). This buried soil was within 1 m of the modern soil surface and contained mammoth skeletal elements. Dating of soil organic carbon from a buried soil below the lunette crest indicates a 33,000 ± 210 RCYBP surface at 4.2 m (OS-39284; 38,400 CALYBP), suggesting that the chronozone of early human occupation is situated relatively close to the modern surface. Existence of multiple buried soils within a single lunette has been confirmed elsewhere in Kansas (Arbogast 1996), suggesting that such pedostratigraphy is commonplace in these features.

A GIS-based statistical model predicting the distribution of archaeological sites on the High Plains of southwestern Kansas (Campbell 2006) demonstrated that the existence and distribution of playas are significant predictor variables in determining archaeological site locations. While the regional focus of that study was adjacent to but exclusive of the Ehmke playa, knowledge derived from the modeling exercise predicted that the archaeological value of playa-lunette systems increases within the area of the Ehmke playa due to decreased availability of other water sources, principally perennial stream flow. Long-time landowner V. Ehmke has observed that the playa basin can maintain surface water for up to two years under modern, non-drought climate conditions. Accordingly, playas may have been a dependable water source under the prevailing late-Pleistocene/early-Holocene climate. Upcoming backhoe trenching and high-resolution coring will provide detailed lunette pedo- and chronostratigraphy.

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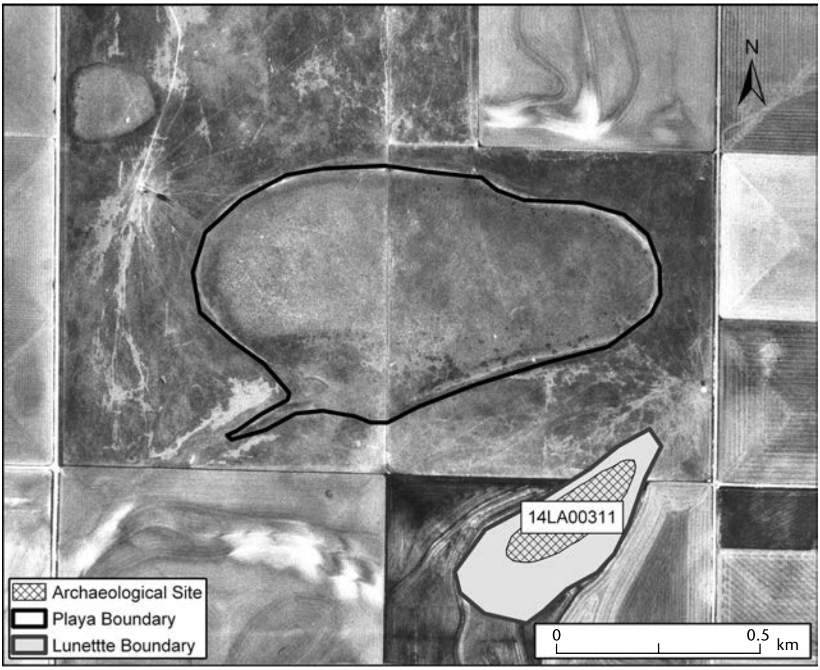

Figure 1. Aerial view of Ehmke playa and lunette, Lane County, west-central Kansas. The playa basin is outlined, as are the lunette crest and approximate area of the archaeological site. Note the alluvial fan or delta-like feature developed in the southwestern corner of the playa basin, where the intermittent drainage enters.

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Paleobiomes and Paleopastures: A Reconstruction of Interactions of Vegetation, Climate, Grazing, and Fire in South-Central North America since the Last Glacial Maximum

Carlos E. Cordova and William C. Johnson

Paleobiomes and Paleopastures is a research initiative that aims at collecting, analyzing, and integrating paleobotanical data for reconstructing vegetation change in south-central North America since the Last Glacial Maximum. The proxy records for this reconstruction are phytoliths and other palynomorphs (pollen, charcoal, and fungal spores) and stable carbon isotopic values from paleosols. The stress on phytoliths derives from the vacuum of pollen records still existing in the central and southern Great Plains, despite a few records that cover the terminal Pleistocene and the Holocene such as Cheyenne Bottoms, Muscotah Marsh, and Arrington Marsh in Kansas; Ferndale Bog and other localities in South Western Oklahoma; and Boriack Bog and other localities in East Texas (See North American Pollen Databases in WDC for Paleoclimatology 2007), most of which are concentrated on the eastern fringes of the Great Plains. Not only have phytoliths shown potential in areas where pollen does not preserve (e.g., Fredlund 1998, Johnson et al. 2002), they also add information on non-grass phytoliths, which are crucial for determining wooded vs. grassland phytolith forms (e.g., Fredlund 1998)

