CURRENT RESEARCH IN THE PLEISTOCENE

Volume 16 1999

A Peopling of the Americas Publication

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Center for the Study of the First Americans
Oregon State University
Corvallis, Oregon

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Volume 16 **1999**

Current Research in the Pleistocene is published annually by the Center for the Study of the First Americans. ISSN 8755-898X.

Typesetting and camera-ready preparation by C & C Wordsmiths, Blue Hill, Maine.

Printed by Downeast Graphics & Printing, Inc., Ellsworth, Maine.

Contents

Physical Anthropology

Lithic Studies

Methods

Paleoenvironments: Plants

Paleoenvironments: Vertebrates

From the Editor

NAGPRA, Racism, and the First Americans

Throughout 1999, prominent stories in the popular media continued to trumpet claims that America was peopled by Europeans as well as by the Asian ancestors of American Indians. Some of the reports even suggested the Asians were relative latecomers who displaced the Europeans (e.g., Begley and Murr 1999; Wright 1999). The evidence offered by those scholars interviewed in these articles includes the remarkably "European" appearance of reconstructions of the facial features of Kennewick Man and Spirit Cave Man, a mysterious genetic link between Paleoamericans and European populations, and purported similarities between Clovis points and Solutrean points (Begley and Murr 1999; Mirsky 1999; Wright 1999).

Frederic Sellet (1998) addressed the putative similarities between Clovis and Solutrean technology in the last volume of *CRP*. James Chatters, Walter Neves, and Max Blum consider the "European" or "Caucasoid" appearance of Kennewick Man in this volume; moreover, Alan Goodman (1997) has argued forcefully against any relevance for the "racial ambiguity" of Kennewick Man. Finally, the mysterious European component to the Native American gene pool doesn't look quite so mysterious anymore (cf. Culotta 1999; Mendoza and Braginski 1999). In her article on the "First Americans," *Discover* magazine reporter Karen Wright asserted that "in archeology, when you lack direct evidence, whoever tells the best story wins" (1999:10). The story of the European Paleolithic colonization of America, as presented in the recent popular media, has no credible data to support it. The fact that this story has garnered such attention is a testimonial to how powerfully it resonates with the popular imagination. Indeed, it has been pronounced a good story by a master storyteller (Auel 1998). It is reminiscent of another good story that served the needs of an earlier generation: the story of the lost race of Moundbuilders.

The Moundbuilders were the mythical people thought by many 19th-century antiquarians to have built the magnificent mounds and enclosures of the Ohio Valley. The early scholars were drawn to this conclusion by the contrast between the grandiose architecture of the mounds and the more humble life-style of the land's Indian inhabitants. Surely these evidences of a marvelous civilization must have been the work of a lost race of white-skinned folk and not the red-skinned barbarian hordes then living amidst the long-abandoned sites. It was a myth that appealed to transplanted Europeans because it seemed to grant them a birthright to America. By expelling or exterminating the Indian occupants, they could believe they were reclaiming the land from savagery. But Squier and Davis (1848), Thomas (1894), and other archaeologists collected the data that finally exploded this myth. The mounds were built by ancient Indians, not by some vanished European civilization.

Are we now in danger of re-creating the racist Moundbuilder myth in the modern guise of white-skinned Paleoamericans from France and Spain being supplanted by Mongoloid invaders from the Asian steppes? If, in our legitimate desire to wrest the skeleton of Kennewick Man from the oblivion of reburial, we attempt to justify our scientific interests by arguing that NAGPRA doesn't apply because he was a "Caucasian," then we put our discipline in serious danger. If we are finally allowed to study Kennewick Man's DNA and find out he is, after all, an ancestor of American Indians, then we will lose the basis for claiming a right to study this person's remains. We also open ourselves to charges of racism from Indians who perceive the story as yet another scientifically veiled political attempt to supersede their claims to America by asserting that "we" were here first. I do not mean to suggest that any archaeologist making these claims is an imperialistic racist, but we make ourselves vulnerable to this charge when we advance such politically volatile claims on the basis of weak evidence. (It does not help our cause that the claims are being splashed across magazine and newspaper headlines before any supporting data have been presented in the peer-reviewed literature.) Those of us in the archaeological community shouldn't be arguing that NAGPRA doesn't apply to Kennewick Man because he could be a Paleo-European; we should be arguing that NAGPRA doesn't apply to 10,000-year-old skeletons because any putative bonds of biological and cultural affinity are stretched too fantastically thin across such an immense gulf of time. In addition, the scientific value of what we can learn from such ancient remains should supersede the religious sensibilities of particular individuals or groups. The scientific search for the origins of the first Americans should not be a contest over who can tell the best story. Science is about proposing cogent hypotheses and testing them against empirical data. So far, the mass of empirical data supports an Asian origin for Paleoamericans—Kennewick Man's superficial resemblance to Star Trek's Patrick Stewart notwithstanding.

B. D. Lepper

References Cited

Auel, J. 1998 Early Americans. *Science* 280:1674–1675.

Begley, S., and A. Murr 1999 The First Americans. *Newsweek* 26 April 1999, pp. 50–57.

Culotta, E. 1999 Anthropologists Probe Bones, Stones, and Molecules. *Science* 284:1109–1111.

Goodman, A. 1997 Racializing Kennewick Man. *Anthropology Newsletter* 38(7):3, 5.

Mendoza, D. H. de, and R. Braginski 1999 Y Chromosomes Point to Native American Adam. *Science* 283:1439–1440.

Mirsky, S. 1999 Bones to Pick. *Scientific American* 280(2):36–38.

Sellet, F. 1998 The French Connection: Investigating a Possible ClovisSolutrean Link. *Current Research in the Pleistocene* 15:67–68.

Squier, E., and E. Davis 1848 Ancient Monuments of the Mississippi Valley. Smithsonian Institution, Contributions to Knowledge 1. Washington, D.C.

Thomas, C. 1894 Report on the Mound Explorations of the Bureau of Ethnology. Twelfth Annual Report of the Bureau of Ethnology, 1890–1891. Washington, D.C.

Wright, K. 1999 First Americans. *Discover* 20(2):52–62.

Archaeology

A Hartville Chert Folsom Point from Goshen County, Wyoming

Richard Adams, Dennis Seipp, and Yvette Widman

As an indirect result of archaeological monitoring of earthwork related to road construction, a broken Folsom projectile point was found on the surface of eolian deposits covering a high Pleistocene terrace (Love and Christiansen 1985) above the North Platte River in the city of Torrington, Goshen County, Wyoming.

No surface artifacts were found in the immediate vicinity nor were any artifacts found in a 1-m² test unit excavated at the location of the find. Two sedimentary units were exposed in the excavation. The upper unit had been disturbed by waterline construction. The lower sedimentary unit is eolian sand with a paleosol at the top. The 10-cm-thick A horizon has a moist mixed Munsell color of 2.5Y 4/4 (olive-brown); the C horizon is 2.5Y 5/3 (light olive-brown). Neither the A nor C horizon exhibits much calcareous cementation. These sediments slope down to the northwest—away from the edge of the terrace. A similar A horizon was encountered in five auger probes and one test unit during testing of the nearby middle-Archaic site. This A horizon also slopes to the northwest (Adams 1997:24). Middle-Archaic projectile points were found on the surface above the A horizon.

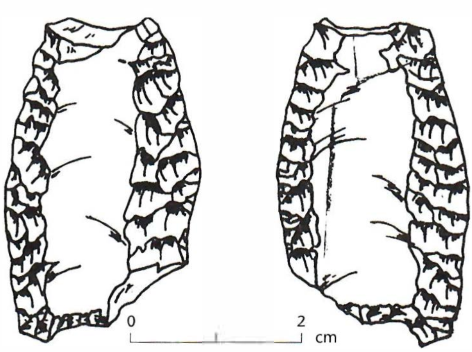

Figure 1. Hartville chert Folsom point from Torrington, Wyoming.

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The point is broken at both ends and has been resharpened. At the base, one ear is partially present, the other is completely missing (Figure 1). The edges are ground up to the widest point on the tool. Above the sub-parallel ground edges the outline of the point narrows owing to resharpening. There is what Bradley (Frison and Bradley 1980:50) calls "non-invasive marginal retouch" along the edges that regularizes the edges, resulting in two sets of flake scars: pressure thinning flakes and pressure edge retouch.

An impact removed the tip of the point about one-quarter of the way down its length. The impact scar is on the same side as the ear break scar. Two of the resharpening flake scars invade the flute in the distal portion of the point. No trace is left of the fluting platforms.

The point is 38.3 mm long, 22.9 mm wide, and 5 mm thick. The measurements were sent to Jack Hofman (University of Kansas) to be included in the Great Plains Fluted Point Survey.

The point is made from butterscotch-colored chert with a grainy appearance and only a few specks of black manganese oxide (Miller 1991:461). Outcrops of this chert occur in the Hartville Uplift, about 40 km northwest of Torrington (Adams 1996).

The Hartville Uplift is an anticlinal uplift measuring about 50 km N-S by 30 km E-W that rises about 400 m from the plains of eastern Wyoming. Uplifted roughly 60 million years ago, the western flank of the Hartville Uplift exposes Paleozoic, Mesozoic, and Tertiary sedimentary rocks; the faulted eastern edge of the uplift exposes Precambrian rocks. Quarries in the late Mississippian, Pennsylvanian, and Permian Hartville Formation (Love and Christiansen 1985) produced the vast majority of aboriginally utilized chert.

Archaeological inventories conducted by the Office of the Wyoming State Archaeologist since 1991 have documented at least 11 chert quarries with an area exceeding 765 hectares in the Hartville Formation (Reiss et al., in prep). This figure is based on a survey of less than 8 percent of the Hartville Uplift. We estimate that the Hartville uplift could contain well over 9,000 hectares of aboriginal chert and quartzite quarries (see also Reher 1991). At least one of these quarries, 48PL1010, contained chronologically diagnostic Paleoindian artifacts (Reiss et al., in prep).

References Cited

Adams, R. 1997 Class III Cultural Resource Survey and Test Excavation Results, WYDOT Project STPUTO-4969(2), Torrington Streets East "M" and 20th Ave., Goshen County, Wyoming. Report submitted to the Wyoming Department of Transportation by the Office of the Wyoming State Archaeologist. OWSA Project Number WY-7-97. On file at the Office of the Wyoming State Archaeologist, Laramie.

——— 1996 Geology of the Hartville Uplift. In Results of the Class III Cultural Resource Inventory of the Wyoming Army National Guard Camp Guernsey Training Areas, 1994 Field Season, Platte County, Wyoming, pages 10–14 by David Reiss, Richard Adams, Paul Sanders, and David G. Eckles. Report submitted to the Wyoming Army National Guard by the Office of the Wyoming State Archaeologist. OWSA Project Number WY-15-94. On file at the Office of the Wyoming State Archaeologist, Laramie.

Frison, G. C., and B. Bradley 1980 *Folsom Tools and Technology at the Hanson site, Wyoming.* University of New Mexico Press, Albuquerque.

Love, J. D., and A. C. Christiansen 1985 *Geologic Map of Wyoming*. U.S. Geological Survey, Denver.

Miller, J. C. 1991 Lithic Resources. In *Prehistoric Hunters of the High Plains, Second edition*, by George C. Frison, pp. 449–476. Academic Press, New York.

Reher, C. A. 1991 Large Scale Lithic Quarries and Regional Transport Systems on the High Plains of Eastern Wyoming: Spanish Diggings Revisited. In *Raw Material Economies Among Prehistoric Hunter-Gatherers*, edited by A. Montet-White and S. Holen. University of Kansas Publications in Anthropology, 19, Lawrence, Kansas.

Reiss, D., P. H. Sanders, D. Seipp, and M. Rogers in prep Artifact Analysis and Prehistoric Land Use Patterns on the Wyoming Army National Guard Training Areas, 1991–1997 Field Seasons, Platte County, Wyoming. Manuscript on file at the Office of the Wyoming State Archaeologist, Laramie.

Joe Ben Wheat's Investigations at Chispa Creek in Trans-Pecos, Texas

Daniel S. Amick and Jack L. Hofman

This paper discusses the minimally reported Paleoindian collections from the Chispa Creek locality in the Trans-Pecos region of west Texas. Previously reported evidence of Folsom occupations in the Trans-Pecos are scarce (Hedrick 1975:63–64; Sommer 1974), and most references to Chispa Creek just mention it briefly as a notable Folsom campsite in the region (Boisvert 1983; Foster and Kelley 1989:15; Hicks 1989:36; Hofman 1995; Judge 1974; Largent et al. 1991; Lehmer 1958:122; Lindsay 1969:103; Mallouf 1985:98; Wheat 1971:24). Situated about 200 km SE of El Paso, this locality was first recorded and collected by the late Joe Ben Wheat (University of Colorado). Our primary goal in this paper is to provide published documentation on the Chispa Creek assemblage and to credit Wheat for his work there.

Chispa Creek is located in the southeastern extension of the Basin and Range physiographic province. This area is separated from the Southern Plains by the Davis Mountains. Bedrock in this region is dominated by Cretaceous sedimentary formations and Tertiary volcanics. Diverse lithic materials are available in the Trans-Pecos including cherts, jaspers, chalcedonies, petrified and opalized woods, quartzites, hornfels, rhyolites, novaculites, felsites, and silicified tuffs (Banks 1990:83–87; Mallouf 1985:12–14). Although these lithic resources remain poorly investigated, it appears that most materials in the Chispa Creek assemblage are derived from these regional sources.

Chispa Creek is represented by three discrete surface concentrations near Wild Horse Draw on a closed basin floor. In 1946, Wheat surface collected a

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Folsom point from a dune he recorded as 45A5-2. In April 1957, he collected numerous Folsom points, channel flakes, gravers, and scrapers from the surface of a site located about 1.6 km north of that original find. He recorded this site as 45A5-6, and his subsequent investigations showed this 4-hectare area to be the most productive. Later that fall, Wheat located another Folsom occupation about 1.2 km farther north, which he designated 45A5-7. He continued collecting the area around these sites intermittently during the next several years. In 1962 and 1965, he conducted test excavations at 45A5-6 and recovered a few artifacts up to 43 cm deep in carbonate-cemented sediments. Although Wheat recorded a late-period hearth on the surface of 45A5-6, he found no diagnostic artifacts of later Holocene occupation at the site.

Only one chalcedony Folsom preform base was added to the artifact collection from 45A5-2, the site where Wheat found the original chert Folsom point at Chispa Creek. His work at Chispa Creek reinforces the importance of using a long-term strategy of repeated survey and collection at what first appeared to be an isolated Paleoindian find.

Wheat's assemblage from 45A5-7 contains 16 Folsom points, 4 Folsom preforms, 3 Angostura points, 1 Agate Basin point, 28 end scrapers, 9 Folsom channel flakes, and 5 gravers. All these Folsom preforms are distal fragments made of chert. The Folsom points from 45A5-7 include eight complete points (four are miniature), five bases, two midsections, and one tip. Lithic materials represented in the Folsom points include ten chert, four jasper, one quartzite, and one felsite.

At site 45A5-6, Wheat accumulated 73 Folsom points, 56 Folsom preforms, 38 Folsom channel flakes, 37 gravers, 300 end scrapers, 1 Clovis, 2 Agate Basin, 2 Angostura, 2 Scottsbluff, 3 Milnesand, and 7 Plainview points. The Folsom points from 45A5-6 include 7 complete points (4 are miniatures), 35 bases (2 are miniatures), 21 midsections, and 6 tips. The Folsom preform assemblage is represented by 17 bases, 11 midsections, and 28 tips. Among the preforms, 48 percent (n = 27) are felsite, 32 percent (n = 18) jasper, 13 percent (n = 7) chalcedony, and 7 percent (n = 4) chert. In contrast, only 19 percent (n = 14) of the points are felsite (including five of the six miniatures), while 37 percent (n = 27) are chert, 25 percent (n = 18) jasper, and 19 percent (n = 14) chalcedony. These felsite tools may represent locally procured stone, while the cherts, jaspers, and chalcedonies may include materials from more distant sources. On a recent visit to this site, we noted abundant evidence of post-Folsom occupations and found one Folsom ear fragment from a split preform.

We are currently reanalyzing Wheat's collections to compare these materials with those found in Folsom assemblages from the Tularosa Basin and Southern Plains (Amick 1994, 1996; Hofman 1991; Hofman et al. 1990). Our preliminary analysis identifies 12 of the Chispa Creek artifacts (3 Folsom points, 1 Midland point, 4 Folsom preforms, 3 channel flake fragments, and 1 unmodified flake) as Edwards chert from Southern Plains sources about 400 km to the east. However, most of the tool stones in these Folsom assemblages from Chispa Creek are derived from Trans-Pecos sources not more than 200 km away. This scale of regional lithic movement is much less than that reported from the Southern Plains, but it resembles that recorded for Folsom assemblages in the Basin and Range.

This paper is dedicated to the memory of Joe Ben Wheat and his many contributions to Paleoindian archaeology. Thanks to Doug Bamforth, Fred Lange, Diana Leonard, and Nicolette Meister at the University of Colorado for helping provide access to the collection and field notes. Helpful commentary about Chispa Creek was provided by the late Jack Hedrick of the El Paso Archeological Society, Dennis Stanford and Pegi Jodry of the Smithsonian Institution, and Pat Hicks (formerly of the Desert Research Institute). Thanks also to Jeannette Blackmar for assisting with data collection in Boulder.

References Cited

Amick, D. S. 1994 Technological Organization and the Structure of Inference in Lithic Analysis: An Examination of Folsom Hunting Behavior in the American Southwest. In *The Organization of Prehistoric North American Chipped Stone Tool Technologies*, edited by P. Carr, pp. 9–34. Archaeological Series No. 7. International Monographs in Prehistory, Ann Arbor.

——— 1996 Regional Patterns of Folsom Mobility and Land Use in the American Southwest. *World Archaeology*. 27:411–426.

Banks, L. D. 1990 *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Sources in the Trans-Mississippi South, Southern Plains, and Adjacent Southwest*, Memoir No. 4. Oklahoma Anthropological Society, Norman.

Boisvert, R. 1983 A Technological Analysis of Lithic Assemblages from Guadalupe Mountains National Park, Texas. *Bulletin of the Texas Archeological Society*, 54:1–104.

Foster, M. S., and J. C. Kelley 1989 Archaeological Investigations in the Three-Mile and Sulpher Draw Watershed, Culberson County, Texas. *The Artifact*. 27(3):1–82. El Paso Archaeological Society.

Hedrick, J. 1975 Archeological Survey of the Plateau Complex. *The Artifact*. 13(4):45–82. El Paso Archeological Society.

Hicks, P. A. 1989 Trans-Pecos. In *Human Adaptations and Cultural Change in the Greater Southwest*, edited by A. Simmons, A. Stodder, D. Dykeman, and P. Hicks, pp. 36–38. Study Unit 4 of the Southwestern Division Archaeological Overview. Research Series No. 32. Arkansas Archeological Survey, Fayetteville.

Hofman, J. L. 1991 Folsom Land Use: Projectile Point Variability as a Key to Mobility. In *Raw Material Economies Among Prehistoric Hunter-Gatherers*, edited by A. Montet-White and S. Holen, pp. 335–355. Publications in Anthropology No. 19. University of Kansas, Lawrence.

——— 1995 Unbounded Hunters: Folsom Bison Hunting on the Southern Plains circa 10,500 B.P. Paper presented at the International Meeting on Bison Subsistence through Time from the Paleolithic to Paleoindian Times, Toulouse, France.