This research initiative includes three phases (Figure 1). The first phase aims at obtaining modern reference data for interpreting fossil phytolith and palynomorph assemblages. The procedure includes sampling of modern soils inside nature preserves, wildlife management areas, parks, and other managed environments. In each sampling locality, phytolith and palynomorph assemblages are linked not only to climate and vegetation, but also to environmental variables such as lithology, topography, soil types, fire management, and grazing patterns of domestic and native ungulates. The second phase of the project involves collecting and analyzing fossil data from existing datasets and directly from stratigraphic sections. The third phase of this study will integrate data obtained through the previous phases into a GIS-based model that will recreate changes in vegetation boundaries and pasture conditions since the late Pleistocene. Additional layers with paleoenvironmental information will be inserted in the model. These will include georeferenced and dated paleofaunal records (e.g., FAUNMAP Working Group 1994) as well as macrobotanical studies directly associated

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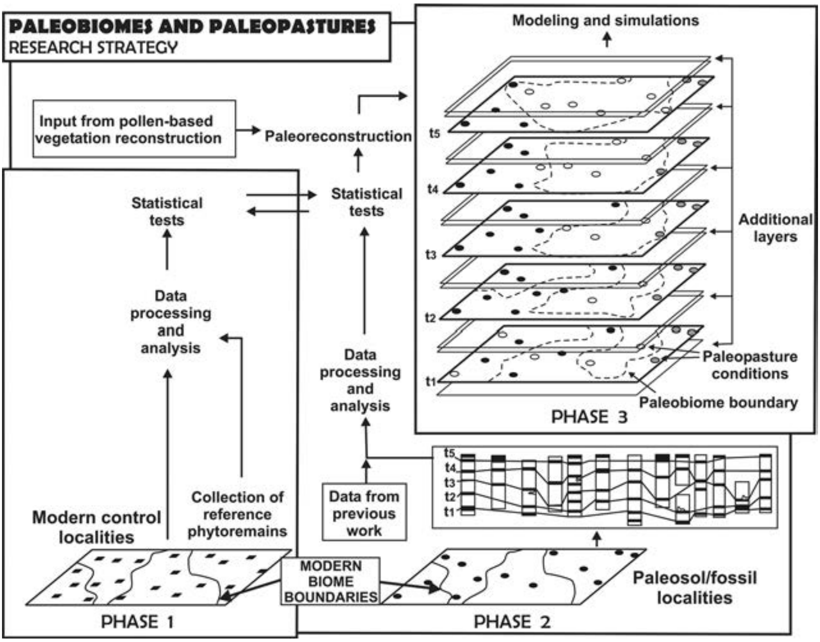

Figure 1. The three phases of the Paleobiome and Paleopastures Initiative.

with megafaunal remains (e.g., Bozarth and Hofman 1998; Gobetz and Bozarth 2001). Other inputs in the model will include aspects of hunting and land use by the cultures inhabiting the areas over time, provided by long-term interdisciplinary work at key sites (e.g., Collins 1998; Holliday 1995). The chronological and geographic associations between paleo-vegetation mosaics and large herbivores are expected to contribute to understanding habitat change associated with late-glacial mammal faunas. This procedure responds to suggestions made by Graham and Lundelius Jr. (1984) as a step toward understanding the habitats of mammals that went extinct at the end of the Pleistocene, the evidence of vegetation change accompanying extinctions outlined by Barnosky et al. (2004), and regional correlations between faunal and floral change (Bousman and Brown 1998).

The proposed project will also tackle questions regarding the long-term role of fire in forming the grass-dominated ecosystems of the Great Plains. Burnt phytoliths and micro-charcoal records in relation to vegetation structure are the basis for reconstructing the chronology of fire in the prairies (e.g., Boyd 2002). This research protocol is being tested through experimental studies in areas with historical and modern prescribed fires (e.g., Cordova et al. 2006).

The proposed project is in its theoretical phase and the preliminary stages of phase 1. Requests for cooperation and data contribution for phase 2 will be mailed to archaeologists and paleoecologists in the south-central United States over the course of 2008.