Hofman, J. L., D. S. Amick, and R. O. Rose 1990 Shifting Sands: A Folsom-Midland Assemblage from a Campsite in Western Texas. *Plains Anthropologist*, 35:221–253.

Largent, F. B., Jr., M. R. Waters, and D. L. Carlson 1991 The Spatiotemporal Distribution and Characteristics of Folsom Projectile Points in Texas. *Plains Anthropologist*, 36:323–341.

Lehmer, D. 1958 A Review of Trans-Pecos Archeology. *Bulletin of the Texas Archeological Society*, 29:109–144.

Lindsay, A. J. 1969 Current Research: Southwest: Texas. *American Antiquity*. 34:102–103.

Mallouf, R. J. 1985 *A Synthesis of Eastern Trans-Pecos Prehistory*. Unpublished M.A. thesis, Department of Anthropology, University of Texas, Austin.

Sommer, A. 1974 1973 Early Man Conference. *Transactions of the Regional Archaeological Symposium for Southeastern New Mexico and Western Texas*, 9:109–141. Midland Archeological Society, Texas.

Wheat, J. B. 1971 Lifeways of Early Man in North America. *Arctic Anthropology*, 7(2):22–31.

Early Paleoindian Evidence from the Oklahoma Panhandle

Jesse A. M. Ballenger

Despite archaeologists' preoccupation with late Prehistoric villages in the Oklahoma panhandle, avocationists in the area have amassed significant collections of Paleoindian materials. Among these assemblages is the "Uncle Billy" Baker collection from the Nall site (Baker et al. 1957). Though littered with late Paleoindian tools such as the Plainview and Frederick-Allen types (Ballenger 1999a), early Paleoindian evidence from the site is relatively sparse. Two Clovis points, a Folsom preform, and a few Midland examples are identified in the collection (LaBelle 1997). Charles Rhoton (1954), Vincent Dale (1967), and Bill White (White 1987) accumulated other collections from the Oklahoma panhandle. The Rhoton collection, reportedly containing some Clovis points, has changed hands and is not documented. The Dale and White collections are curated at the Oklahoma Museum of Natural History.

In the White collection, 16 points exhibit early Paleoindian affinity. Five early Paleoindian forms exist in the Dale collection. Dale's acquisitions include four replica Folsom points presented to him as genuine by Marvin McCormick, an expert flintknapper who resided in Prichett, Colorado. According to Dale (1939a), McCormick passed 11 Folsom replicas in Texas County during the summer of 1939.

The Muncy site (White 1987) has produced nine early Paleoindian forms including three Clovis, a Folsom, and five Midland points. All the Clovis examples (Figure 1A, B) are made from Alibates flint. The Alibates flint Folsom (Figure 1C) barely falls within the metric ranges identified by Largent et al. (1991). The Midland points from the Muncy site (Figure 1D, E) are made from Alibates flint (three) and chalcedony (two).

Three early Paleoindian points were found by White along Goff Creek (Ballenger 1999b). These include a fluted point made from Edwards chert (Figure 1F), a Folsom (Figure 1G), and a Midland point (Figure 1H). Other specimens in the White collection include three Clovis and a Midland point. The largest Clovis point (Figure 1I) was collected from the Beaver River near Goodwell, Oklahoma, and is made from Morrison quartzite. Still other specimens were collected from New Mexico. The two Clovis points from New Mexico are manufactured from Alibates flint and Ogallala quartzite. The Midland point from New Mexico is made from Edwards chert. A single McCormick replica, a Folsom point made from Alibates flint (Figure 1K), is identified in the White collection. Well fluted on both faces, this biface is 6.9 mm thick.

Of the two Alibates flint Midland points in the Dale collection (Figure 1J), one was found at Eva playa in Texas County (Brosowske and Bement 1998).

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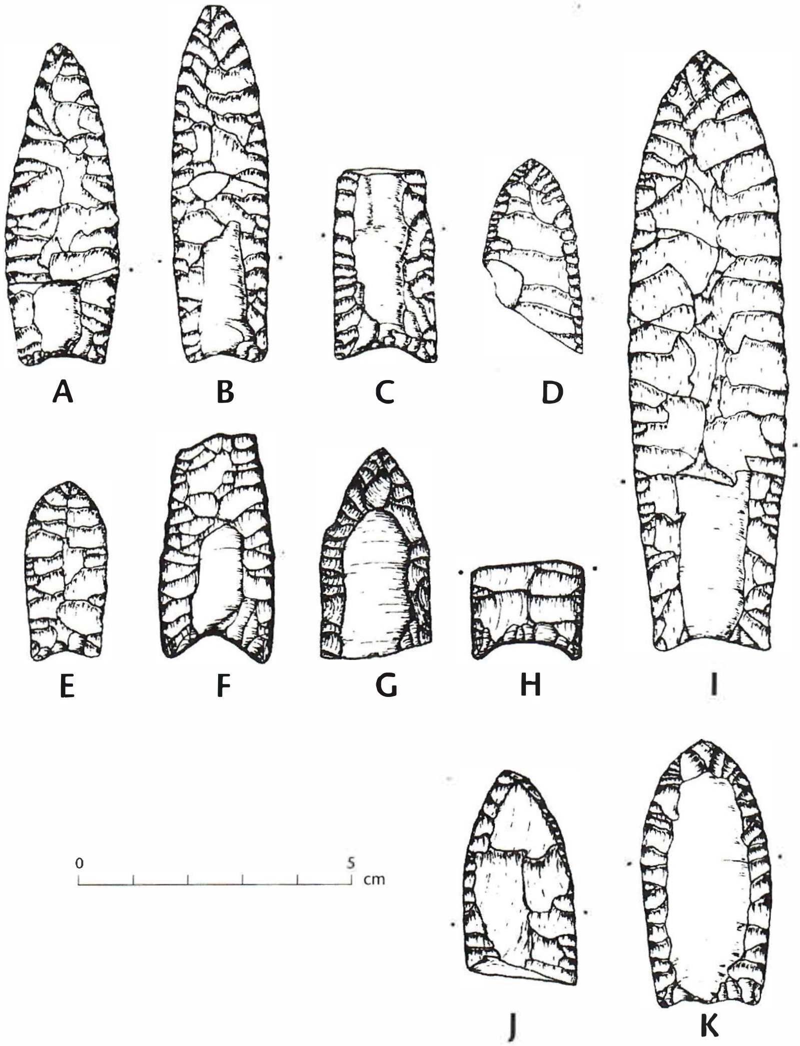

Figure 1. Early Paleoindian points. **A–E,** Muncy site; **F–H,** Goff Creek; **I,** Beaver River; **J,** Eva Playa; **K,** McCormick replica.

Dale also recovered one Clovis point made from Tesesquite quartzite and two Folsom points made from Alibates flint, but his notes do not reveal where these items were found within the Oklahoma Panhandle. Other Panhandle finds include a scavenged and reworked Folsom point in the Ross Goodner collection from Beaver County (Scott Brosowske, pers. comm. 1998) and a Folsom point in the Harold Kachel collection, reportedly from Beaver County in Ballenger (1999b), that was actually found near the town of Adams in Texas County.

Don Wyckoff (Oklahoma Museum of Natural History) provided access to the White and Dale collections and offered comments that improved the presentation of this research.

References Cited

Baker, W. E., T. N. Campbell, and G. L. Evans 1957 The Nall Site: Evidence of Early Man in the Oklahoma Panhandle. *Bulletin of the Oklahoma Anthropological Society,* 5:1–20.

Ballenger, J. A. M. 1999a Late Paleoindian Land Use in the Oklahoma Panhandle: Goff Creek and Nall Playa. *Plains Anthropologist,* in press.

——— 1999b *Goff Creek: Collection Strategy and Occupation Prehistory on the Southern High Plains, Texas County, Oklahoma.* Oklahoma Museum of Natural History and Oklahoma Anthropological Society, Memoir 8.

Brosowske, S. D., and L. C. Bement 1998 *Pedestrian Survey of Playa Lake Environments in Beaver and Texas Counties, Oklahoma, Project 40-97-12040.021.* Oklahoma Archeological Survey, Archeological Resource Survey Report 39, Norman.

Dale, V. 1939 Four Folsom Points. Manuscript on file, Oklahoma Museum of Natural History, Norman.

——— 1967 The Garcia Plainview. *Oklahoma Anthropological Society Newsletter,* 15(3):4.

LaBelle, J. M. 1997 "Uncle Bill" and Panhandle Paleoindians. Paper presented at the 55th Plains Anthropological Conference, Boulder. Temporarily available at http://www.ele.net/LaBelle/unc_bill.htm.

Largent, F. B., Jr., M. R. Waters, and D. L. Carlson 1991 The Spatiotemporal Distribution and Characteristics of Folsom Projectile Points in Texas. *Plains Anthropologist,* 36(137):323–342.

Rhoton, C., Jr. 1954 Outlines of Projectile Points Found in Western Oklahoma. *Oklahoma Anthropological Society Newsletter,* 2(8):4.

White, R. W. 1987 The Muncy Site in the Oklahoma Panhandle: Indian Cultural Evidence Over a Long Time Span. *Bulletin of the Oklahoma Anthropological Society,* 36:39–103.

Investigation of a Paleoindian Bison Processing Locality Near the Cooper Site, NW Oklahoma

Leland Bement, Brian Carter, and Scott Brosowske

The Cooper site in northwest Oklahoma was the scene of three large-scale, arroyo-style Folsom bison kills. Unlike other Folsom bison kill sites, no processing areas were found in the immediate vicinity, suggesting that perhaps a major encampment was some distance away and that meat packages were transported there for further processing and consumption. Alternatively, erosion may have removed processing areas not on the arroyo floor. Based on the work at the Cooper site, a model has been proposed (Bement

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1999) integrating large numbers of animals, gourmet butchering techniques, little carcass dismemberment, seasonal redundancy, ritual, and the possible aggregation of more than a single group of hunters.

To better understand the Cooper site and aspects of the Cooper model, a program of survey, coring, and testing along the adjacent bluff line was undertaken. Limited excavation of bison bone eroding from sediments of an ancient buried arroyo nearly half a kilometer from the Cooper site uncovered the remains of a suspected bone marrow processing area containing parts of at least three bison. A chert flake was found with the broken bones. Limited probing indicates the bone accumulation is at least 2.5 m long by 1 m wide and is located on the rim of an arroyo. Bone from this feature cascades into the buried arroyo. Twelve meters from this accumulation, two more flakes and additional bison bone erode from the bottom of the same ancient arroyo. A soil core placed between the bone pile and bluff face encountered bone at a depth of 2.25 m—perhaps another processing area on the arroyo floor or the kill itself. The feature and arroyo are recorded as the Jake Bluff site (34HP60).

Preliminary field assessment identified portions of at least three bison in the bone pile. Tooth eruption and wear from paired mandibles removed from the top of the pile identify a 3.3- to 3.4-year-old and suggest a fall season for the death of this animal—similar to those in all three kills at the Cooper site. Breakage patterns of the bones in the concentration suggest that butchering tasks included marrow extraction.

Geomorphic investigation at the Cooper site indicates arroyos at this position on the landscape above the Beaver River floodplain filled during the late Pleistocene/early Holocene (Carter and Bement 1995), suggesting this new find is Paleoindian in age. Further support is provided by a metatarsal, astragalus, and mandible from this accumulation that clearly fall within the size range of *Bison antiquus* skeletal elements from the Cooper site (Bement 1999).

The bison processing location, in addition to 1) being in a similar landscape setting as the Cooper site, 2) contains *B. antiquus* skeletal remains, and 3) overlaps in seasonality, also has a similar soil horizon sequence (Carter and Bement 1995). The profile contains a surface soil, two buried soils, and two types of parent materials. The surface soil is weakly developed (does not contain a B horizon) and is formed in eolian sand. The source of this eolian sand is the Beaver (North Canadian) River. The surface soil and eolian sand bury a soil formed in gully sediments (alluvium). The first buried soil is also weakly developed (contains a Bw horizon; some soil structure) and overlies a second buried soil containing the bison bones (processing site). The second buried soil lacks an A horizon but is identified by the 2Btk,b2 horizon. The second buried horizon is also formed in gully alluvium. Permian-age sandstones underlie the deposits.

In light of the Cooper model, Jake Bluff is important because it is the closest Paleoindian-age site to the Cooper kills with definite bison processing attributes. If this site proves to be of Folsom age, it will provide a glimpse of bison processing not seen at Cooper and will allow assessment of the Cooper model. If the processing site proves not of Folsom cultural affinity, then this project will advance our understanding of broader Paleoindian subsistence patterns on the eastern margins of the southern Plains where information is as meager for other ancient cultures as it is for Folsom.

A Historic Preservation Grant from the Oklahoma Historical Society and National Parks Service funded this work.

References Cited

Bement, L. C. 1999 *Bison Hunting at Cooper Site: Where Lightning Bolts Drew Thundering Herds.* University of Oklahoma Press, Norman.

Carter, B. J., and L. C. Bement 1995 Soil Investigations at the Cooper Site. *Current Research in the Pleistocene.* 12:119–121.

Stone Tool Use at the Hilltop Site, Arctic Alaska: Notes on a Late-Pleistocene Lanceolate Point Occupation

Michael R. Bever

The Hilltop site (PSM-017) lies in the Atigun Gorge in the Eastern Brooks Range, Alaska. Situated on a knoll on the northern side of the gorge, the elevated setting provides a spectacular view of the surrounding terrain. The assemblage recovered in previous excavations contains projectile points, bifaces and gravers similar to those from the Mesa site, some 250 km to the west (Kunz and Reanier 1995), and has been included in the Mesa Paleoindian Complex (Reanier 1995). These similarities prompted an analysis of the Hilltop collection, as part of a larger study of patterns of stone tool use at the Hilltop and other Mesa Complex sites of late Pleistocene Alaska.

Discovered in 1970 (Cook 1970), Hilltop was surface collected and tested in 1970 and 1973 (von Krogh 1973). A sample of charcoal mixed with soil organics collected in 1973 produced a radiocarbon date of 6,160 ± 130 yr. B.P. (GaK-4924), which has been questioned owing to possible contamination with recent organics (Reanier 1995) and potential laboratory error (Blakeslee 1994). The Bureau of Land Management excavated the site in 1993 and 1994. A charcoal sample recovered in 1993 returned an AMS date of 10,360 ± 60 yr. B.P. (Beta-69897, CAMS-11034) (Reanier 1995). Though not directly associated with any diagnostic artifacts, the sample came from within the greatest concentration of material on the site. Comparable dates

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from similar Alaskan assemblages (Ackerman 1996; Kunz and Reanier 1994, 1995; Reanier 1995) suggest that this is an accurate age for the lanceolate point occupation.

This analysis includes the collection housed by the Bureau of Land Management, Fairbanks. Unfortunately, the whereabouts of about 1,300 pieces from the 1970 and 1973 excavations, mostly flakes, is unknown. Artifacts analyzed (n = 1,356) include: 114 complete and fragmentary bifaces, including 10 projectile points (1 complete and heavily reworked, 4 bases, 2 midsections, and 3 final stage manufacturing breaks); 2 flake cores; 4 flake gravers; 3 side scrapers; 1 end scraper; and 1,231 flakes and non-diagnostic chunks of chert, 19 of which show signs of retouch or utilization. The majority of bifacial forms are similar to those from the Mesa site, the type site of the Mesa Complex (Kunz and Reanier 1995). Besides the diagnostic projectile points, the bifaces include point preforms (n = 26) and two forms of relatively straight-sided pointed bifaces (n = 24). Microblades are absent from the analyzed collection and are not apparent on the surface of the site (Michael Kunz, pers. comm. 1999).

Vertical stratification is not evident; artifacts, including the diagnostic points and bifaces, occur throughout the shallow (20- to 30-cm-thick) deposits, presumably as a result of postdepositional disturbance. Given the possibility of mixing, preliminary research objectives were to determine the number of components at the site and to isolate the one associated with the Mesa points. The assemblage proved to be rather homogenous, reflecting the manufacture of only a few different bifacial types. As such, most of the assemblage may represent a single component. An exception may be a series of large flake removals from a unifacial core on a nodule of high-quality chert not present in the rest of the assemblage. While likely associated with the bulk of the cultural material, analysis of the horizontal distribution of artifacts may help clarify this.

The dominant activity at the site was the production of bifacial forms. Several chert and mudstone sources lie within 2 or 3 km of the site, and over 83 percent of the artifacts likely derive from these sources. The assemblage is dominated by amorphous flakes and biface failures. Much of the local raw material is poor quality and heavily shattered, probably accounting for the high frequency of failures and non-diagnostic flakes. Artifacts on rare, possibly non-local materials include all but one of the points: a flake graver on the same material as two of the points; and a scraper, an associated resharpening flake, and a bipointed biface, all on the same material. Chert sources are poorly known in this region of Alaska, however, and source identification is uncertain. While early stages of bifacial reduction are better represented in the assemblage, abundant small bifacial thinning flakes and preforms broken in the later stages of manufacture suggest that some points and bifaces were reduced to a finished state and transported from the site, presumably to replace those discarded on site.

Though based on preliminary findings and an incomplete collection, the patterns of biface manufacture, expedient tool use and point discard are generally similar to those at the Mesa site (Bever 1998; Kunz and Reanier

1995), though on a much smaller scale. Ongoing analysis of the Hilltop collection will hopefully expand upon these results, and in so doing will contribute to a more complete picture of the Pleistocene prehistory of Alaska.

This research was supported in part by a National Science Foundation doctoral dissertation improvement grant, SBR-9711546. Michael Kunz and the Bureau of Land Management, Fairbanks, provided support and a generous loan of the Hilltop collection and field notes. This paper benefited from comments by David J. Meltzer, Michael L. Kunz, Jason M. LaBelle and Sandra W. Bever.

References Cited

Ackerman, R. E. 1996 Spein Mountain. In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by Frederick H. West, pp. 456–460. University of Chicago Press, Chicago.

Bever, M. R. 1998 The Mesa Site and Paleoindian Technology: Unscrambling the Pleistocene Prehistory of Alaska. Paper Presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle.

Cook, J. P. 1970 *Report of Archaeological Survey and Excavations along the Alyeska Pipeline Service Company Haulroad and Pipeline Alignments*. Report Submitted to Alyeska Pipeline Service Company, Anchorage.

Kunz, M. L., and R. E. Reanier 1994 Paleoindians in Beringia: Evidence from Arctic Alaska. *Science*, 263:660–662.

——— 1995 The Mesa Site: A Paleoindian Hunting Lookout in Arctic Alaska. *Arctic Anthropology*, 32(1):5–30.

Reanier, R. E. 1995 The Antiquity of Paleoindian Materials in Northern Alaska. *Arctic Anthropology*, 32(1):31–50.

von Krogh, H. 1973 Preliminary Report on Three Archaeological Sites in the Central Brooks Range, Alaska. Ms. On file with the Bureau of Land Management, Northern Field Office, Fairbanks.

AMS Dating of the Area 22 American Paleoarctic Tradition Microblade Component at the Lisburne Site, Arctic Alaska

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Current evidence from Alaska firmly establishes a date for the earliest microblades in eastern Beringia of at least 11,770 yr B.P. (Holmes et al. 1996; Holmes 1998). However, data continue to accumulate suggesting that microblade technologies, including wedge-shaped cores, persisted throughout most of the Holocene (e.g., Bowers et al. 1996; Cook 1969; Dixon 1985; Ferguson 1997; Hare and Hammer 1997; Holmes 1996; Mobley 1991). Additional data for mid-late Holocene microblades come from the Lisburne site, located 9 km north of the Paleoindian Mesa site (Kunz and Reanier 1994, 1995) in the Arctic foothills, Brooks Range, Alaska.

The Lisburne site was excavated in 1978–79 (Bowers 1982). Lithic artifacts

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(n = 47,298) were recovered from pergelic cryothent soils generally less than 30 cm deep. We sampled a total area of 7,401 m^2 and excavated 540 m^2 within the 27 spatially discrete areas of Locality A. Diagnostic artifacts represent most of the major recognized traditions of Northern Alaskan prehistory: Paleoindian, American Paleoarctic (APAT), Northern Archaic, Arctic Small Tool, and Late Prehistoric Eskimo. The two Paleoindian loci were horizontally separated from one another and from core and blade APAT Areas 1, 12, 13, 15, 22, and B. The Paleoindian occupation of the site is represented by a fluted point (Area 3; Bowers 1982:98, Figure 9) and two fragmentary Mesa points (Area 9; Bowers 1982:99, Figure 10, s and t; cf. Kunz and Reanier 1995:15). Loy and Dixon (1998:38–41) included these points in their recent blood residue analyses and claim to have identified sheep and bear (1998:38; Table 2) or bear (1998:39; Figure 6) residue on the fluted point (UA-78-80-633), and mammoth (1998:38; Table 2) or mammoth and sheep (1998:39; Figure 6) residue on one of the two Mesa points (UA-78-80-1105) from Lisburne.

Lisburne Area 22, enclosing an area of 31.2 m^2, is one of the best areas of the site in terms of artifact clustering, containing 27 tools and 342 unmodified lithic flakes (blue-gray chert = 48 percent; black chert = 27 percent). Stylistically, the artifacts are nearly identical to those described for the late-Pleistocene/early-Holocene APAT (Anderson 1988; cf. Denali Complex, West 1967). They include 2 wedge-shaped microblade cores (1 tan chert, 1 blue-gray chert), 13 blades and microblades, 5 burins, 2 burin spalls, 1 biface, 2 core bifaces, and 2 retouched flakes (Bowers 1982:89, Table 2 (with corrections); 106, Figure 12).

Of particular interest during the 1979 excavations was the discovery of one of only two features found at the site, a concentration of 29 fire-reddened and -cracked cobbles in association with the above artifacts. Owing to a lack of discernible hearth-like pattern, the Area 22 cobbles were interpreted as a stone boiling feature (Bowers 1981:433, 1982:107). At the time of excavation no charcoal was visible, and it was assumed that none was preserved at the site.

Fortunately, a sample of dark soil from the feature was collected and later archived in the University of Alaska Museum. Although not dateable in the late 1970s by conventional radiocarbon dating techniques, recent restudy of the archived sample from Area 22 revealed microscopic charcoal fragments. Wood charcoal was isolated and submitted for AMS analysis, resulting in a date of 3,470 ± 50 yr B.P. (Beta-124965).

The AMS date from Lisburne Area 22 has several important implications: (1) It offers additional evidence for mid-late-Holocene persistence of a widespread Beringian lithic technology characterized primarily by wedge-shaped cores, microblades, and distinctive burins. Although the concept of a "post-American Paleoarctic Tradition" has been speculated about previously (Anderson 1972; Gal 1982; Gerlach and Hall 1987; Schoenberg 1995), this find represents the first ^{14}C dated late-Holocene wedge-shaped cores in Arctic Alaska. It remains to be determined how these materials relate to the earlier, well-described APAT (cf. Anderson 1988). (2) The Lisburne date adds yet another caution to the *de facto* assumption of a late-Pleistocene/early-Holocene age for such artifacts. Interpreting microblades and wedge-shaped cores as strictly "early" index fossils remains problematic in the absence of detailed analyses of core and blade collections (cf. Mauger 1971; Mobley 1991) and discovery of more sites with good geochronological contexts. (3) The comparatively recent age for the Lisburne wedge-shaped core component also has a bearing on the nearby Mesa site, which has been the subject of some debate regarding the possible association of undated microblades with what is otherwise a "classic" Paleoindian assemblage (Bever 1998). Although by no means conclusive proof, the fourth millennium B.P. age of Lisburne Area 22 offers some support to the proposition that microblades may have been intrusive within Paleoindian component of Mesa ca. 10,000 yr B.P.

Thanks to C. Gerlach and A. Higgs for reviewing an earlier draft of this manuscript, to R. Ackerman, J. Cook, R. Gal, G. Hare, C. Holmes, M. Kunz and R. Reanier for helpful discussions, and the Bureau of Land Management for support of the Lisburne site research. AMS analysis was provided courtesy of Northern Land Use Research, Inc.

References Cited

Anderson, D. D. 1972 An Archaeological Survey of the Noatak Drainage, Alaska. *Arctic Anthropology,* 9(1):66–117.

——— 1988 Onion Portage: The Archaeology of a Stratified Site from the Kobuk River, Northwest Alaska. *Anthropological Papers of the University of Alaska,* 22(1-2).

Bever, M. R. 1998 The Mesa Site and Paleoindian Technology: Unscrambling the Pleistocene Prehistory of Alaska. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle.

Bowers, P. M. 1981 Current Research, Far North. *American Antiquity,* 46(2):433.

——— 1982 The Lisburne Site: Analysis and Cultural History of a Multi-Component Lithic Workshop in the Iteriak Valley, Arctic Foothills, Northern Alaska. *Anthropological Papers of the University of Alaska,* 20(1-2):79–112.

Bowers, P. M., C. M. Williams, R. C. Betts, O. K. Mason, R. T. Gould, and M. L. Moss 1996 The North Point Site: Archaeological Investigations of a Prehistoric Wet Site at Port Houghton, Alaska. Report by Northern Land Use Research, Inc. prepared for the U.S. Forest Service, Sitka, Alaska.

Cook, J. P. 1969 The Early Prehistory of Healy Lake Alaska. Ph.D. dissertation, University of Wisconsin, Madison.

Dixon, E. J. 1985 Cultural Chronology of Central Interior Alaska. *Arctic Anthropology,* 22(1):47–66.

Ferguson, D. E. 1997 Revised Temporal Assessment of a Proposed PaleoArctic Site in the Sagavanirtok Valley, Northern Alaska. *Current Research in the Pleistocene,* 14:24–26.

Gal, R. 1982 Excavation of the Tunalik Site, Northwestern National Petroleum Reserve in Alaska. *Anthropological Papers of the University of Alaska,* 20(1-2):61–78.

Gerlach, S. C., and E. S. Hall, Jr. 1986 The View From the Hinterland: A Reconsideration of the American PaleoArctic and Post-PaleoArctic Tradition Concepts Based on Data from the Red Dog Sites. Paper presented at the 14th Annual Meeting of the Alaska Anthropological Association, Fairbanks.

Hare, P. G., and T. J. Hammer 1997 New Data For a Late Persistence of Microblades in the Yukon. Paper presented at the 24th Annual Meeting of the Alaska Anthropological Association, Whitehorse.

Holmes, C. E. 1996 Broken Mammoth. In *American Beginnings: The Prehistory and Paleoecology of Beringia,* edited by F. H. West, pp. 312–317. University of Chicago Press.

——— 1998 New Data Pertaining to Swan Point, the Oldest Microblade Site Known in Alaska. *Current Research in the Pleistocene* 15:21–22.

Holmes, C. E., R. VanderHoek, and T. E. Dilley 1996 Swan Point. In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by F. H. West, pp. 319–323. University of Chicago Press, Chicago.

Kunz, M. L., and R. E. Reanier 1994 Paleoindians in Beringia: Evidence from Arctic Alaska. *Science*, 263:660–662.

——— 1995 The Mesa Site: A Paleoindian Hunting Lookout in Arctic Alaska. *Arctic Anthropology*, 32(1):5–30.

Loy, T. H., and E. J. Dixon 1998 Blood Residues on Fluted Points from Eastern Beringia. *American Antiquity*, 63(1):21–46.

Mauger, J. E. 1971 The Manufacture of Campus Site Microcores. Unpublished manuscript in possession of the author.

Mobley, C. M. 1991 *The Campus Site: A Prehistoric Camp at Fairbanks, Alaska*. University of Alaska Press, Fairbanks.

Schoenberg, K. E. 1995 The Post-PaleoArctic Interval in the Central Brooks Range. *Arctic Anthropology*, 32(1):51–61.

West, F. H. 1967 The Donnelly Ridge Site and the Definition of and Early Core and Blade Complex in Central Alaska. *American Antiquity*, 32(2):360–382.

A Note on OCR Dates from the Carson-Conn-Short Site (40Bn190), Benton County, Tennessee

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Since the discovery of the Carson-Conn-Short site in 1991, the Tennessee Division of Archaeology has conducted test excavations and surface mapping in the hopes of defining spatial concentrations of Clovis artifacts and features and to obtain charcoal samples for dating (Broster and Norton 1993, 1996). The first part of this goal has been met with great success; we have piece plotted over 500 formal tools and fluted preforms and excavated 24 m^2 of deposit to an average depth of 40 cm. However, collecting suitable carbon samples has so far eluded our efforts.

To address this lack of conventional ^{14}C dates, a column of OCR (Oxidizable Carbon Ratio) samples was excavated from the south wall of square 998N/991E. For a discussion of OCR dating the reader is referred to the published work of Douglas Frink (1992, 1994, and 1995). The first 35 cm of fill appears to be a mixed level of redeposited alluvium containing Clovis, late Paleoindian, and Archaic artifacts. An intact Clovis level recorded some 40–45 cm below present ground surface was dated by OCR to 11,747 yr B.P. (ACT-3188). The level below this also contained fluted preforms and uniface blade tools. It produced an OCR date of 12,469 yr B.P. (ACT-3189). Unfortu-

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nately, excavations could not be continued below this level due to the rising waters of Kentucky Lake brought on by unseasonable heavy rains.

An additional column of samples was taken from 20 m to the north of square of 998N/991E. A Clovis level 50 cm below the surface was OCR dated to 12,796 yr B.P. (ACT-3142). This date is consistent with the one from the same depth in the test square to the south. An additional lower level at 60 cm was dated to 15,344 yr B.P. (ACT-3143). This level contained prismatic blades, blade tools, and numerous resharpening flakes struck from bifaces.

Given these initial dates, the fluted point (Clovis) occupation of this site would appear to date between 11,000 and 12,500 yr B.P. This certainly places the Clovis utilization of the area within or slightly older than the known dates for Clovis in the New World. It is possible that the date older than 15,000 yr B.P. represented a pre-Clovis or proto-Clovis presence in the Western Valley of Tennessee. Further research is planned for the next field season. In order to test the OCR dates, bulk soil samples will be collected for conventional carbon dating. It will be of great interest to see how these samples compare with what we know from the OCR method.

References Cited

Broster, J. B., and M. R. Norton 1993 The Carson-Conn-Short Site (40Bn190): An Extensive Clovis Habitation in Benton County, Tennessee. *Current Research in the Pleistocene,* 10:3–5.

——— 1996 Recent Paleoindian Research in Tennessee. In *The Paleoindian and Early Archaic Southeast,* edited by D. G. Anderson and K. E. Sassaman, pp. 288–297. University of Alabama Press. Tuscaloosa.

Frink, D. S. 1992 The Chemical Variability of Carbonized Organic Matter through Time. *Archaeology of Eastern North America,* 20:67–79.

——— 1992 The Oxidizable Carbon Ratio (OCR): A Proposed Solution to Some of the Problems Encountered with Radiocarbon Data. *North American Archaeologist,* 15(1):17–29.

——— 1995 Application of the Oxidizable Carbon Ratio Dating Procedure and Its Implications for Pedogenic Research. In *Pedological Perspectives in Archaeological Research.* Soil Science Society of America Special Publication 44.

Evidence of Mountain Paleoindian Use of the Colorado Piedmont and Plains Territories

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In recent years, two broadly similar models of late-Paleoindian/early-Archaic lowland (plains)-highland (mountain) adaptive life-styles have been proposed. Black (1991:20) suggests that a distinctive Mountain Tradition involving year-round human adaptive strategies and systematic utilization of south-

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ern Rocky Mountain territories was in place "by . . . 8,000 yr B.P. and . . . as early as 10,000–9,500 yr B.P." George Frison (1997) posits a similar development (the *Foothill-Mountains Tradition*) for the northern plains and central Rockies. Both authors see dichotomous Paleoindian cultural traditions coexisting in western U.S. adjacent highland-lowland ecosystems. A recent study of paleoenvironmental and archaeological data from northern Colorado mountains and plains concluded that climatic and environmental change had opened high-elevation territories previously covered by snow and glaciers to migrating herbivores and Paleoindian hunters by 9,000 yr B.P. (Brunswig in press). Resulting interactions of multi-regional Paleoindian groups involved in a complex web of migratory subsistence systems produced the current picture of site components containing so-called Mountain Paleoindian and Plains Paleoindian projectile point types. A less complex view is suggested by Frison (1997:100), who divides "Late" Paleoindian cultural complexes into Pryor Stemmed (characteristic of mountain-foothill areas) and Plains Paleoindian complexes such as Frederick, which "represent the last gasp of the two different subsistence strategies in operation at the same time."

Recent finds in the eastern plains of Colorado suggest that dichotomy is less than clear-cut, particularly if seasonal highland-lowland transhumance patterns are considered. Those finds document Mountain Paleoindian projectile point types beyond mountain and foothill territories they are normally

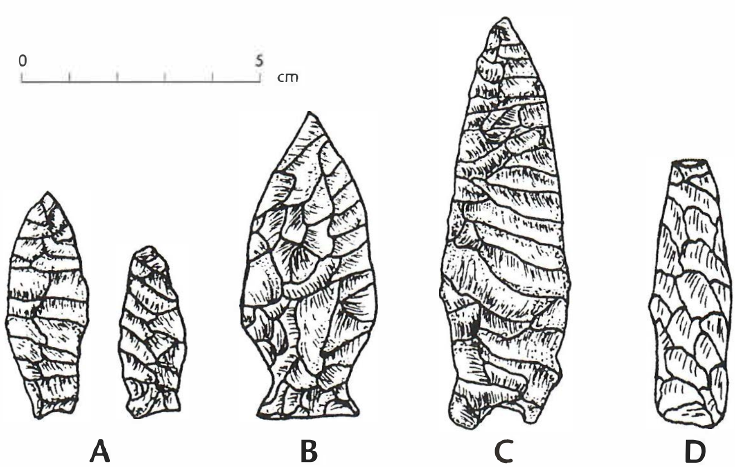

Figure 1. Mountain Paleoindian-style points from Colorado Plains sites.

associated with. Mountain Paleoindian associated finds are now being documented from Colorado plains sites (see Figure 1).

In 1992, this author recorded Pryor Stem points from the Nichols site (5WL2087), located in an Altithermal sand dune camp site east of the South Platte River (Figure 1A). A large parallel-oblique-flaked Pryor Stem variant point from the Fox site (5WL1477) (Figure 1B) and a Lovell Constricted point from the Gieseck site (Figure 1C) have also been documented near the South Platte River, at Kersey, Colorado (Pitblado and Brunswig, in prep.). The Fox point corresponds well to Pryor Stem point descriptions from central Rocky Mountain sites (cf. Frison 1991, Figures 2.35 and 2.36) and was collected from an extensive sand dune field near the South Platte River.

The Gieseck point is a large leaf-shaped, expanded stem point with elements of parallel-oblique flaking closely resembling Foothill-Mountain, or Lovell Constricted points from northern Wyoming's Paint Rock Cave V, dated to ca. 8,140–8,500 yr B.P. (Frison 1992, Table 2.3, Figure 2.38E–F). The point was recovered from an early-Holocene terrace of the South Platte River. Finally, University of Northern Colorado surveys in 1997 in the Pawnee National Grassland in northeastern Colorado recovered another stemmed point from a creek terrace multicomponent campsite (5WL2540) (Figure 1D).

Growing evidence of Mountain Paleoindian point finds in Colorado mountain, foothills, and plains-piedmont sites suggests somewhat more than suspected complexity of late Paleoindian cultural interactions and subsistence adaptations. Our future understanding of those interactions and adaptations can only be clarified with further research on the nature of late Paleoindian cultural adaptations and environmental change in the terminal Pleistocene and early Holocene.

References Cited

Black, K. D. 1991 Archaic Continuity in the Colorado Rockies: The Mountain Tradition. *Plains Anthropologist* 36(133):1–29.

Butler, W. B. 1985 Taxonomy in Northeastern Colorado Prehistory. Ph.D. Dissertation, Department of Anthropology, University of Missouri-Columbia.

Brunswig, R. H., Jr. in press Late Pleistocene/Early Holocene Landscapes and Paleoindian Economic Systems in Colorado's Southern Rocky Mountains. In *Proceedings of the 31st Chacmool Conference: On Being First: Cultural Innovation and Environmental Consequences of First Peoplings.* Calgary, Canada: Department of Archaeology, University of Calgary.

Frison, G. C. 1991 *Prehistoric Hunters of the High Plains.* 2nd Ed. Orlando, FL, Academic Press.

——— 1997 The Foothill-Mountain Late Paleoindian and Early Plains Archaic Chronology and Subsistence. In *Changing Perspectives of the Archaic on the Northwest Plains and Rocky Mountains,* edited by M. L. Larson and J. E. Francis. pp. 84–105. Vermillion, SD: University of South Dakota Press.

Pitblado, B. L., and R. H. Brunswig, Jr. in prep The Late Paleoindian Period in Colorado: An Overview of the Literature. In *Emerging Frontiers in Colorado Paleoindian Archaeology,* R. H. Brunswig, Jr. and E. James Dixon, Eds. Niwot, Colorado, University Press of Colorado.

Geoarchaeological Investigations of the Crescent H Ranch Site (48TE1079), Teton County, Wyoming

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A Midwest Archeological Center field crew conducted geoarchaeological investigations in cooperation with Western GeoArch Research and the U.S. Geological Survey at three sites in the summer and fall of 1998 as part of data recovery for the reconstruction of the Fall Creek Road south of the community of Wilson in northwestern Wyoming (Cannon 1998). Each of the sites lies within areas mapped as alluvial deposits at the base of the Snake River Range. The Crescent H Ranch site (48TE1079) produced the greatest amount of geoarchaeological information.

Excavations revealed cultural deposits locally to a depth exceeding 2.5 m. Preliminary interpretation indicates a cultural record that extends back to the terminal Pleistocene. We date a possible paleosol minimally at 4050 ± 70 yr B.P. (Beta-126072; wood charcoal; $\delta^{13}C = -19.2‰$). The interpretation of the length of occupation is based on stratigraphic position and the presence of a burin spall from basal deposits. Frison (1991:131–132) notes that deliberate burination occurs occasionally in northwestern Plains Paleoindian assemblages.

"Obsidian Hill Creek" (OHC), a first-order east-flowing intermittent stream, heads in the Snake River Range at an elevation of ca. 2591 m altitude and debouches onto the postglacial floodplain of Fish Creek. Prior to the last deglaciation, Snake River outwash aggraded to near the level of the present Fish Creek floodplain. OHC drains an area composed of pre-Tertiary sedimentary rocks veneered with pre-Wisconsin glacial drift and a Tertiary rhyolite flow. Part of the Tertiary rhyolite forms "Obsidian Hill," named for its abundance of obsidian clasts.