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Stratigraphy and Quaternary Landscape Evolution in the Vicinity of the Marias River, North-Central Montana

Christopher L. Hill

Stratigraphic exposures near the Marias River contain evidence of multiple glacial advance by lobes of the Laurentide Ice Sheet (LIS) as well as a postgla-

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cial aggradational sequence containing two tephras and a series of buried soils. Field mapping was conducted in the region northwest of Fort Benton and southeast of Shelby in Liberty County, Montana, where the Marias River occupies a broad valley containing late-Mesozoic and Quaternary strata (Lopez 2002; Smith et al. 1959). Three Cretaceous units are exposed, including Colorado shale, the Telegraph Creek formation, and Eagle sandstone. Gravels that lie directly on top of the Colorado shale have been correlated with the Saskachewan or Wiota Gravels which contain Pleistocene fossils (Hill 2006; Jensen and Varnes 1964).

The oldest till, designated the Lothair till (Smith et al. 1959), consists of a diamicton. It is a cemented light tan silt matrix with boulders and lenses of sand and gravel. Clasts are composed of quartz, limestone, and dolomite and are often stained by manganese. In some places the Lothair till is directly overlain by laminated silts, interpreted as lake sediments. This till forms a regional ground moraine that is likely the local equivalent of the middle Pleistocene (pre-Illinoian) Havre till (Fullerton et al. 2004: 15).

In the vicinity of the Marias River a younger till, designated as the Pondera till, has been recognized (Smith et al. 1959). It overlies the Lothair till and is primarily restricted to the Marias River and Pondera Coulee. The Pondera till is darker than the Lothair till and consists of a clayey matrix with pebbles, cobbles, and boulders that exhibit no manganese staining. These clasts are composed chiefly of limestone, dolomite, and granite. The deposits assigned to the Pondera till are less indurated and darker than the Lothair till. The darker color could be the result of erosion of the Colorado shale. It appears to have been deposited by glacial ice that advanced from the west. Fullerton et al. (2004:18) have assigned exposures of the Pondera till to the Illinoian Herron Park till and late-Wisconsin Fort Assiniboin till. The Fort Assiniboin till in north-central Montana was deposited by the western Shelby lobe and eastern Havre lobe (Fullerton and Colton 1986). Based on evidence from glacial Lake Mussselshell, there may have been three advances of the LIS in central Montana during the late Wisconsin (Davis et al. 2006).

Ice-contact deposits and outwash channel deposits reflect the melting of the late Wisconsin ice. Four gravel terraces have been mapped; they overlie the glacial deposits or exposed bedrock (cf. Roll 1978; Smith et al. 1959). Calcium carbonate coats the underside of clasts within the upper parts of the gravels.

A stratigraphic exposure west of the Tiber Dam is an example of the postglacial Quaternary deposits and their relationships to older strata. The base of the sequence consists of Cretaceous shale overlain by sands and gravels. These are overlain by till 3–5 m thick. The top of the till is covered by well-sorted sand and oxidized gravels. The gravels are buried by a 2-m-thick light tan silt that contains a ca. 1-cm-thick tephra. A bone fragment embedded in this silt and overlying the tephra has an age of 11,375 ± 45 RCYBP (XAD-gelatin, KOH-collagen, SR-6022). A buried soil has developed within the silt above the bone fragment.

Based on the ^{14}C measurement, this tephra could be volcanic ash from Mount St. Helens or Glacier Peak. Mount St. Helens Jy dates to about 11,400 RCYBP (MacLeod et al. 2006). The Mount St. Helens S tephra, dated to ca. 12,900–12,100 RCYBP, has been tentatively identified regionally within deposits of glacial

Lake Great Falls (Mullineaux 1996; Parker and Smith 2004). Two Glacier Peak tephras (B and G) identified in Montana have an age of ca. 11,250 RCYBP (Carrara 1989; Gardner et al. 1998; Lemke et al. 1975; Porter 1978).

Two additional buried soils are developed within a ca. 2-m-thick silt deposit that is overlain by another tephra. This volcanic ash correlates with Galata ash, the local equivalent of the Mazama tephra dated to ca. 6800–6600 RCYBP (cf. Carrara 1989; Horberg and Robie 1955; Lemke et al. 1975). A unit of silt 2-3 m thick overlies the upper tephra. The top of the silt contains a late-Holocene soil.

Evidence for Quaternary landscape evolution in the Marias River region begins with gravels underlying glacial deposits, which may reflect stream activity of an early-Pleistocene Marias River. The fluvial gravels underlie till, lake, and glaciofluvial deposits formed by glacial advances from the north and from the northwest during the middle and late Pleistocene. As the late-Pleistocene LIS began to melt, stagnant ice resulted in kame terraces and outwash sediments were deposited. As the Marias River was reestablished, a series of four gravel terraces formed. After a valley incision, late-Pleistocene/ Holocene aggradation occurred. This aggradational sequence contains a late-Pleistocene tephra and middle-Holocene tephra along with several buried soils developed within silts.