Presently, the distributary channel near the southeast margin of the fan provides a topographic boundary for two portions of the site. The northwestern portion of the site consists of redeposited loess overlying red gravel units that were probably emplaced as stream deposits under Pleistocene flow regimes. Obsidian cobbles are interspersed with clasts derived from the sedimentary bedrock. The archaeological materials within this portion of the site lie within an overlying sheet of silt that includes a high proportion of redeposited loess, some sand and pebbles, and an occasional debris flow. The sheetwash sediments aggraded over a partly dissected Pleistocene alluvial fan that had formerly prograded onto the floodplain of Fish Creek. Fish Creek has trimmed back this alluvial fan revealing the postglacial sheetwash sediments overlying

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the Pleistocene gravel in a cutbank. This suggests that the trimming occurred as a late-Holocene event after the sheetwash sediments were deposited.

The presence of good tool-quality obsidian cobbles in the fan gravel, or at the nearby bedrock source, appears to have been a major focus for groups occupying the site. The northwestern portion of the site is dominated by debris produced in the manufacture of bifaces. These include primary decortication flakes and broken bifaces at various reduction stages. No evidence of domestic activities was found in this portion of the site.

In contrast, the southeastern portion of the site produced a similar assemblage of biface reduction debris, and also a number of buried fired-rock concentrations that are tentatively interpreted as cooking features. One feature (F98-2), dated at 3,630 ± 80 yr B.P. (Beta-130273; wood charcoal; $\delta^{13}C$ =-26.6‰), consists of fired rock in association with humic silty deposits. Several classes of artifacts, including expedient tools and ground stone, are associated with this feature, which appears to be the center of a processing area.

Sediments on this portion of the site consist of well-sorted fine sandy silt, which we inferred to have been emplaced as redeposited loess and which buries the (apparently) in situ cultural material. This sediment contrasts with the more poorly sorted, slightly pebbly sheetwash-derived sandy silt capping the OHC fan to the northwest in that it is texturally similar to primary loess. The origin of this deposit is problematic. One possibility is that it is slope-reworked sediment derived wholly from the Wisconsin-aged loess deposits that mantle the slope that forms the southeast valley wall of OHC and tributary drainages to the south. This primary loess probably underlies the cultural materials; it extends to a depth of 4.5 m, although its contact with overlying Holocene reworked loess was not identifiable. Alternatively, the deposits might be a locally over-thickened unit of primary Holocene loess not present at nearby sites on Pleistocene gravels.

Additional analyses of the cultural deposits will occur over the next several months, and the National Park Service will publish a final report in 2000. This site is of considerable significance due to its large concentration, in buried context, of worked obsidian procured from nearby sources. These investigations also fill a gap in the archaeological record of the region that has been almost exclusively concentrated in the northern part of Jackson Hole in Grand Teton National Park (e.g., Connor 1998).

This project was funded by the Federal Highway Administration. We would like to extend our thanks to Anne Brunick (FHWA), Rick Cushing (FHWA), Scott Pierson (Pierson Land Surveys), and Pete Jorgenson (Jorgenson Engineering) for their assistance. Thanks also to Ralph Hartley (MWAC) for his support and good-natured view of the world. We would also like to thank John Andresen (MWAC) and Dan Muhs (USGS) for their editorial comments.

References Cited

Cannon, K. P. 1998 *Data Recovery Plan for Fall Creek Road Archeological Sites, Teton County, Wyoming.* National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Connor, M. A. 1998 *Final Report on the Jackson Lake Archeological Project, Grand Teton National Park, Wyoming.* Midwest Archeological Center Technical Report No. 46. Lincoln, Nebraska.

Frison, G. C. 1991 *Prehistoric Hunters of the High Plains.* Second Edition. Academic Press, New York.

Stratigraphic, Chronometric, and Lithic Technological Evidence for Pre-Clovis at Wilson-Leonard, Texas

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Wilson-Leonard (41WM235) is a deeply stratified prehistoric site in alluvium and colluvium along the south side of Brushy Creek in Williamson County, Texas (Collins 1998; Collins et al. 1993). Excavations penetrated 6.25 m of Quaternary fill resting on Cretaceous bedrock. Three major stratigraphic units with their archaeological content are recognized, from bedrock upward, as follows: Unit I is primarily fluvial with one late-Paleoindian and three early-Paleoindian components, Unit II is fluvial and colluvial with one mixed late-Paleoindian component, and Unit III is colluvial and anthropogenic with early-, middle-, and late-Archaic as well as late Prehistoric components. The chronology of these units in radiocarbon years before the present, established by 96 radiocarbon determinations, is as follows: Unit I, 12,000+ to 9,500; Unit II, 9,500 to 8,800; and Unit III, 8,700 to 1,000. This note discusses the physical characteristics, radiocarbon ages, and archaeological content of the lowest two subunits of stratigraphic unit I, roughly the lower 2.75 m of the section.

Resting on bedrock is a fluvial gravel deposit, generally about 2 m thick, designated Igl. No radiocarbon dating was possible for Igl, but the base of the overlying unit is dated to ca. 11,500 yr B.P. The archaeological content of Igl is a large biface, 3 other bifacial pieces, 3 edge-modified flakes, a uniface, and 52 flakes. Stratigraphically, chronologically, and technologically these artifacts meet the criteria for a pre-Clovis assemblage.

Overlying the gravel is a clayey pond deposit with krotovina, Icl; 29 radiocarbon determinations on sediment date Icl to the interval ca. 11,500–10,600 yr B.P. Near the base of Icl were recovered a projectile point tip, 7 bifaces, 31 other chipped stone tools, a hammerstone, and 658 flakes, all with strong technological similarities to Clovis, including the projectile point fragment which closely resembles tips of Clovis points. Dates constrain this assemblage, inferred to be of Clovis affiliation, to the interval ca. 11,500–11,400 yr B.P.

Immediately higher in Icl is another assemblage with a projectile point, 26 bifaces, numerous other chipped stone tools, an engraved stone, a *mano,* pieces of exotic sandstone and hematite, and more than 3,000 pieces of debitage associated with skeletal remains of bison and a single horse bone. Radiocarbon dating places this assemblage in the interval ca. 11,400–11,000 yr B.P. Ultrathin bifaces and other characteristics of this assemblage compare closely with Folsom assemblages; the projectile point is thin, unfluted, and flaked in a manner more reminiscent of Plainview than of Midland or Folsom

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flaking patterns. This is designated the Bone Bed component. Although it exhibits strong technological affinities to Folsom and is associated with bison, a Folsom designation is not imposed.

A third component consisting of more than 4,500 flakes and 104 non-diagnostic tools was documented at the top of Icl and is dated to ca. 11,000–10,600 yr B.P. No specific cultural affinity is inferred for this assemblage.

The archaeological content of the gravel, Unit Igl, underlies the stratified sequence of Clovis and Folsom-like Bone Bed components. Dating places the top of unit Igl at greater than 11,500 yr B.P. Krotovina and other signs of turbation in the silty and muddy deposits where the Clovis and Bone Bed components occur end abruptly at the top of the compact gravel deposits of Unit Igl, absolutely precluding any downward movement of these artifacts from above. Chert is virtually absent from the natural gravels of Brushy Creek from the location of Wilson-Leonard upstream. Chert outcrops on the northern valley margin at about the location of the site and is present in the gravels downstream.

Of this assemblage, only the large biface has been examined closely at this time. It is of Edwards chert, retains cortex at one end, and is 118 mm long, 59 mm wide, and 16 mm thick. Flaking is collateral and ends at low ridges near the center of the piece on both faces. This is unlike the flaking on Clovis bifaces, where flake scars carry well past the midline and are often overshot.

The absolute age of this earliest component at Wilson-Leonard is unknown, but an estimate would be ca. 12,000 yr B.P. It is definitely pre-Clovis in its stratigraphic position, and technologically it seems not to be Clovis.

I thank the Texas Department of Transportation for its support of the investigations at Wilson-Leonard.

References Cited

Collins, M. B. (editor) 1998 *Wilson-Leonard, An 11,000-year Archeological Record of Hunter-Gatherers in Central Texas.* Studies in Archeology 31, Texas Archeological Research Laboratory, The University of Texas at Austin and Archeological Studies Program, Report 10, Environmental Affairs Division, Texas Department of Transportation. Austin.

Collins, M. B., C. B. Bousman, P. Goldberg, P. R. Takac, J. C. Guy, J. L. Lanata, T. W. Stafford, and V. T. Holliday 1993 The Paleoindian Sequence at the Wilson-Leonard Site, Texas. *Current Research in the Pleistocene,* 10:10–12.

Marine Fauna and Subsistence Data from a 9,200-Year-Old Shell Midden at CA-SRI-1, Santa Rosa Island, California

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The California coast contains a remarkable record of early maritime adaptations (Erlandson 1994). Data from Daisy Cave on San Miguel Island show that Paleoindians settled the Channel Islands by boat by at least Folsom times, about 10,400 yr B.P. (ca. 12,300 cal. B.P.). Seven other island sites have been ^{14}C dated between 10,000 and 8,000 yr B.P. Other than ^{14}C dates and anecdotal descriptions, however, few quantitative data have been published for these. We are now engaged in research designed to fill this gap, collecting samples from several of the earliest Channel Island sites (Erlandson et al. 1996, 1998). Here, we report on our analysis of a small shell midden sample from a 9,200-year-old component at CA-SRI-1, exposed in sea-cliff profiles near Garanon Canyon on Santa Rosa Island (Erlandson and Morris 1992). Our analysis allows us to reconstruct aspects of the local environment, marine resource harvesting patterns, site function, and the diet of the site occupants.

Orr (1968:86) monitored eroding site exposures at CA-SRI-1 for over 20 years, noting human bones, marine shells, and mammoth bones stratified within 6 inches of each other. Erlandson and Morris (1992) visited the site in 1989 and 1991 to study the stratigraphy and collect ^{14}C samples, tracing a thin lens of mussel shells for 15 m along the sea-cliff just 10–15 cm above mammoth bones. Although no artifacts were observed in the shell lens, they concluded it was a cultural deposit, an interpretation supported by recent recovery of a piece of Monterey chert debitage. A mussel shell from this lens was ^{14}C dated to 8,730 ± 110 yr B.P. (Beta-34922), with a calibrated midpoint of ca. 9,200 cal. B.P.

In 1997, we returned to CA-SRI-1 and found considerable erosion damage from recent El Niño events. We found higher marine shell density, but no more mammoth bones. In response to coastal erosion, we collected a 5-liter sediment sample from the densest midden exposure. Analysis of this small sample, wet-screened over 1/16-inch mesh, provides quantitative data on the most common site constituents, data crucial to reconstructing the coastal paleogeography of the vicinity and early maritime subsistence patterns.

The sample produced almost 1 kg of faunal remains, over 99 percent of which was marine shell (Table 1). Although at least 12 shellfish taxa are represented, the assemblage is dominated by California mussel (ca. 90 percent) and black abalone (ca. 5 percent) shell. All other shellfish taxa were probably minor dietary constituents (i.e., black turban, chiton) or incidental "riders" (small limpets, barnacles, gastropods, etc.) brought in attached to mussels and abalones consumed by the site occupants.

Animal bone is relatively rare in the sample, with just 82 small bone

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Table 1: Faunal remains from a 9200-year-old stratum at CA-SRI-1

Taxon	NISP	MNI	Weight	Weight (%)
Shellfish				
Balanus sp. (acorn barnacle)	-	1	12.56	1.4
Pholadidae sp. (boring clam)	-	1	0.07	-
Amphineura, undiff. (chiton)	-	1	0.06	-
gastropod, undiff. (marine snail)	-	6	0.10	-
Haliotis cracherodii (black abalone)	-	4	43.99	5.0
Haliotis rufescens (red abalone)	-	1	0.03	-
Haliotis sp. (abalone, undiff.)	-	1	2.28	0.3
Helminthes ayresiana (land snail)	-	2	0.36	-
Acmaedae (limpet)	-	5	0.55	0.1
Mytilus californianus (California mussel)	-	148	768.14	87.2
Pollicipes polymerus (gooseneck barnacle)	-	1	1.40	0.2
Septifer bifurcatus (platform mussel)	-	14	4.43	0.5
Serpulorbis squamigerus (tube worm)	-	1	0.18	-
Tegula funebralis (black turban)	-	2	0.73	0.1
undiff. nacre (abalone or mussel)	-	-	12.57	1.4
undiff. shell	-	-	33.41	3.8
shellfish total	-	188	880.86	100.0
Vertebrates				
fish	21	1	0.43	50.6
reptile/amphibian	1	1	0.01	1.2
undiff. mammal	60	1	0.41	48.2
vertebrate total	82	3	0.85	100.0

Note: Based on 1/16-inch screen recovery; undiff. shell includes 30.7 g of unidentified 1/16-inch shell that is predominantly mussel; 63 bone fragments, 11 of fish (0.07 g) and 52 of undiff. mammal (0.34 g) from 1/16-inch mesh.

fragments (0.85 g) recovered. This could be partly due to small sample size, since large bones (sea mammal, etc.) are often more widely distributed in coastal middens, but bone is relatively rare in most early California shell middens, reflecting a dietary reliance on shellfish by many early groups. By weight, almost half the bone is from marine fish, whose bones are generally more evenly distributed in coastal middens. Most other bone fragments are probably from rodents or other small fauna, many of which may be noncultural site constituents. Dietary reconstructions via the weight method (see Erlandson 1994) suggest that shellfish provided roughly 95 percent of the edible meat represented, mostly mussels (ca. 76 percent) and black abalones (ca. 18 percent).

About 8,700 yr B.P. (9,200 cal. B.P.), a small group camped briefly on the bluffs at CA-SRI-1. These early maritime people seem to have foraged mostly in rocky intertidal habitats, subsisting primarily on mussels and abalones while at the site. This contrasts with many early mainland sites, where estuarine shellfish were a dietary staple (Erlandson 1994) and adds to our knowledge of adaptive diversity among some of the earliest peoples of the California coast.

Our research at CA-SRI-1 was supported by Channel Islands National Park and a Summer Research Award from the College of Arts and Sciences, University of Oregon. We thank Don Morris, Channel Islands National Park archaeologist, Doug Kennett, and Rene Vellanoweth for help in the field and Jason Thompson for help in the lab.

References Cited

Erlandson, J. M. 1994 *Early HunterGatherers of the California Coast.* Plenum, New York.

Erlandson, J., and D. Morris 1992 CA-SRI-1: A "Pleistocene" Shell Midden on Santa Rosa Island, California. *Current Research in the Pleistocene*, 9:7–10.

Erlandson, J., D. Kennett, B. Ingram, D. Guthrie, D. Morris, M. Tveskov, G. West, and P. Walker 1996 An Archaeological and Paleontological Chronology for Daisy Cave (CA-SMI-261), San Miguel Island, California. *Radiocarbon*, 38(2):355–373.

Erlandson, J., T. Rick, R. Vellanoweth, and D. Kennett 1998 Maritime Subsistence Patterns at CA-SRI-6: A 9300 Year Old Shell Midden from Santa Rosa Island, California. *Journal of Field Archaeology* (in review).

Orr, P. C. 1968 *Prehistory of Santa Rosa Island.* Santa Barbara Museum of Natural History.

Morrow-Hensel: A New Fluted Point Site in Far Western Wisconsin

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Morrow-Hensel is a single-component fluted point locality in Pierce County, Wisconsin discovered by Daniel Morrow. Morrow and Hensel made repeated surface collections of this plowzone site from 1991 through 1994. The field was cultivated 11 times during this interval and was intensively collected after rainstorms. There was a decline in artifact abundance during this period. Even the smallest artifacts were collected; more than 40 percent of the collection is smaller than 0.64 cm mesh.

The site is situated on a knoll among rolling uplands and covers 3,000 m^2. The closest surface water is a seep 50 m away with a perennial stream nearby. Local landforms generally increase in elevation to the west, north and east. Slope on the site is 2 to 4 percent. Cultivation and erosion has deflated the silt-loam topsoil at the apex of the site to less than 10 cm above clay bedrock. Mixed colluvial sediments are up to 60 cm deep along an existing fence line, which defines the downslope boundary of the site. Plow throw and downslope movement have transported some artifacts to this fence line with two distinct clusters of lithic debris observed.

A total of 12,681 lithic artifacts were collected. Debitage accounts for 98 percent of this total. Platforms are absent on 78 percent (n = 9,679) of the flakes, while 11.4 percent (n = 1,412) exhibit biface thinning platforms, 8.7 percent (n = 1,084) core reduction platforms and 1.8 percent (n = 234)

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pressure retouch platforms. The assemblage is 97 percent (n = 12,312) Hixton silicified sandstone from the Silver Mound source about 110 km ESE (Hill 1994). The rest is mostly Prairie du Chien oolitic chert and various toolstones probably collected from local streams and glacial till. Hensel identified more than 200 broken Hixton flakes as expedient "finger knives" resembling "cutters" described by Gramly (1982:40–41; 1988). These artifacts display no secondary retouch but have a potential knife edge opposing a break or snap. This break could have provided an index finger hold for a slicing motion. These artifacts are not classified as tools in this analysis because they exhibit no secondary retouch, and microscopic edge wear analysis is very difficult on this granular orthoquartzite.

There are 101 bifaces from Morrow-Hensel. Hixton accounts for 95 percent (n = 96) of these artifacts. Two are adze/chisels. The rest are production failures and broken projectile points. Bifacial reduction at Morrow-Hensel follows strategies of fluted point production described for both Parkhill and Bull Brook (Gainey) complexes (Grimes 1979; Storck 1983, 1997). There are 25 fluted point fragments, 34 fluted preforms, and 3 preforms prepared for fluting but broken before the first flute removal. Also there are 7 possible point fragments without flute remnants, 13 bifaces broken during thinning, 8 broken during edging, and 12 too fragmentary to classify. Several of these broken fragments were refitted resulting in a minimum number of 93 bifaces.

Unifacial scrapers account for 136 tools: 36 percent (n = 49) are side scrapers, 48 percent (n = 65) end scrapers, and 15 percent (n = 20) miscellaneous scrapers too fragmentary to classify. Hixton toolstone represents 80.1 percent (n = 109) of the scrapers, while 19.1 percent (n = 26) are Prairie du Chien and one may be Burlington chert (sources about 350 km south). Sixteen flakes were modified as gravers. Two basalt hammerstones and four bipolar cores were also recovered.

Some thermal damage is indicated by crenation fractures, pot-lidding, and smoked surface discoloration. Evidence of thermal damage is most pronounced in the tool assemblage. Although 8 percent (n = 20) of the chipped-stone tools are burned, only 3.5 percent (n = 433) of the waste flakes are burned. This pattern may suggest some tools were discarded in or near fire hearths at the site.

The assemblage exhibits some bipolar reduction of Prairie du Chien pebbles and bipolar recycling of broken tools. Three bipolar cores and eight bipolar flakes were identified. Eleven bifaces and five scrapers exhibit radial fractures, burin scars on transverse breaks, and bipolar crushing. Evidence of bipolar recycling at Morrow-Hensel may suggest toolstone conservation (Goodyear 1993). Broken points and failed preforms from Morrow-Hensel also suggest efforts to conserve toolstone. Many of the broken points are represented by relatively wide base fragments with large flutes, while many of the preform failures are narrow and made on flake blanks with minimal shaping and fluting. This assemblage may reflect a group that has been away from the Hixton quarry for some time and must soon return to a lithic source area to replenish their toolstone.

Furthermore, Hensel believes he has found a location several hundred meters from the site where ambush kills could have been made. This proposed location has perpendicular side walls with a floor 30 m wide, which opens to extensive river bottoms.

Special thanks to Ernie Boszhardt of the Mississippi Valley Archaeology Center at UW–La Crosse for providing the essential support and encouragement to complete this project. Funding for this study was provided by a Historic Preservation Fund subgrant to Boszhardt from the Division of Historic Preservation at the State Historical Society of Wisconsin. Thanks also to Clark Dobbs of the Institute for Minnesota Archaeology and to Daniel Wilcox of River Falls, Wisconsin. Finally, we thank Dr. Robert Baker of UW–River Falls for graciously providing the lab facilities necessary for conducting our analysis and documentation.

References Cited

Goodyear, A. C. 1993 Tool Kit Entropy and Bipolar Reduction: A Study of Interassemblage Lithic Variability among Paleo-Indian Sites in the Northeastern United States. *North American Archaeologist,* 14:1–23.

Gramly, R. M. 1982 *The Vail Site: A Paleoindian Encampment in Maine.* Volume 30. Bulletin of the Buffalo Society of Natural Sciences, New York.

——— 1988 *The Adkins Site: A Paleoindian Habitation and Associated Stone Structure.* Persimmon Press, Buffalo, New York.

Grimes, J. R. 1979 A New Look at Bull Brook. *Anthropology,* 3:109–130.

Hill, M. G. 1994 Paleoindian Projectile Points from the Vicinity of Silver Mound (47JA21), Jackson County, Wisconsin. *Midcontinental Journal of Archaeology,* 19:223–259.

Storck, P. L. 1983 The Fisher Site, Fluting Techniques, and Early Paleo-Indian Cultural Relationships. *Archaeology of Eastern North America,* 11:80–97.

——— 1997 *The Fisher Site: Archaeological, Geological and Paleobotanical Studies at an Early Paleo-Indian Site in Southern Ontario, Canada.* Memoir No. 30. Museum of Anthropology, University of Michigan, Ann Arbor.

Badger Springs: A Late-Paleoindian Site in Northeastern Arizona

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Diverse materials recovered from a blowout near Inscription House Trading Post in northeastern Arizona provide substantial new data for late Paleoindian studies. The Badger Springs site (NA 10924) is believed to represent a late Paleoindian-age campsite and possible cremation burial. The site was reported to the Museum of Northern Arizona (MNA) in 1970 and was surface collected by Bruce Harrill and Alexander Lindsay, then Curator of

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Anthropology at MNA. Investigators recovered two complete, lanceolate projectile points along with more than 80 additional lanceolate point fragments, an intact fossil bison skull, over 20 fragments of groundstone, and nearly 200 fragments of burned and mineralized bone fragments, including fragments of highly calcined human bone and teeth. A striking feature of the Badger Springs assemblage is the presence of thermal alteration on 50 percent (n = 43) of the projectile point fragments. In addition, three charcoal stained areas were noted eroding out of the edges of the blowout during collection.

Recognizing the significance of the first known Paleoindian site in the region with preserved organic remains, Lindsay submitted a research proposal to the National Science Foundation in 1971 in hopes of conducting further investigations. The grant proposal was rejected. However, interest remained in the site and the assemblage has been studied, although not published, by several individuals over the past 20 years (e.g., Parry and Smiley 1990; Smiley, in preparation).

The projectile points are lanceolate in plan with slight basal constrictions. Edges are ground and bases are straight to slightly concave. Most points have fine parallel-oblique flaking (58 percent, n = 36), and some specimens exhibit serrated lateral edges. The assemblage is dominated by medium- to fine-quality white and gray cherts and quartzites, as well as jaspers, all of as yet unknown origin. Refitting attempts have been only partially successful. Although many point fragments can derive from only a few individual points, the assemblage likely represents a minimum of 20 projectile points as indicated by the number of bases present.

The Badger Springs points closely resemble Angostura points recovered from the Ray Long site (39FA65; Hannus 1986) and the Travis 2 site (39WW15; Ahler 1980; Toom 1994), both in South Dakota. Similarities are also apparent between the Badger Springs points and Foothill-Mountain Paleoindian points reported from Wyoming (Frison 1991), raising interesting questions about Plains-mountain interaction during the late Paleoindian period (cf. Frison 1992; Pitblado and Brunswig 1995). Although no radiometric dating has been done, the Badger Springs site projectile point morphology can provide at least a tentative age estimate in the 7,500 to 9,500 yr B.P. range.

Collection within the 30 × 15 m blowout also yielded 6 biface fragments, a drill, a graving tool, a fragmentary scraper, 9 edge-modified flakes, 10 cores and tested pieces, and 259 pieces of flaking debris. The debitage and non-projectile point tools appear to represent opportunistic reduction of low-quality cherts available on site. Unlike the projectile point assemblage, the tools and debris show no evidence of thermal fracture or alteration.

The bone assemblage consists of highly fragmentary large and small mammal, and human, bones and teeth (Christy G. Turner II, pers. comm. 1996). Some of the bones evidence burning and mineralization. Also present is the nearly complete skull of a bison, housed in the MNA Geology Department. The condition and preservation of the skull appear similar to those of the bison remains from the Horner site, a Cody-complex bison kill in northwestern Wyoming (Frison and Todd 1987).

Badger Springs may represent a terminal Paleoindian cremation burial.

Although Paleoindian cremations appear extremely rarely in the archaeological record, some comparative data are available. The large assemblage of burned projectile points and bone fragments appears comparable to the features interpreted as Paleoindian cremation burials at the Renier site in Wisconsin (Mason and Irwin 1960) and the Crowfield site in southwestern Ontario (Deller and Ellis 1984). Certain camp-related activities also appear to have occurred at Badger Springs, given the presence of groundstone and flaking debris.

Late Paleoindian occupations of any kind are rare in the Southwest in general, and almost unknown in northeastern Arizona (Agenbroad 1967; Ayres 1966; Danson 1961; Downum 1993; Geib 1995; Hesse 1995; Huckell 1982; Morris 1958; Schroedl 1977). As an unequivocally significant Paleoindian manifestation, the Badger Springs site warrants further investigation, including radiometric dating, a search for additional site materials in private collections, and additional on-site work. If more cultural materials remain, the Badger Springs locality may provide the first glimpse of early occupation situations in northern Arizona.

References Cited

Agenbroad, L. D. 1967 The Distribution of Fluted Points in Arizona. *Kiva* 32:113–120.

Ahler, S. A. 1980 Evaluation of the Condition of the Travis 2 Archeological Site, 39WW15, Oahe Reservoir, South Dakota, November 1979. Department of Anthropology. University of North Dakota, Grand Forks. Submitted to the U.S. Army Corps of Engineers, Omaha District.

Ayres, J. E. 1966 A Clovis Fluted Point from the Kayenta, Arizona Area. *Plateau,* 38:76–78.

Danson, E. B. 1961 Early Man Points from the Vicinity of Sanders, Arizona. *Plateau,* 34:67–68.

Deller, D. B., and C. J. Ellis 1984 Crowfield: A Preliminary Report on a Probable Paleo-Indian Cremation in Southwestern Ontario. *Archaeology of Eastern North America,* 12:41–71.

Downum, C. E. 1993 Evidence of a Clovis Presence at Wupatki National Monument. *Kiva,* 58(4):487–494.

Frison, G. C. 1991 *Prehistoric Hunters of the High Plains* (2nd ed.). Academic Press, San Diego.

——— 1992 The Foothills-Mountains and the Open Plains: The Dichotomy in Paleoindian Subsistence Strategies between Two Ecosystems. In *Ice Age Hunters of the Rockies,* Dennis J. Stanford and Jane S. Day (eds.). pp. 323–342. Denver Museum of Natural History and University Press of Colorado, Niwot.

Frison, G. C., and L. C. Todd (eds.) 1987 *The Horner Site: The Type Site of the Cody Cultural Complex.* Academic Press, Orlando.

Geib, P. R. 1995 Two Fluted Points from the Kaibito Plateau, Northeastern Arizona. *Kiva,* 61(1):89–97.

Hannus, L. A. 1986 Report on 1985 Test Excavations at the Ray Long Site (39FA65), Angostura Reservoir, Fall River County, South Dakota. *South Dakota Archaeology,* 10:48–104.

Hesse, I. S. 1995 A Reworked Clovis Point Near Chevelon Ruin, Arizona. *Kiva,* 61(1):83–88.

Huckell, B. B. 1982 *The Distribution of Fluted Points in Arizona: A Review and an Update.* Arizona State Museum Archaeological Series No. 145. University of Arizona, Tucson.

Mason, R. J., and C. Irwin 1960 An Eden-Scottsbluff Burial in Northeastern Wisconsin. *American Antiquity,* 26(1):43–57.

Morris, E. A. 1958 A Possible Early Projectile Point from the Prayer Rock District, Arizona. *Southwestern Lore,* 24(1):1–5.

Parry, W. J., and F. E. Smiley 1990 Hunter-Gatherer Archaeology in Northeastern Arizona and Southeastern Utah. In *Perspectives on Southwestern Prehistory*, P. E. Minnis and C. L. Redman (eds.). pp. 47–67. Westview Press, Boulder.

Pitblado, B. L., and R. H. Brunswig, Jr. 1995 Late Paleoindian Culture Dynamics and Environmental Change in the Central High Plains and Rocky Mountains. Paper presented at the 60th Annual Meeting of the Society for American Archaeology, Minneapolis, MN.

Schroedl, A. R. 1977 The Paleo-Indian Period on the Colorado Plateau. *Southwestern Lore,* 43(3):1–9.

Smiley, F. E. (in preparation) The Preagricultural Period on Black Mesa: A Regional Perspective. In *10,000 Years on Black Mesa: Prehistoric Culture Change on the Colorado Plateaus*, F. E. Smiley and S. Powell (eds.). Southern Illinois University Press, Carbondale.

Toom, D. L. 1994 Last Tango at Travis 2: A Brief Overview of the Findings of the 1989 Excavations at the Travis 2 Site (39WW15), Mobridge, South Dakota. *Newsletter of the South Dakota Archaeological Society,* 24(3):1–6.

Inferring Season of Kill for a Cody-Complex Bison Bonebed in Middle Park, Colorado

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Paleoindian bison kill-butchery locales constitute much of the terminal Pleistocene archaeological record west of the Mississippi River (e.g., Frison 1991). Although high-altitude sites in the Rocky Mountains have historically received relatively little attention, they provide an important alternative source of information on the dynamics of Paleoindian subsistence and settlement (e.g., Jodry and Stanford 1996; Pitblado 1998). The George C. Frison Institute, University of Wyoming, has recently initiated investigations in Middle Park, Colorado, as part of the Rocky Mountain Paleoindian Project. Middle Park, 150 km northwest of Denver, is the highest basin in the Rocky Mountains, surrounded by peaks in excess of 4000 m ASL.

To date, approximately 40 Paleoindian components at over 30 separate localities have been recorded (Kornfeld 1998; Kornfeld and Frison 1999). Projectile points diagnostic of Goshen, Folsom, Cody, and various late Paleoindian complexes have been recovered or documented in avocational collections. Of special interest here are the Upper Twin Mountain (5GA1513; Todd et al. 1996) and Jerry Craig (5GA639) bison bonebeds. This paper summarizes the Jerry Craig site, emphasizing eruption and wear of the bison lower dentitions to infer the season of death, a important aspect of Paleoindian settlement-subsistence research.

The Jerry Craig site was discovered and surface collected by avocational

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archaeologist Jerry Craig of Granby, Colorado. Over 40 Cody Complex points or point fragments were recovered from erosional rills adjacent to a road that passes near the site. Excavation of 14 m^2 in July 1997 revealed an in situ bonebed and associated lithic assemblage. Its areal extent is estimated to be at least 112 m^2. The bison assemblage consists of 57 specimens, 20 of which are identifiable to element. In general, cortical surfaces are heavily weathered and evidence of human butchery modification has been obscured (Logan et al. 1998). A ^{14}C assay on charcoal in direct association with the artifacts and bone yielded a date of 9310 ± 50 yr B.P. (Beta 109467; Kornfeld 1998:53).

Mandibular rami and isolated teeth are the most abundant element in the Jerry Craig faunal assemblage, providing a season-of-death inference for the assemblage. The fragmentary condition and overall poor condition of most specimens precludes documentation of many of the attributes recorded in recent eruption and wear studies (e.g., Niven and Hill 1998; Todd et al. 1996). Five bison (maximal distinction MNI) in three dental age groups are represented by lower teeth and yield the highest estimate of the number of animals in the assemblage. The youngest animals represent those in Dental Age Group 2, while the oldest are Group 5+.

Known tooth eruption schedules and wear patterns of modern northern Plains bison (Reher and Frison 1980; Todd et al. 1996), and comparison with other prehistoric dentary assemblages, suggest that the Jerry Craig bison died in the late summer-early fall (y+0.3–0.5 yrs.). There is no evidence that more than one mortality episode occurred at the site. Modern bison M2s erupt around 1.1–1.2 years, and by 1.5 years wear is evident on the facets I–II (Reher and Frison 1980:65). The Jerry Craig Group 2 M2s are fully erupted, or nearly so, and the metaconids are very lightly worn or polished. This suggests that these animals were not more than 1.5 dental age years old at death. Eruption and wear descriptions of the Scottsbluff Group 2 mandibles (1.1–1.2 yrs.; Todd et al. 1990) indicate that the Group 2 specimens at Jerry Craig were older than 1.1–1.2 years at death. However, eruption and wear are not as advanced as that reported at Hawken (1.7 yrs.; Frison et al. 1976), and are most similar to the Group 2 animals at Glenrock (Frison and Reher 1970).

The Group 3 mandibles also exhibit eruption and wear suggestive of a late summer-early fall mortality. First and second molars are worn on all facets. Cusps 1 and 2 of the M3s are erupted above the alveolus, but not to the level of the second molars. The hypoconulids are probably at or slightly below the alveolus. Eruption and wear are slightly more advanced than reported for the Group 3 animals at Scottsbluff (2.1–2.2 yrs.; Todd et al. 1990). M3 eruption is most similar to that reported at Glenrock (2.5 yrs.; Frison and Reher 1970) and the older animals in this group at Lipscomb (2.2–2.5 yrs.; Todd et al. 1990). In these assemblages, cusps 1 and 2 are erupted above the jaw, but are unworn. At Hawken (2.7 yrs.; Frison et al. 1976), M3 facets I–II of the Group 3 animals are occasionally worn. These comparisons effectively (and tentatively due to small sample size) bracket the season of death of the Jerry Craig bison between y+0.3–0.5 yrs, or late summer-early fall.

Although Paleoindian bison kills on the open plains are documented in all seasons of the year, there appears to be a cold season peak (Todd 1991). Given that only two season-of-death inferences are currently available, fall-early winter at Upper Twin Mountain (Todd et al. 1996) and later summer-early fall at Jerry Craig, it is difficult to evaluate whether or not this pattern is upheld in Middle Park. Future investigations in the region are certain to illuminate this poorly understood and not well documented aspect of Paleoindian adaptive strategies.

We are indebted to Mr. Jerry Craig for recognizing the importance of this site, monitoring it over a 20 plus year period. The Colorado State Historic Preservation Fund provided support for the bulk of fieldwork and laboratory analysis reported here. University of Wyoming archaeological field school students and volunteers (including the Colorado Archaeological Society) contributed to the investigations at the site. The BLM, Kremmling Resource Area, has supported the project and we are particularly grateful to Mr. Frank Rupp for facilitating Federal permitting, consultation, funding, and other aspects of the project.

References Cited

Frison, G. C. 1991 *Prehistoric Hunters of the High Plains,* 2nd ed. Academic Press, New York.

Frison, G. C., and C. A. Reher 1970 Appendix I: Age Determination of Buffalo by Teeth Eruption and Wear. In *The Glenrock Buffalo Jump, 48CO304: Late Prehistoric Period Buffalo Procurement and Butchering on the Northwestern Plains,* by G. C. Frison, pp. 46–47. Plains Anthropologist Memoir No. 7.

Frison, G. C., M. C. Wilson, and D. J. Wilson 1976 Fossil Bison and Artifacts from an Early Altithermal Period Arroyo Trap in Wyoming. *American Antiquity,* 41:28–57.

Jodry, M. A., and D. J. Stanford 1996 Changing Hydrologic Regimes and Prehistoric Landscape Use in the Northern San Luis Valley, Colorado. In *Geologic Excursion to the Rocky Mountains and Beyond: Fieldtrip Guidebook for the 1996 Annual Meeting Geological Society of America, Denver.* Special Publication 44, Colorado Geological Survey, Department of Natural Resources, Denver.

Kornfeld, M., editor 1998 *Early Prehistory of Middle Park: The 1997 Project and Summary of Paleoindian Archaeology.* Technical Report No. 15a, Department of Anthropology, University of Wyoming, Laramie.

Kornfeld, M., and G. C. Frison 1999 Paleoindian Occupation of the High Country: the Case of Middle Park, Colorado. In *Recent Advances in Colorado Paleoindian archaeology,* edited by R. H. Brunswig, Jr. University of Colorado Press, Niwot, in press.

Logan, J., J. Durr, M. G. Hill, C. Lee, and V. McMillan 1998 Jerry Craig Site, 5GA639, A Cody Complex site in Colorado. In *Early Prehistory of Middle Park: The 1997 Project and Summary of Paleoindian Archaeology,* by M. Kornfeld. Technical Report No. 15a, Department of Anthropology, University of Wyoming, Laramie.

Niven, L. B., and M. G. Hill 1998 Season of Bison Mortality at Three Plains Archaic Kills in Wyoming. *Plains Anthropologist,* 43:5–26.

Pitblado, B. L. 1998 Peak to Peak in Paleoindian Time: Occupation of Southwest Colorado. *Plains Anthropologist,* 43:333–348.

Reher, C. A., and G. C. Frison 1980 *The Vore Site, 48CK302, a Stratified Buffalo Jump in the Wyoming Black Hills.* Plains Anthropologist Memoir No. 16.

Todd, L. C. 1991 Seasonality Studies and Paleoindian Subsistence Strategies. In *Human Predators and Prey Mortality,* edited by M. C. Stiner, pp. 217–238. Westview Press, Boulder.

Todd, L. C., D. J. Rapson, and J. L. Hofman 1996 Dentition Studies of the Mill Iron and Other Early Paleoindian Bison Bonebed Sites. In *The Mill Iron Site,* edited by G. C. Frison, pp. 145–175. University of New Mexico Press, Albuquerque.

Preliminary Report on the Gail Stone Fluted Point Site (47TR351), Trempealeau County, Western Wisconsin

Matthew Glenn Hill, Robert F. Boszhardt, Daniel S. Amick, and Thomas J. Loebel

Since Stoltman and Workman's (1969) fluted point survey 30 years ago, there has been little systematic, long-term research effort directed toward Wisconsin's early Paleoindian archaeological record. There are minimal data concerning strategies of lithic raw material procurement, chipped-stone tool production, or land use, and models of early Paleoindian behavior in the East rarely incorporate data from this region. In order to lessen this imbalance, we are developing a database through examination of collections, literature review, and excavation, analysis and interpretation of sites (Amick et al. 1999; Hensel et al. 1998; Hill 1994; Hill et al. 1998a, 1998b; Loebel et al. 1998). This paper adds new information to Wisconsin's terminal Pleistocene occupation by reporting on the fluted point assemblage from the Gail Stone site.