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A Dynamic Record of Late-Holocene Environmental Change Recorded in Banded Colluvium from the Northern Great Plains: Preliminary Data and Implications for Long-Term Drought Cycles since the Late Pleistocene

Kenneth Lepper and Allan C. Ashworth

We report here on a late-Holocene colluvial record of environmental change from the Little Badlands, 13 km south of South Heart, Stark County, North Dakota (103° 00′ 39″ W, 46° 45′ 20″ N). Gully erosion of a pediment has exposed more than 3 m of poorly consolidated, color-banded clayey silts. At least 11 distinct couplets of dark carbon-rich and light carbon-poor bands (Figure 1) record multiple episodes of sediment accumulation and soil formation. Banded colluvium of late-Pleistocene to Holocene age occurs throughout the unglaciated regions of southwestern North Dakota. Here we demonstrate the potential value of these deposits as proxy paleoclimatic indicators, especially for determining longer-term drought cycles (ca. 200 yr). Drought cycles have been reported from studies of late-Holocene lacustrine deposits in eastern and central North Dakota (Laird et al. 1996a, 1996b; Yu and Ito 1999), but their occurrence in the late Pleistocene and early Holocene is less well known, having been reported from only a single site on the Missouri Coteau (Newbrey and Ashworth 2004).

The colluvium was deposited by sheet wash following erosion of Oligocene Brule Formation mudstones and sandstones exposed in a 30-m-high escarpment about 300 m east of the section. Although modern soil development has overprinted the upper part of the profile, banding is present from a depth of

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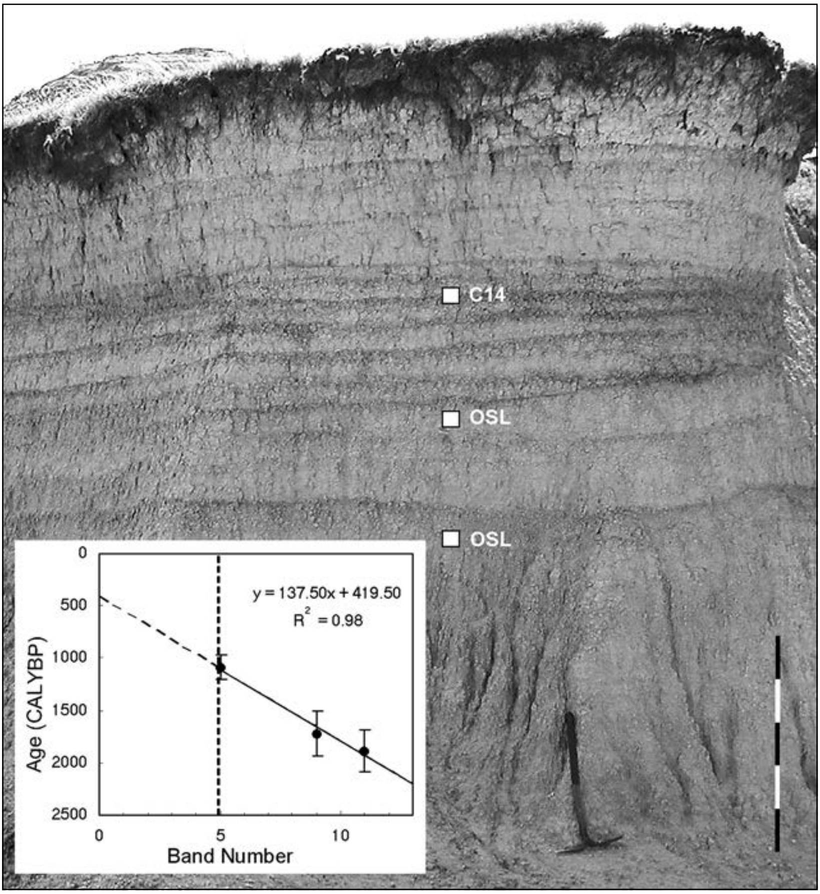

Figure 1. Banded colluvial deposits in the Little Badlands, Stark County, North Dakota. ^{14}C and OSL sample horizons are indicated. The ^{14}C sample was collected from a hearth at the equivalent stratigraphic position exposed in the opposite wall of the gully. The vertical scale on the photograph is 1 m. The inset shows the dating results and an analysis of banding periodicity (slope). The vertical dashed line in the inset represents the discontinuity surface.