The site is located in the western fringe of Wisconsin's unglaciated "Driftless Area," 7 km northwest of the Mississippi River at Trempealeau. More specifically, it is situated at the mouth of Tamarack Valley on the south-facing slope of an eroded loess bench that is oriented roughly perpendicular to the valley. The location affords an excellent view to the south of a broad, featureless plain formed as an abandoned trench of the Mississippi River that filled with Pleistocene outwash (Martin 1965:148–149, 151). Tamarack Creek drains the valley, flowing north and east of the site before reaching the Mississippi River west of the Trempealeau Bluffs. Nearly 15 years of avocational collecting and our fieldwork indicate that early Paleoindian artifacts are entirely within the plowzone and sparsely scattered over an area of 3750 m^2 along the bench slope between 225–229 m ASL. Evidence of later occupation is limited.

The lithic assemblage is not large. Most specimens are made of either "glossy" red or yellow Cochrane chert, a toolstone local to the area that has recently been recognized as being utilized by early Paleoindians (Boszhardt 1996). Specimens made of this material include 5 fluted preforms, 3 fluted points, 2 fluted point or fluted preform fragments, 26 scrapers, 6 channel flakes, 1 graver, and about 150 pieces of debitage. Non-Cochrane artifacts

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include a scraper of Niagara chert, and two bifaces and three core reduction flakes made of rhyolite from eastern Wisconsin. To our knowledge, this represents the first occurrence of early Paleoindian rhyolite use in the state, as well as a very rare example of prehistoric rhyolite use in western Wisconsin.

The bright red and yellow Cochrane cherts used by fluted point makers at Gail Stone are extremely glossy and easily worked, but they possess low tensile strength. Thus its aesthetic qualities must have appealed to early Paleoindians (Haynes 1987), but its intrinsic properties (Goodyear 1989) are deceptive because of structural cracks in the material. At least two bifaces broke during fluting. One preform was fluted successfully but broke during lateral edge shaping. Four other preform fragments show flute remnants on one or both faces, but it is not clear if they are fluting failures or broke during subsequent lateral shaping. The strategies of fluted biface production used at Gail Stone are generally consistent with those of the Gainey complex.

Preliminary interpretation of the lithic assemblage from Gail Stone suggests that it represents a short-term occupation in which fluted biface manufacture and hide working were important activities. The nearly exclusive use of Cochrane chert and the absence of Hixton silicified sandstone (HSS) artifacts are unusual. Hixton was the favored toolstone of Paleoindians throughout the state (Hill et al. 1998a), and its absence is noticeable, especially considering that it outcrops 55 km northeast at Silver Mound. However, Gail Stone is not the only Wisconsin fluted point assemblage dominated by one toolstone. The collections from Aebischer (Mason 1988; Stoltman 1993) and Morrow-Hensel (Amick et al. 1999; Hensel et al. 1999) have low toolstone diversity. Moline and Burlington chert from western Illinois are represented at Aebischer, while the Morrow-Hensel assemblage is almost exclusively HSS. Wisconsin can be considered "resource poor" in terms of not having a homogenous distribution of high-quality toolstone (Morrow and Behm 1985). Early Paleoindians unfamiliar with the resource geography of the region may have carried bifaces suitable for the production of a suite of tools as part of a risk reduction strategy (Binford 1979; Kelly 1988; Kelly and Todd 1988). Thus, one possibility that may explain the use of Cochrane chert and the lack of HSS at Gail Stone is that Cochrane chert did not have the preferred flaking properties and was therefore sought only in specific situations (e.g., expedient technology?, tool-kit depletion?), much like other poor-quality, local cherts. The presence of eastern Wisconsin rhyolite in the assemblage may be a indicator of this behavior as well.

Special thanks to Gail, Harland, Scot, and Mark Stone for allowing specimens in their possession to be studied. Others who have assisted in various capacities include Chris Widga, Jeffery Behm, Sam Drucker, Ryan Letterly, Ed Brush, Ken Hensel, and Bob, Karl, and Marie Lettner. Portions of the analysis were conducted at the George C. Frison Institute of Archaeology & Anthropology, Department of Anthropology, University of Wyoming, Laramie. This research was funded in part by a Survey and Planning Grant from the Historic Preservation Division, State Historical Society of Wisconsin, Madison.

References Cited

Amick, D. S., T. J. Loebel, R. F. Boszhardt, M. G. Hill, and K. C. Hensel 1999 New Evidence for the Early Paleoindian Occupation of Western Wisconsin. Paper presented at the 64th Society for Archaeology Meeting, Chicago, IL.

Binford, L. R. 1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research*, 35:255–273.

Boszhardt, R. F. 1996 Newly Discovered Lithic Resources in Western Wisconsin. *Minnesota Archaeologist*, in press.

Goodyear, A. C. 1989 A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleoindian Groups of North America. In *Eastern Paleoindian Lithic Resource Use*, edited by C. J. Ellis and J. C. Lothrop, pp. 1–9. Westview Press, Boulder.

Haynes, C. V., Jr. 1987 Clovis Origin Update. *Kiva*, 52:83–93.

Hensel, K. C., D. S. Amick, M. G. Hill, and T. J. Loebel 1999 Morrow-Hensel: A New Fluted Point Site in Far Western Wisconsin. *Current Research in the Pleistocene*, 16:25–27.

Hill, M. G. 1994 Paleoindian Projectile Points from the Vicinity of Silver Mound (47JA21), Jackson County, Wisconsin. *Midcontinental Journal of Archaeology*, 19:223–259.

Hill, M. G., D. S. Amick, and T. J. Loebel 1998a An Inventory of Wisconsin Paleoindian Projectile Points at the Milwaukee Public Museum. *Current Research in the Pleistocene*, 15:18–20.

Hill, M. G., R. F. Boszhardt, D. S., Amick, and T. J. Loebel 1998b The Gail Stone Fluted Point Site (47TR351), Trempealeau County, Western Wisconsin. Presented at the 56th Plains Anthropological Conference, Bismarck, North Dakota.

Kelly, R. L. 1987 The Three Sides of a Biface. *American Antiquity*, 53:717–734.

Kelly, R. L., and L. C. Todd 1988 Coming into the Country: Early Paleoindian Mobility and Hunting. *American Antiquity*, 53:231–244.

Loebel, T. J., D. S. Amick, M. G. Hill, R. F. Boszhardt, and K. C. Hensel 1998 Early Paleoindian Lithic Technology in Wisconsin: Evidence from Two New Sites. Paper presented at the 43rd Midwest Archaeological Conference, Muncie, Indiana.

Martin, L. 1965 *The Physical Geography of Wisconsin*, 3rd ed. University of Wisconsin Press, Madison.

Mason, R. P. 1988 Preliminary Report on the Fluted Point Component at the Acbischer Site (47Ct30) in Calumet County, Wisconsin. *The Wisconsin Archeologist*, 69:211–226.

Morrow, T. A., and J. A. Behm 1985 Descriptions of Common Lithic Raw Materials Encountered on Wisconsin Archaeological Sites. Paper distributed at the Lithic Identification Workshop held in conjunction with the Fall Meeting of the Wisconsin Archeological Survey, Madison.

Stoltman, J. B. 1993 A Reconsideration of Fluted Point Diversity in Wisconsin. In Archaeology of Eastern North America: Papers in Honor of Stephen Williams, edited by J. B. Stoltman, pp. 61–72. Mississippi Department of Archives and History, Archaeology Report 25.

Stoltman, J. B., and K. Workman 1969 A Preliminary Study of Wisconsin Fluted Points. *The Wisconsin Archeologist*, 50:189–214.

Folsom Land Use in West Texas: Evidence from the Robertson Site

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The Robertson site, 41CB64, is located on a large sand dune near the eastern caprock escarpment of the southern High Plains in western Texas (Holliday

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1997; Parker 1972, 1978). The escarpment edge and freshwater springs are located within 2 km south of the site near the mouth of Yellow House Canyon. The dune is a prominent topographic feature in the vicinity and was formed by deflation of a small playa lake immediately to the west. Mammoth and bison remains have been found in the playa sediments and a variety of Paleoindian projectile points, including at least six Clovis, have been found at the site. The mouth of Yellow House Canyon is a distinctive feature of the eastern Caprock escarpment, and the valley provides access between the dissected plains to the east and the High Plains to the west. From the sand ridge at Robertson, one can view a considerable area of High Plains, and from the Caprock edge many kilometers of dissected red bed plains can be monitored. The promontories, Double Mountains, are visible 100 km to the southeast; 40 km beyond is the Adair-Steadman Folsom camp and lithic workshop (Tunnell 1977). For groups moving east or west or those hunting along the caprock escarpment, the Robertson site provided an ideal setting that could be easily relocated. This location was repeatedly selected for use by Folsom people and other prehistoric groups.

Yellow House Canyon forks to become Yellow House Draw and Blackwater Draw, which extend northwest across the Llano. These drainages would have contained live streams or ponds in Clovis and Folsom times (Holliday 1995:6; 1997:177). The Lubbock Lake site is 48 km west (Johnson 1987), and Blackwater Draw is 180 km to the northwest (Hester 1972; Holliday 1997:178). The Folsom assemblages at both these sites, as at Robertson, are dominated by Edwards cherts, the closest residual gravel sources of which occur east of Double Mountains near the Adair-Steadman site.

Aboriginal use of Robertson occurred intermittently from Clovis through historic times, and distinctive tool forms of probable Paleoindian attribution are common. These include spurred end scrapers, gravers, spokeshaves, compound tools on blade-like flakes, and large biface thinning flakes. A wide range of activities is reflected.

At least 19 Folsom points, 11 Midland points, and 4 Folsom preforms have been collected. Lithic material is primarily Edwards formation cherts with only five pieces (four Folsoms and one Midland) manufactured from unidentified materials. This sample consists mostly of point bases (18 of 30 finished points [60 percent], and 3 of 4 preforms). Nine of 30 finished points have evidence of distal reworking prior to loss or discard. Of the points, 20 percent are complete or nearly so (2 Folsoms and 4 Midlands), and another 20 percent represent blade, edge, or tip fragments (5 Folsoms and 1 Midland). Flake blanks were used as preforms on at least two Folsom and two Midland points, and three Folsom preforms are made on flakes. Mean length of two Folsom points and four Midland points is 4.57 and 4.2 cm, respectively. The mean basal width and maximum thickness of Folsom points is 18.6 and 4.1 mm, whereas the comparable measurements for Midland points are 17.5 and 4.4 mm. Folsom points have a mean fluted thickness of 2.8 mm. One unfluted Folsom has a prominent nipple at the base, but was used without fluting as evidenced by lateral edge grinding and a reworked tip (Figure 1A). One Folsom point is pseudo-fluted, one is fluted on only one side, and

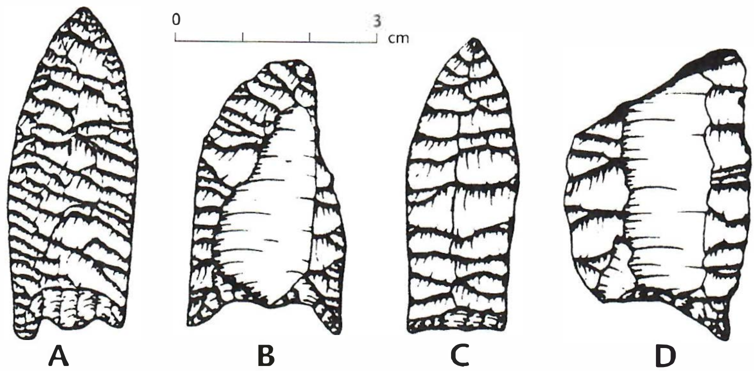

Figure 1. Selected Robertson site artifacts. **A,** unfluted Folsom point; **B,** reworked Folsom point; **C,** Midland point; **D,** Folsom point preform.

another is basally thinned on one side. The remaining Folsom points are fluted on both faces. Seven of the Folsom points exhibit oblique parallel flaking (37 percent) from upper left to lower right. This pattern has been noted on a number of other Folsom assemblages (e.g., Agogino and Parrish 1971). The most complete Folsom preform was fluted on both faces and broken by a perverse fracture during final shaping. One basal corner has been reworked to form a graver spur (Figure 1D).

Some Folsom sites reflect specific events enacted due to situational circumstances, such as the presence of a bison herd of sufficient size to trap in a gully or sand dune (Bement 1997; Hofman et al. 1990). Such sites are often single component or used only by Folsom people. Other Folsom sites are fixed with reference to topography, ecological setting, and specific site characteristics, such as lithic resources, springs, or favorable position for seasonal use (Hester 1972; Tunnell 1977; Wilmsen and Roberts 1978). Robertson appears to be a location of the latter type. At least the recurrent use of the dune throughout prehistory supports this notion. The inability to precisely identify the Folsom assemblage at Robertson, beyond points and preforms, limits a more complete evaluation of the varied roles the site may have played during Folsom time. The setting and assemblage from Robertson indicate that it was probably a repeatedly used camp and retooling station from which logistical, specific task group, information gathering, and hunting excursions were initiated. It may also have served as a domestic camp or aggregation site. Given the exposed setting, it is likely that Robertson was primarily used during warm seasons, although protected settings along the eastern edge of the caprock escarpment could have facilitated cold weather use of the general area.

The artifact collection on which this study is based was made by Wayne Parker over a significant period of his life. His long-term collecting and curation efforts should enable continued study of his well-documented collection, which was donated to the Crosby County Pioneer Memorial Museum in 1992. This study is dedicated to Wayne's memory and to his efforts to bring the prehistory and history of west Texas to the general public. The research for this paper was done in 1990, and I thank Wayne Parker and John Redder for a most memorable tour of Crosby County archaeological sites in May of that year.

References Cited

Agogino, G. A., and A. Parrish 1971 The Fowler-Parrish Site: A Folsom Campsite in Eastern Colorado. *Plains Anthropologist,* 16:111–114.

Bement, L. C. 1997 The Cooper Site: A stratified Folsom Bison Kill in Oklahoma. *Plains Anthropologist,* Memoir 29:85–100.

Hester, J. J. 1972 *Blackwater Locality No. 1: A Stratified Early Man Site in Eastern New Mexico.* Fort Burgwin Research Center and Southern Methodist University Publication 8.

Hofman, J. L., D. S. Amick, and R. O. Rose 1990 Shifting Sands: A Folsom-Midland Assemblage from a Campsite in Western Texas. *Plains Anthropologist,* 35:221–253.

Holliday, V. T. 1995 *Stratigraphy and Paleoenvironments of Late Quaternary Valley Fills on the Southern High Plains.* Geological Society of America, Memoir 186. Boulder.

——— 1997 *Paleoindian Geoarchaeology of the Southern High Plains.* University of Texas Press, Austin.

Johnson, E. ed. 1987 *Lubbock Lake: Late Quaternary Studies on the Southern High Plains.* Texas A&M Press, College Station.

Parker, W. 1972 Projectile Points from a Sand Hill Site in Crosby County, Texas. *Central States Archaeological Journal,* 19(4):176–178.

——— 1978 An Unfluted Folsom from Crosby County, Texas. *Central States Archaeological Journal,* 25(2):82-83.

Wilmsen, E. N., and F. H. H. Roberts, Jr. 1978 *Lindenmeier, 1934–1974: Concluding Report of Investigations.* Smithsonian Contributions to Anthropology 24. Washington, D.C.

Folsom Evidence from the Nebraska Sand Hills: The Elfgren Site

Steven R. Holen and Jack L. Hofman

The Elfgren site is in the eastern Sand Hills of central Nebraska (Holen 1998), on the divide of the North Loup and Calamus Rivers in Blaine County. Carl Elfgren collected artifacts from the blowout's surface between 1959 and 1963, including Archaic dart points, late-prehistoric arrow points, and historic materials (Holen 1998, Fig. 13-7). Of special interest here are some tools and four Folsom points (Figure 1), which were collected from a small area (ca. 100 m^2) on the west side of the 4- to 5-hectare site. Elfgren is one of few Folsom localities documented in Nebraska (Barbour and Schultz 1936; Greiser 1985; Hofman 1996; Holen et al. 1996; Langford 1969:10–12; Myers 1987), although Folsom and other Paleoindian surface evidence has been noted from the Sand Hills (Barbour and Schultz 1936; Carlson 1971; Holen 1998; McIntosh 1996; Myers 1987, 1995; Renaud 1934).

Four Folsom points from the Elfgren site are all manufactured from

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Hartville Uplift cherts with primary source areas in southeastern Wyoming (Miller 1991), and secondary gravels in western Nebraska (Swinehart and Diffendal 1989: figs. 3-9 and 3-10). A Folsom point reported by Myers (1995) from nearby Loup County is also of Hartville chert. In addition to the Folsom points, several probable Paleoindian tools were collected from Elfgren. Because other Paleoindian point types are lacking, we suspect these tools reflect Folsom activity. These artifacts include four thin end scrapers (made from Alibates flint, Knife River flint, Hartville chert, and chalcedony), one small blade fragment of probable Burlington-Crescent chert, and one graver of chalcedony. The Knife River flint scraper is spurred, and three flakes of Alibates are present.

Three of the Folsom points have distal impact damage. Three points are complete or nearly so, while the fourth lacks its base. The tips of three points were reworked prior to loss or discard. The largest specimen may have a reworked base, but has its original impact-damaged tip. One point (Figure 1A) was manufactured from a flake, and the channel flake on the opposite side originated from the tip (Figure 1A). The points exhibit a light sand polish, but none are patinated. Dimensions of the four points are 3.16–4.86 cm length, 1.81–2.18 cm maximum width, 1.62–1.85 cm in basal width, .42–.54 cm thickness, and .25–.47 cm fluted thickness. The means for these measurements are 3.81, 1.98, 1.75, .47, and .37 cm, respectively.

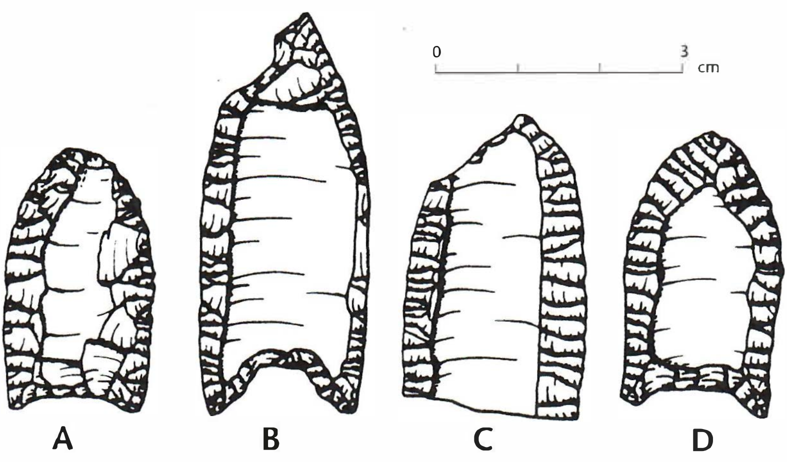

Figure 1. Elfgren site (25BL10) Folsom points.

The presence of impact-damaged complete points and the point tip are what we might expect in a bone bed or kill situation. The points could reflect an animal which was wounded and escaped; however, the Paleoindian-style scrapers suggest that some processing activities occurred at this location. Future coring and testing will enable assessment of deposits remaining in the Folsom area at Elfgren. Significant Holocene modification of the region's dune fields is indicated by radiocarbon dates (Ahlbrandt et al. 1983;

Swinehart and Diffendal 1998:Table 3-2; Wright et al. 1985), so investigation of Sand Hills sites such as Elfgren may contribute substantially to refining regional paleoecological models.