about 50 cm from the surface to the base of the colluvium. The bands range in thickness from 18 to 33 cm. Each couplet consists of a 1- to 2-cm brown to dark grayish brown (10YR 4/2, 10YR 4/3, 10YR 5/2), carbon-rich horizon, including finely disseminated charcoal, with soil structures and textures ranging from granular loam to platy loamy clay overlying light gray to pale brown (10YR 7/3, 10YR 7/2, 10YR 6/3, 10YR 5/3), carbon-poor, angular blocky to prismatic friable loams (Munsell colors and organic carbon analysis from Foss, written comm., 1992). Induration of the sediments increases downward from weakly to well indurated due to the presence of the carbonate.

A buried hearth with charcoal, bison-bone fragments, and chert was exposed in the profile at a distinctive discontinuity surface marked by a thin lag of gravel (Figure 1). The occurrence of several hearths in nearby sections of colluvium, abundant bison bones, chert and quartzite tools, and deboutage indicates that the area was inhabited by Plains Indians taking advantage of potable water from springs and fuel from an ash woodland located at the base of the Brule escarpment. Within the banded deposits in an adjacent gully, at a depth of 122 cm, Ashworth recovered the skull of an adult gray wolf (*Canis lupus*) with worn teeth. The blunting of the canines appears too extreme for natural wear and may be the result of intentional human modification, in which case the skull could represent that of a domesticated animal.

A ^{14}C sample was obtained from charcoal extracted from the hearth at 200-cm depth. Sediment samples for OSL dating were collected at a depth of 255 cm and 295 cm below the modern surface (Figure 1). OSL dating was conducted in the Optical Dating and Dosimetry (ODD) Lab at North Dakota State University. Experimental methods included single-aliquot regeneration (SAR) data collection procedures (adapted from Murray and Wintle 2000, 2006) and the "leading edge" data-analysis approach (Lepper and McKeever 2002; Lepper et al. 2007). These methods make it possible to determine hundreds of age estimations per sample and to select a representative age for the deposit based on the shape of the data distribution. Dosimetric data were obtained via instrument neutron activation analysis (INAA; Ohio State University Research Reactor). The OSL ages obtained were 1720 ± 220 (255 cm; n = 45; M/m = 1.85) and 1890 ± 200 (295 cm; n = 93; M/m = 1.43) CALYBP. The radiocarbon age of the hearth was 1170 ± 100 (Beta-23335) RCYBP or 1086 ± 114 CALYBP (Fairbanks et al. 2005).

The dates represent a stratigraphically coherent chronology suggesting rapid but episodic deposition of the thick colluvial pediment in the late Holocene; subsequent gully incision occurred in the latest Holocene, perhaps even in historic times. We interpret the banded structure of the colluvium to be related to long-term wet-dry cycles, with increased rates of erosion and colluvial mobilization alternating with phases of landscape stability and incipient soil development. We recognize that fire, through natural and possibly anthropogenic activities, may have played a role in the accumulation of carbon but consider it secondary to climate in couplet formation.

In one of the few continuous paleoclimatological records from western North Dakota, Yu and Ito (1999), using spectral analysis of geochemical data, show cyclical drought periodicities at 400, 200, 130, and 100 years. They consider the most likely cause to be long-term variation in solar output. Based on our chronology, an average length for the formation of a couplet below the distinctive discontinuity surface is 137 yr (Figure 1, inset). The discontinuous nature of deposition and low resolution of the chronological control make it impossible to know if deposition of the colluvium is cyclically controlled by centennial scale drought cycles, but the average age of couplets places them in the correct time framework for that to be a possibility. Another lacustrine record from central North Dakota suggests that drought cycling in the region was not limited to the late Holocene, but occurred in the early Holocene and late Pleistocene (Newbrey and Ashworth 2004). The colluvial archives of unglaciated southwestern North Dakota, such as the one examined in this report, have the potential to hold a complete Quaternary drought record.

Our preliminary data indicate that ^{14}C and OSL dating can be used together to yield a coherent chronology for these deposits. Continued work in this area may reveal a longer Quaternary record assembled from similar colluvial deposits and may answer such outstanding questions as: How are local colluvial records linked to regional climate factors such as drought and fire history? How have humans influenced the development of these colluvial records? When was pediment incision initiated, and was it influenced by changes in modern land-use practices, especially in introducing upland farming of small grains, corn, and sunflowers?

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Databases

The Siberian Mammoth ^{14}C Database: Accumulating and Interpreting Data

Lyobov A. Orlova, Yaroslav V. Kuzmin, and Vyacheslav N. Dementiev

Constructing ^{14}C databases is important for modeling and simulating environmental change. Compiling woolly mammoth (*Mammuthus primigenius* Blum.) ^{14}C dates makes it possible to investigate patterns of extinction and other relationships with climatic fluctuations in the late Pleistocene and early Holocene (e.g., Guthrie 2006; Kuzmin and Orlova 2004; Orlova et al. 2004a; Stuart 2005). The Siberian ^{14}C mammoth database (available at: http://www.uiggm.nsc.ru/uiggm/geology/evol/lab924/orlova/Mammoth.xls) contains regularly updated information on radiocarbon determinations from mammoth localities in northern Asia, including eastern Russia and neighboring Japan, China, Kazakhstan, and Mongolia (Figure 1). A total of about 760 ^{14}C dates from 300 locales (as of the end of 2006) are contained in the database, including multiple ^{14}C dates on the same sample of bone and tusk, and on the same carcass.

As for the geographic distribution of ^{14}C-dated mammoths, the highest concentrations are in two regions: 1) north of 70° N latitude, and 2) between 50° and 60° N latitude. The large number of ^{14}C dates in the Siberian Arctic is due to continuous collecting and ^{14}C-dating of megafaunal remains in this region (e.g., MacPhee et al. 2002; Mol et al. 2006; Sher et al. 2005). In temperate eastern and western parts of Siberia, numerous ^{14}C dates have recently been obtained (Orlova et al. 2004a; Kuzmin and Orlova 2004). In other parts of Siberia, more work needs to be done to fill gaps where mammoth remains are known from the literature, but few dates are available (e.g., Kuzmin and Orlova 2004:145). As for chronological subdivisions of the database, about 110 ^{14}C dates correspond to the Holocene, ca. 3700–9900 RCYBP; and about 650 determinations belong to the late Pleistocene, from ca. 10,000 RCYBP to more than 53,700 RCYBP.

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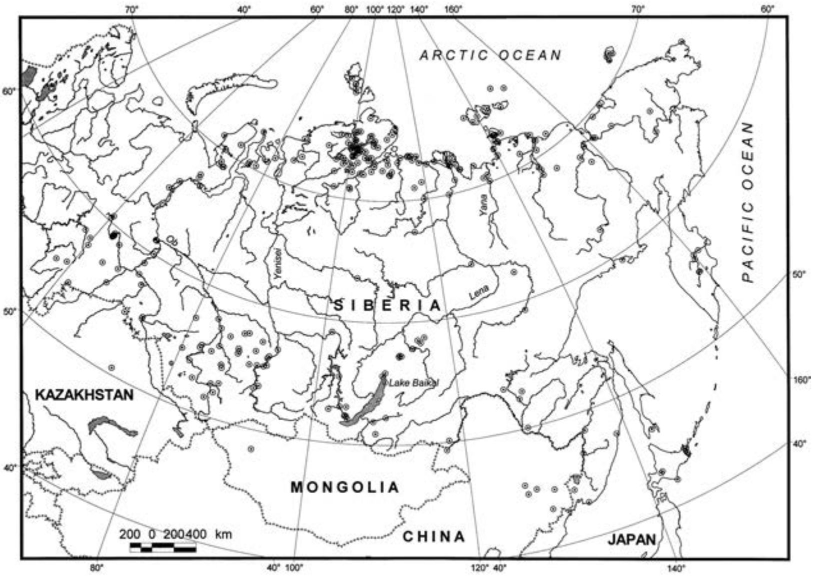

Figure 1. Radiocarbon-dated mammoth remains from Siberia and adjacent northern Asia (after Kuzmin and Orlova 2004, with additions).

The database is being used to investigate several topics, including patterns of mammoth final extinction (Kuzmin and Orlova 2004; Orlova et al. 2003, 2004a; Stuart et al. 2002), the relationship between mammoth populations and climatic fluctuations in the Northern Hemisphere in the second half of the late Pleistocene (Kuzmin et al., in press), the paleoenvironment of the West Siberian Plain at the Last Glacial Maximum (Kuzmin et al. 2004), and the spatial-temporal nature of interaction between Paleolithic humans and mammoths in Siberia (Kuzmin and Orlova 2004:155–160; Orlova et al. 2004b).

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