Study of the Elfgren site has been possible due to the efforts of Carl Elfgren, a latter-day pioneer who arrived in Nebraska by covered wagon in 1956. Special thanks are also extended to Jim Fox.

References Cited

Ahlbrandt, T. S., J. B. Swinehart, and D. G. Maroney 1983 The Dynamic Holocene Dune Fields of the Great Plains and Rocky Mountain Basins, U.S.A. In *Eolian Sediments and Processes*, edited by M. E. Brookfield and T. S. Ahlbrandt, pp. 379–406. Elsevier, Amsterdam.

Barbour, E. H., and C. B. Schultz 1936 Paleontologic and Geologic Consideration of Early Man in Nebraska. *Bulletin of the Nebraska State Museum* 45 Volume 1, pp. 431–449.

Carlson, G. 1971 Nebraska State Historical Society Highway Salvage Archeology Report Number 7. Manuscript on File at Nebraska State Historical Society, Lincoln.

Greiser, S. T. 1985 *Predictive Models of Hunter-gatherer Subsistence and Settlement Strategies on the Central High Plains.* Plains Anthropologist Memoir 20. Lincoln.

Hofman, J. L. 1996 Early Hunter-Gatherers of the Central Great Plains: Paleoindian and Mesoindian (Archaic) Cultures. In *Archeology and Paleoecology of the Central Great Plains*, edited by J. L. Hofman, pp. 41–100. Arkansas Archeological Survey, Research Series 48. Fayetteville.

Holen, S. R. 1998 The Native American Occupation of the Sand Hills. In *An Atlas of the Sand Hills* (second expanded edition, original 1989), edited by A. S Bleed and C. A. Flowerday, pp. 201–217. Resource Atlas 5b. Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln.

Holen, S. R., D. W. May, and P. M. Prettyman 1996 *An Archaeological and Geomorphic Survey of Paleoindian Sites at Harlan County Lake, Harlan County, Nebraska.* Nebraska Archaeological Survey Technical Report 96-01. University of Nebraska State Museum, Lincoln.

Langford, R. R. 1969 *Yuma-Folsom Archeology* (1977 printing). Golden, CO.

McIntosh, C. B. 1996 *The Nebraska Sand Hills: The Human Landscape.* The University of Nebraska Press. Lincoln.

Miller, J. 1991 Lithic Resources. In *Prehistoric Hunters of the High Plains* (second edition), by G. C. Frison. Academic Press. San Diego.

Myers, T. P. 1987 Preliminary Study of the Distribution of Fluted Points in Nebraska. *Current Research in the Pleistocene* 4:67–68.

——— 1995 Paleoindian Occupation of the Eastern Sand Hills. *Plains Anthropologist* 40(151):61–68.

Renaud, E. B. 1934 *Archeological Survey of Western Nebraska*, 1933. The Archeological Survey of the High Western Plains, Fifth Report. University of Denver.

Swinehart, J. B., and R. F. Diffendal, Jr. 1998 Geology of the Pre-Dune Strata. In *An Atlas of the Sand Hills* (second expanded edition) edited by A. S. Bleed and C. A. Flowerday, pp. 29–42. Resource Atlas 5b. Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln.

Wright, H. E., Jr., J. C. Almendinger, and J. Gruger 1985 Pollen Diagram from the Nebraska Sand Hills and the Age of the Dunes. *Quaternary Research* 24:115–120.

El Jobo Points: Age, Context, and Definition

Lawrence J. Jackson

The age and context of narrow, parallel-flaked lanceolate points in South America has recently become a subject of much interest with publication of the site of Monte Verde, Chile (Dillehay 1997). Since some North American researchers (but not Dillehay) have begun referring to the Monte Verde lanceolates as El Jobo points, a review of the history of the type is appropriate.

Jose Cruxent first recognized El Jobo points from surface sites near El Jobo in the Coro region of northwest Venezuela (Rouse and Cruxent 1956). These elongated, leaf-shaped points with rounded base, lenticular cross-section, basal grinding, and "coarse" flaking producing a serrated appearance were made mainly on bifacially worked quartzite flakes. Today, we recognize these points as early by their parallel flaking and basal edge grinding. Weaknesses in the type description, however, may cause serious identification errors. Two of the primary examples illustrated by Cruxent (see Figure 1A, B) show significant variability in flaking and metrics. Wide and coarsely flaked specimen A is best described as a late-stage preform. Narrow and finely flaked specimen B is more like a projectile point. Little is known of reduction sequences or of variability in metrics and morphology within the type.

Rouse and Cruxent (1963) noted El Jobo sites with El Jobo points and scrapers on the third terrace of Rio Pedregal. The sites, which included workshops, were small, shallow, and badly eroded. The two higher river terraces, associated with the Camare and Las Lagunas lithic complexes, are presumed to be older. El Jobo points continued into Las Casitas—last in the sequence of Joboid complexes—on the fourth river terrace. Relative geological ages for the four complexes were never well established.

Gordon Willey (1971) suggested El Jobo might date to 10,000 or 9000 yr B.P. based on similarity with points of other South American complexes—Chivateros II, Lauricocha II, and Ayampitin. The Las Lagunas complex (above) he saw as typologically close to Chivateros I of coastal Peru, ending 10,500 yr B.P., making El Jobo younger. Rouse and Cruxent (1963) noted El Jobo's similarity to Ayampitin I points in central Argentina, dated to 8000 yr B.P. They also recorded three El Jobo dates in northwest Venezuela: 16,920 yr B.P. on burned bone at Muaco (El Jobo point eroding out of deposit with extinct fauna), 14,780 yr B.P. also on burned bone at Muaco, and 14,380 yr B.P. on charcoal (with no El Jobo points) at the base of a ceramic deposit with Manzanillo complex artifacts.

Increasing confusion about the age of El Jobo is Santa Isabel de Ixtapan in the Valley of Mexico, where El Jobo–like lanceolates occur with mammoth and produce problematic dates near 33,000 yr B.P. (Rouse and Cruxent 1963 after de Anda 1955). An El Jobo point midsection with a juvenile mastodon at the site of Taima-Taima in northwest Venezuela appeared to resolve dating

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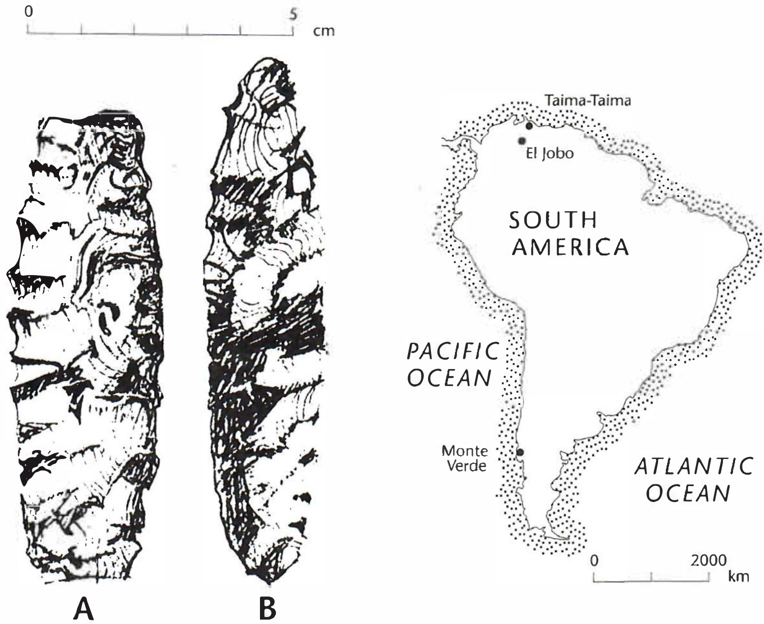

Figure 1. El Jobo Points from Venezuela (after Rouse and Cruxent 1963) and location of Taima-Taima and Monte Verde Sites. Point A appears to be a Stage 3 preform. Point drawings by Arthor Horn.

problems. Burned wooden twigs found near the mastodon dated 12,980, 13,000, 13,880 and 14,200 yr B.P. (Bryan et al. 1978). Cruxent's earlier work at Taima-Taima produced 14 dates from 14,000 to 12,000 yr B.P. on water-saturated artifact-bearing gray sand. However, he also noted a concentration of material that "looked like charcoal but which proved upon analysis to be coal" and a non-Joboid scraper. Augusto Cardich's work at the highland cave of Lauricocha, Peru, gives one of the few South American examples of a culturally stratified context for El Jobo-like points and a date for Lauricocha I (a presumed variant of El Jobo-Chivateros II points) younger than 10,000 yr B.P. (Willey 1971).

Alex Krieger's suggestion (see Willey 1971) of a broad New World distribution of El Jobo from Argentina and Chile to Venezuela, Mexico, and the midcontinental United States begs the question of a complete type description and consistent dating. Pleistocene archaeologists might best follow Dillehay's (1997) example and avoid using a Venezuelan-type name until regional sequences and the range of type variability are well established.

References Cited

Bryan, A. L., R. M. Casamiquela, M. M. Cruxent, R. Gruhn, and C. Ochsenius 1978 An El Jobo Mastodon Kill at Taima-Taima, Venezuela. *Science,* 200:1275–77.

Cardich, A. 1964 Lauricocha, Fundamentos para una Prehistoria de los Andes Centrales. Studia Prehistorica III, Centro Aregentino de Estudios Prehistoricos, Buenos Aires.

Cruxent, J. M., and I. Rouse 1958–59 An Archaeological Chronology of Venezuela. 2 Vols. Social Science Monographs, Pan American Union, Washington, D.C.

Dillehay, T. 1997 Monte Verde: A Late Pleistocene Settlement in Chile. Vol. 2: The Archaeological Context and Interpretation. Smithsonian Institution Press, Washington, D.C.

Rouse, I., and J. M. Cruxent 1963 *Venezuelan Archaeology*. Yale University Caribbean Series, No. 6, New Haven.

Willey, G. R. 1971 An Introduction to American Archaeology. Vol. 2: South America. New Jersey.

Fluted and Late-Paleoindian Points from the Southern Niagara Escarpment of Southern Ontario, Canada

Lawrence J. Jackson

The Hamilton area at the west end of Lake Ontario has high potential for Paleoindian occupation as an environmentally rich zone with a diversity of habitats—lake-edge, uplands and escarpment, and stream and river valleys. Nineteenth-century construction activity revealed a wealth of extinct faunal remains within Hamilton (Coleman 1932), yet few Paleoindian points have been reported. Part of the puzzle relates to postglacial flooding of the western Ontario basin so that relict shorelines of the Paleoindian period are now actually many kilometers offshore and under water. This paper reports on both old and new records of fluted and unfluted lanceolate points from upland areas along the Niagara Escarpment which lies directly west and north of Hamilton. Table 1 summarizes the measurements of the points.

Garrad (1971) recorded one unfluted and two fluted lanceolate points from farmland in and around the town of Ancaster, which is on top of the Niagara Escarpment only a few kilometers inland from Hamilton. A nicely fluted, heavily reworked Barnes point (Garrad 1971:#36) made on a "cream chert" with "light rust flecks" may be either Collingwood or white Haldimand chert (see Eley and von Bitter 1979) and was found in Ancaster. Fully fluted on both faces and basally ground, it shows distinctive basal ears and Barnes basal finishing. A second fluted point, known only to come from either Ancaster or Onondaga township (Garrad 1971:#35), is made on Onondaga chert and has short flutes (just under half the length of the point on one face and less than a third on the opposite face). This specimen has a markedly concave base and is strongly parallel-sided below the resharpened tip area. In most respects it is comparable to a Gainey point (see Deller and Ellis 1992), with resharpening giving it a Dalton-like appearance.

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Table 1. Measurements of Ancaster-area Paleoindian points.

Type	Site	Length	Width	Thickness	Weight (g)	B.W.	F.L.	F.W.
Gainey	Garrad 1971: #35	70▪	26▪	na	na	na	33▪	11▪
Gainey	Meadowbrook South	50.0▪	(23.5)	6.2	8.00	23.5	21.4▪	6.7
Gainey (unfluted)	Seager	52.3	23.3	7.2	9.18	20.6	-	-
Barnes	Garrad 1971: #36	30▪	24▪	na	na	na	32▪	10▪
Barnes	Rattlesnake Point	36.2	20.2	5.0	4.2	17.5▪	21.3	12.7
Holcombe	Garrad 1971: #37	57▪	27▪	na	na	na	19▪	14▪

note: ▪indicates closest estimated measurement
na denotes measurement not available

Finally, a late Paleoindian unfluted Holcombe lanceolate point is made on gray Onondaga chert (Garrad 1971:#37). This latter point, collected by Edward J. Wahla "near Ancaster," compares very well with the Holcombe site material from Michigan.

Three new finds expand the Paleoindian record for the southern Niagara Escarpment (Figure 1). An unfluted lanceolate surface collected by Stewart Leslie from the Seager site (AhHa-10), in the town of Ancaster, is made on white Haldimand chert, has a markedly concave base with partially broken basal ears and ground basal edges, and is parallel-sided like a Gainey point (Deller and Ellis 1992). The point is probably too thick towards the base to carry a flute, and Haldimand chert is a poor material for most kinds of flaking (D. Morrison 1999: pers. comm.). Bamforth (1991) has noted that up to 30 percent of points recovered from Folsom sites in the Plains are in fact unfluted. The Seager point may well be an example of an unfluted Gainey-type point. A heavily reworked Gainey fluted point was recovered in 1997 from salvage excavations by Northeastern Archaeological Associates at the Meadowbrook South site (AhHa-22) in the town of Ancaster. Made on Onondaga chert, it has two short narrow flutes on one face; burin-like truncations along both basal edges have removed the basal ears. Finally, a small reworked Barnes point was recovered by Mel Brown from near Rattlesnake Point, a promontory of the Niagara Escarpment adjacent to the Milton Gap. This specimen, made on Onondaga chert, is fully fluted on one face with a long and broad flute on the opposing face, snapped basal ears, and light basal grinding. It also fits very well within the published range of measurements for Barnes points in Ontario (see Deller and Ellis 1992). The Seager and Meadowbrook South sites, on top of the Niagara Escarpment, are beside springs that are tributaries of Big Creek and the Grand River. The Rattlesnake Point specimen is just below the Escarpment on relatively level ground near a small stream.

It is tempting to speculate that the early Paleoindian sites of the Hamilton area are directly tied to intercepting caribou (Jackson 1998; Sturdy 1975) moving across the top of the Escarpment, between the Grand River and Hamilton, that connects the rich lake plain areas of Lake Erie with the west end of Lake Ontario. Obviously, there is a substantial Paleoindian presence in the Hamilton-Ancaster area that has seen little systematic investigation.

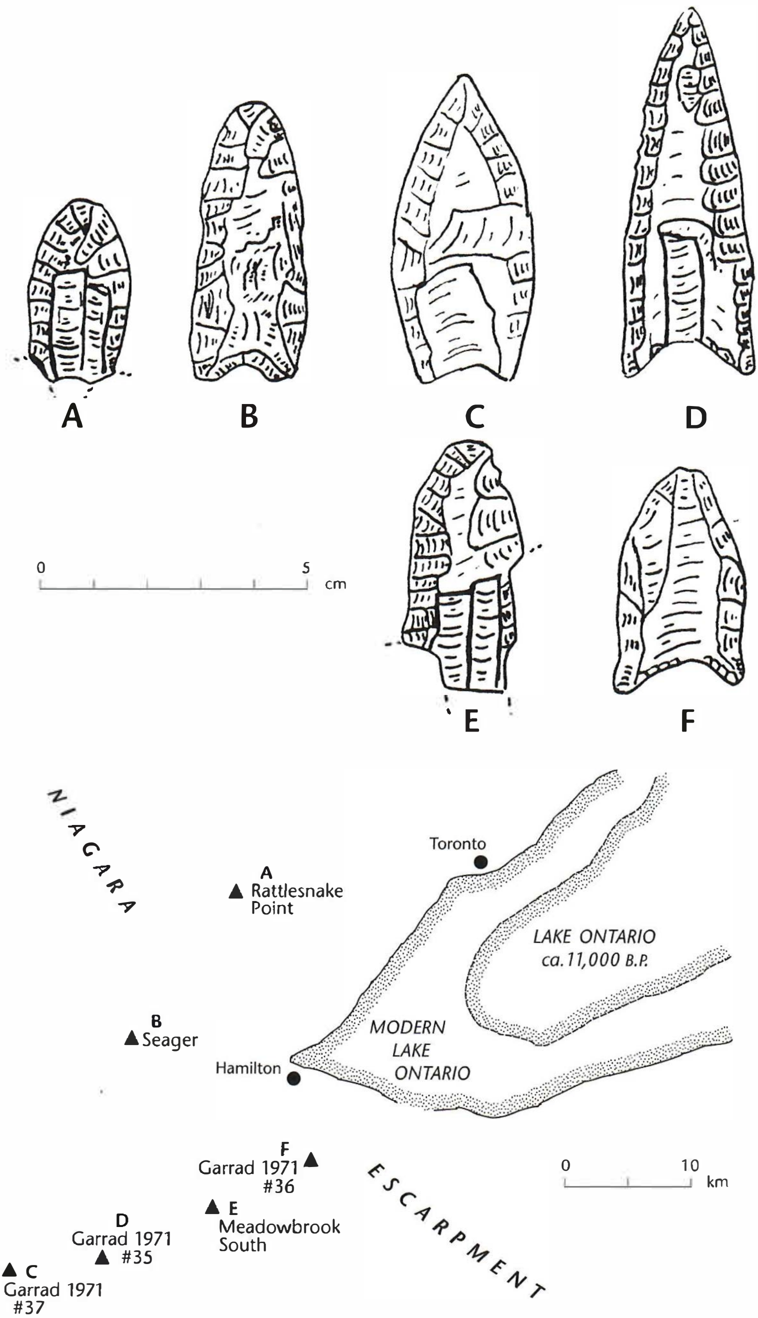

Figure 1. Paleoindian projectile points from southern Niagara Escarpment.

Many thanks to Charlie Garrad, Stew Leslie, and Bill Finlayson for specimens used in this study. Drawings are by L. Jackson.

References Cited

Bamforth, D. 1991 Flintknapping Skill, Communal Hunting, and Paleoindian Projectile Point Typology. *Plains Anthropologist,* 36(137):309–322.

Coleman, A. P. 1932 The Pleistocene of the Toronto Region. Forty-First Annual Report of the Ontario Department of Mines, Vol. 41, Part 7, pp. 1–55, Toronto.

Deller, D., and C. Ellis 1992 *Thedford II: A Paleoindian Site in the Ausable River Watershed of Southwestern Ontario.* Memoirs, Museum of Anthropology, University of Michigan, No. 24, Ann Arbor.

Garrad, C. 1971 Ontario Fluted Point Survey. *Ontario Archaeology,* 16:3–18.

Eley, B., and P. von Bitter 1979 *Cherts of Southern Ontario.* Royal Ontario Museum, Toronto.

Jackson, L. 1998 *The Sandy Ridge and Halstead Paleoindian Sites: Unifacial Tool Use and Gainey Phase Definition in South-Central Ontario.* Memoirs, Museum of Anthropology, University of Michigan, No. 32, Ann Arbor

Sturdy, D. A. 1975 The Exploitation Patterns of a Modern Reindeer Economy in West Greenland. *Papers in Economic Prehistory,* E. S. Higgs, editor, pp. 161–168, Cambridge.

Clovis at Hell Gap?

Marcel Kornfeld

The Hell Gap site at the western edge of the High Plains is significant because of its continuous chronostratigraphic sequence of Pleistocene/Holocene transition sediments associated with Paleoindian complexes (Haynes et al. 1965; Irwin-Williams et al. 1973). The issue of Clovis presence at the Hell Gap site, however, has been debated since the discovery of artifacts below the Folsom component at Locality I of the site (e.g., Frison 1991; Irwin 1971; Irwin and Wormington 1970; Irwin et al. 1973; Irwin-Williams et al. 1973; Sellet 1999). The purpose of this paper is to present recently discovered evidence, a biface, from the original collection that supports the presence of a Clovis component at the site (Figure 1).

Specimen number UWI-477 is an overshot medium to large biface (length = 43.2 mm, width = 43.9 mm, maximum thickness = 12.0 mm). The minimum thickness, measured in the fluted area of the biface, is 9.9 mm, indicating that the removed "channel flake" was at least 2.4 mm thick. The removed flute averages 23.4 mm in width or somewhat greater than half of the biface width. The edge angles around the perimeter of the biface range from 40°–56°, with the angle at the proximal end (at the flute initiation) of 55°. The raw material of this specimen is the same as the majority of Hell Gap

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chipped-stone artifacts, the Pennsylvanian, Hartville Formation Chert, ubiquitous in the region (Love and Christiansen 1985).

The biface edges have been regularized from both sides, although small portions of cortex and original flake scar remain (the upper right of the fluted face in Figure 1). The size of the flake scars suggests that both indirect percussion and pressure flaking were employed in the shaping process, although the latter is a minor component. Grinding of edges for platform preparation is evident on both sides. The proximal (base) end of the biface indicates shaping to isolate the platform for the channel flake removal. The fluting attempt resulted in an *outre passe* break.

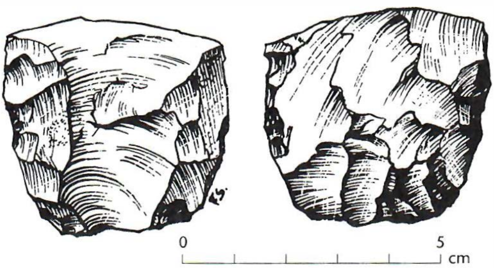

Figure 1. Overshot biface from the lowest cultural stratum of the Hell Gap site.

Specimen UWI-477 is a stage 3 biface (Callahan 1979). Fluting usually occurs at a later stage but can occur at any time given the proper characteristics of the preform. In North America fluting occurs on either Clovis or Folsom preforms. Folsom preforms and the Hell Gap specimen compares favorably with many documented Clovis fluting failures (e.g., Sanders 1990: 88–89, 101; Witthoft 1952: Plate 2 No. 7).

Hell Gap site field notes indicate that UWI-477 was recovered on the last day of the 1965 field season from a trench wall at Locality I adjacent to and within excavation unit V-5, 9′ 11″ below datum. Based on field notes at the time of recovery, UWI-477 was attributed to the Folsom component. Later, however, its stratigraphic position was reevaluated and assigned to the Clovis component and the specimen was typologically classified as a Goshen variant (Irwin et al. 1968).

To conclude, the fluted biface, specimen number UWI-477, is typologically most similar to Clovis preforms fluted on one face and resulting in an *outre passe* failure. The specimen was recovered from Clovis-age deposits and in a stratigraphic position where Clovis cultural material should occur. Further investigations at the site and with the artifacts associated with this specimen are planned to conclusively demonstrate Clovis presence at the Hell Gap site.

I thank George C. Frison, Frederic Sellet, C. Vance Haynes, and Mary Lou Larson for assistance in completing this paper.

References Cited

Callahan, E. 1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flintknappers and Lithic Analysts. *Archaeology of Eastern North America* 7(1):1–180.

Frison, G. C. (editor) 1991 *Prehistoric Hunters of the High Plains*, second edition. Academic Press, San Diego.

Haynes, C. V. 1965 The Hell Gap Site. *VII INQUA Congress, Field Conference E Guide Book*. University of Colorado Press, Boulder.

Irwin, H. T., C. Irwin-Williams, and G. A. Agogino 1968 Archeological Investigations at the Hell Gap Site, Near Guernsey, Wyoming. *National Geographic Research Reports 1963*.

——— 1973 Archeological Investigations at the Hell Gap Site, Guernsey, Wyoming, 1966. *National Geographic Research Reports 1966*.

Irwin, H. T., and H. M. Wormington 1970 Paleo-Indian Tool Types in the Great Plains. *American Antiquity*, 35(1):24–34.

Irwin-Williams, C., H. Irwin, G. Agogino, and C. V. Haynes 1973 Hell Gap: Paleo-Indian Occupation on the High Plains. *Plains Anthropologist*, 18(59):40–53.

Love, J. D., and A. C. Christiansen 1985 *Geologic map of Wyoming*. U.S. Geological Survey.

Sanders, T. N. 1990 *Adams: The Manufacturing of Flaked Stone Tools at a Paleoindian Site in Western Kentucky*. Parsimmon Press Monographs in Archaeology, Buffalo, N.Y.

Sellet, F. 1999 A Dynamic View of Paleoindian Assemblages at the Hell Gap Site, Wyoming: Reconstructing Lithic Technological Systems. Unpublished Ph.D. dissertation, Department of Anthropology, Southern Methodist University.

Witthoft, J. 1952 A Paleo-Indian Site in Eastern Pennsylvania: An Early Hunting Culture. *Proceedings of the American Philosophical Society*, 96(4):464–495.

Recent Fieldwork at the Nall Site (34CI134): A Large Late-Paleoindian Campsite in the Oklahoma Panhandle

Jason M. LaBelle

The Nall site (34CI134) is located several kilometers south of the Beaver River in Cimarron County, Oklahoma. It is situated along the northwestern margin of a large playa and consists of two upland blowouts recorded by William Baker between 1931 and 1956. Baker collected 402 projectile points and fragments, mostly either Plainview or Allen/Frederick types, 146 end scrapers, and a variety of other tool forms including gravers and heavily resharpened "drills" from the two localities (Baker et al. 1957). Preliminary analysis of the extant collection has been presented elsewhere (LaBelle 1998). Briefly, those analyses indicate that Nall is very different from other known late-Paleoindian sites. It is one of the largest late-Paleoindian campsites in terms of the sheer amount of recovered tools and the diversity of tool forms. The majority of the tools are made on local raw materials (quartzites, basalt, and petrified woods) or on Alibates agate, which is available 120 km to

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the southeast (Holliday 1997; Saunders and Saunders 1982). However, distant raw materials are also present, including Edwards chert, Niobrara jasper, Flattop chalcedony, obsidian, and quartz crystal (probably from southwestern Oklahoma). Finally, it is likely that a number of diverse activities took place at the Nall locales and vicinity, possibly including a kill (or kills), processing areas, and tool replacement in campsite areas.

In order to provide an archaeological context to the Baker collection and to see if any of the site still remained, fieldwork was initiated there in 1998. The initial goals were to relocate the two localities collected by Baker, conduct geological work, and test for in situ archaeological materials. Results of fieldwork conducted at the northern of the two localities are discussed below (the majority of the Baker collection is from this locality).

Surface survey delimited a scattering of flakes within an area of 225 x 110 m. The flakes were found along the edges of the blowout, in several concentrations. In all, 97 artifacts were recorded from the surface, including two scrapers of Alibates agate and a biface tip of Tesesquite quartzite. It should be noted that Baker tended to collect only tools on his visits to the site. He observed "thousands of flint flakes" (Baker et al. 1957:15), but these were rarely collected, and only if they were judged to be eroding from intact "Pleistocene" deposits (Baker n.d.).

We took 12 Giddings sediment cores and described six profiles from the northern locality and immediate vicinity. Profile #4 was sampled for radiocarbon dating and paleoenvironmental reconstruction. In this profile, Holocene sands covered a dark reddish brown, sandy loam paleosol 30 to 50 cm thick, which we named the Baker paleosol, since it appeared to match the "Pleistocene" unit from which Baker recovered his Paleoindian material (Baker n.d.).

We recovered a projectile point base from the lower portion of this paleosol. The base, made of Alibates flint, has several parallel-oblique flake scars and might be an Allen/Frederick point or perhaps a Plainview point. Bulk organics from the lower portion of the paleosol dated to 7,740 ± 80 yr B.P. (Beta-121880). A 10-cm-thick lens of reddish brown medium sand separated the paleosol from underlying black to dark olive-gray clays. The clay was approximately 25 cm thick; the upper portion dated to 9,640 ± 110 yr B.P. (Beta-121881), the lower portion to 9,650 ± 100 yr B.P. (Beta-125446).

Seven test units of 1x1 m were excavated. Four units were placed amidst a concentration of flakes eroding from a presumably late-Holocene dune, one was placed in a concentration of bone, and the remaining two were adjacent to Profile #4 (described above). In all, 69 flakes were recovered from the 7 test units.

The two units adjacent to Profile #4 are of particular interest. Bison-sized bone, some of it burned, was recovered within the lower portion of the Baker paleosol, as well as 53 small flakes (predominantly resharpening), of Alibates and various local quartzites. The raw materials in the excavated sample are very similar to the dominant toolstones represented in the Baker Paleoindian collection. The bone and flakes were concentrated within a lens approximately 15 cm thick. Bison-sized bone was also recovered 55 m to the north, at nearly the same absolute elevation and at the same relative position within the paleosol. No artifacts were associated with this bone, however.

Coring of sediments adjacent to the eroded area confirms that the artifact-bearing paleosol extends laterally from the blowout in several directions. Thus, the potential for locating additional early-Holocene buried surfaces is very high. Future excavations are planned for both localities. In addition, we will also be recording local collections, some of which are known to include artifacts from the Nall site.

I wish to extend thanks to the site owner and tenant for their kind hospitality in letting us "revisit" the Nall site. Many thanks to Ken Turner, of the No Man's Land Historical Society, for access to "Uncle Bill" Baker's notes and the Nall collection, and thanks also to Tony Baker for many fine conversations about his proud grandfather. Vance Holliday, Jemuel Ripley, and David Meltzer put in the long hours working on site geology, and the Nall crew deserve special thanks for their hard labor in the dusty winds. This note benefited from the comments of Michael Bever, David Meltzer, John Seebach, and Pei-Lin Yu. Fieldwork and analysis was funded by the Quest Archaeological Research Fund, and seed grants from the Institute for the Study of Earth and Man and the Southwest Studies program at Southern Methodist University.

References Cited

Baker, W. E. n.d. Unpublished fieldbooks and notes. Ms. on file at the No Man's Land Historical Museum, Goodwell, Oklahoma.

Baker, W. E., T. N. Campbell, and G. L. Evans 1957 The Nall Site: Evidence of Early Man in the Oklahoma Panhandle. *Bulletin of the Oklahoma Anthropological Society*, 5:1–20.

Holliday, V. T. 1997 *Paleoindian Geoarchaeology of the Southern High Plains.* University of Texas Press, Austin.

LaBelle, J. M. 1998 Panhandle Paleoindians: New Data from the W. E. Baker Collection. Paper presented at the 63rd Society for American Archaeology meetings, Seattle, Washington.

Saunders, R. S., and K. E. Saunders 1982 Distribution and Density Patterns of Lithic Materials in Cimarron County, Oklahoma. In *Pathways to Plains Prehistory: Anthropological Perspectives of Plains Natives and Their Pasts,* edited by D. G. Wyckoff and J. L. Hofman, pp. 99–110. Oklahoma Anthropological Society Memoir 3.

Early-Holocene Cultural Sequence in the Central Sierra of California

Roger Marks La Jeunesse and John Howard Pryor

There are only two well-documented early-Holocene sites in the central Sierra of California, Skyrocket (CA-Cal-629/630) and Clarks Flat (CA-Cal-S-342), separated by approximately 25 miles. The Skyrocket site is situated on Littlejohns Creek, 40 miles east of Stockton, and Clarks Flat is located on the upper reaches of the Stanislaus River, about 10 miles from Sonora.

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While researchers at the Clarks Flat report a substantial assemblage associated with the Western Pluvial Lakes Tradition, their ^{14}C and obsidian hydration data strongly suggest that the geological strata from which these materials were recovered were mixed (Moratto n.d.:10; Peak and Crew 1990:217–220).

Our objective in this communication is to redefine the temporal placement of the Clarks Flat assemblage by comparing it with the early-Holocene materials from Skyrocket, which were recovered in *sealed* strata. By this temporal "redefinition" we hope to achieve a clearer view of the early-Holocene phases and associated cultural assemblages for the central Sierra of California.

From the materials recovered at Clarks Flat, Peak and Crew (1990) proposed three cultural phases based on the distribution of artifacts within three geologic "spits." The oldest of these was dated to 9,570 ± 150 yr B.P. (Beta-15536). The authors, however, further report that the variation in radiocarbon years *within* each "spit" is nearly greater than the variation *between*, strongly suggesting that these deposits have been mixed, making stratigraphic integrity questionable. Also, their obsidian hydration results were equally confusing, leading the authors to claim that they bore no correspondence to the ^{14}C data (Peak and Crew 1990:220). The following treatment of Clarks Flat ignores the "spits" proposed by Peak and Crew (1990) and instead focuses on the collection as a whole.

The early-Holocene materials at Skyrocket have been discussed elsewhere (La Jeunesse and Pryor, 1998; n.d.). Dated between 9,400 and 7,000 yr B.P., the deposits are the remains of a buried marsh (Component 8), topped by an Altithermal alluvium (Nials pers. comm. 1995), dating between 7,000 and 5,000 yr B.P. and referred to by us as Components 7/6. Skyrocket Component 8 is well represented by materials recovered from a large rock platform measuring 10 x 10 x 0.5 m. Further refinement of this component revealed two distinct subunits. The oldest one dates from 9,410 ± 250 (WSU 4929) to 8,550 150 yr B.P. (WSU 4614), while the more recent one dates from 8,550 ± 150 (WSU 4614) to 7,000 ± 70 yr B.P. (WSU 4616).

To establish comparability between Skyrocket and Clarks Flat collections, we "retyped" the bifaces, unifaces, and groundstone from the latter, taking measurements where necessary and employing criteria used to describe the artifacts from the Skyrocket site (La Jeunesse and Pryor, n.d.). The artifact types from the Clarks Flat site are consistently more similar to the ones from the upper portions of Component 8 at Skyrocket rather than either Component 7/6 or the lower portions of Component 8 (La Jeunesse and Pryor, n.d.:61–78). Another significant point is the fact that Clarks Flat collection has relatively few stemmed lanceolate points that are characteristic of the oldest Skyrocket assemblage (Bieling et al. 1996:4–6), while at the same time possessing a large number of Stanislaus Broad-stemmed (SSBs) points (cf. Pinto Series). This suggests that the oldest Clarks Flat assemblage dates between 8,500 and 7,000 yr B.P., rather than the 9,600 yr B.P. date proposed by Peak and Crew (1990:219).

The temporal redefinition of the oldest Clarks Flat assemblage and its

Table 1. Central Sierran early-Holocene phases.

Time (yr B.P.)	Material	Phase	Assemblage[a]
5,000–7,000	Skyrocket Comps. 7/6	late Stanislaus	SSBs; lanceolates; Teardrops; large Teardrops (A); thin milling slabs with oval basins; side scrapers
7,000–8,500	Skyrocket Upper Comp. 8 (oldest component found at Clarks Flat)	early Stanislaus	SSBs; Lake Mojave series; lanceolates; small long-necks; thicker milling slabs and cobble handstones; keeled concave scrapers; unifacial core tools
8,500–9,600	Skyrocket Lower Comp. 8	Clarks Flat	Slightly shouldered lanceolates; large Teardrops (A/B); Teardrops; lanceolates; large stone platform; thin milling slabs with oval basins; shaped handstones; atlatl weights; keeled, concave, discoidal, unifacial core tools

[a]note: All the bifaces and unifaces described here are defined in the Skyrocket Report (La Jeunesse and Pryor, n.d.). SSB refers to the Stanislaus Broad Stemmed biface, thought by Peak and Crew (1990:226) to represent a Pinto variant from the central Sierra of California. Large Teardrop bifaces are distinguished by the lowest thickness-to-width ratio (1:5) of any of the Skyrocket points. They are teardrop in shape and widest near their base. Designations A and B are determined by their widths. Implements smaller than 50 mm were classified as subtype A; larger ones were placed in subtype B.

inclusion with the Skyrocket materials provides a new interpretation of early-Holocene cultural phases in the central Sierra. Table 1 lists the dates, components, phases, and diagnostic characteristics of these assemblages. We believe this interpretation will assist our understanding of the early-Holocene prehistory of this region.

References Cited

Bieling, D. G., R. M. La Jeunesse, and J. H. Pryor 1996 Skyrocket, a Central Sierran Paleoindian Archaic Transition Site. *Current Research in the Pleistocene,* 13:4–6.

La Jeunesse, R. M., and J. H. Pryor 1998 Romer's Rule and the Paleoindian/Archaic Transition. *Current Research in the Pleistocene,* 15:29–32.

——— n.d. Skyrocket Report CA-Cal-629/630, Calaveras County, California. Prepared for FMC Gold Company, Meridian Minerals, Copperopolis, California.

Moratto, M. J. n.d. Cultural History of the New Melones Reservoir Area, Calaveras and Tuolumne Counties, California.

Nials, F. 1995 Personal Communication.

Peak, A. S., and H. L. Crew 1990 An Archaeological Data Recovery Project at CA-CA:-S-342, Clarks Flat, Calaveras County, California. Cultural Resource Studies, North Fork Stanislaus River Hydroelectric Development Project, Northern California Power Agency.

David Wenner's Documentation of Fluted Points in the Chicago Region

Thomas J. Loebel

Since Stoltman and Workman's (1969) study of fluted point distributions in southeastern Wisconsin, there has been little systematic research effort geared towards early Paleoindian archaeology in the western Lake Michigan basin. Although dozens of isolated fluted point finds have been reported and several new sites are known, the lack of a regional synthesis of this information has hampered efforts to understand the larger patterns of behavior of Clovis-related groups in this area.

In response, an effort to document and synthesize new and existing information concerning Paleoindian occupations of this area is being made (Hill et al. 1998). This paper reports the results of archival research on the fluted point data collected by the late David Wenner in the Chicago region. Throughout the 1950s, Wenner, an avocational archaeologist and early member of the Illinois Archaeological Survey (I.A.S.), documented and reported many sites and private collections, mainly in Will, DuPage, and Cook Counties, and photographed and measured many fluted points contained in these collections. Most of these collections came from long-held family-owned farms, gathered by farmers who over the years often amassed substantial amounts of artifacts. After Wenner's death, his notes and photographs were curated at Northwestern University.

Contained within Wenner's files were data and color slides of many fluted points documented in the private collections he recorded. Slides and information on at least 16 fluted points were available for study. Of these, 11 (10 complete, 1 broken) were depicted by color slides. These early private collections were usually biased towards larger and complete artifacts, a bias possibly reflected in the number of complete versus broken fluted points documented. No preforms were recorded. Because preforms are usually broken and discarded during manufacture, they were probably overlooked by many collectors or were not recognized as such by Wenner. Wenner took detailed notes and measurements on each of the points he recorded. Unfortunately these individual artifact documents have been lost. However, it was possible to relate many of the points with specific sites or areas based on other notes and outline drawings made by Wenner and through publications by other area avocationals (Gates 1961) and by cross-checking these with I.A.S. site files.

Raw-material determinations were attempted for fluted bifaces depicted by color slides. Because Wenner placed a scale in each slide for reference, it was possible to reconstruct some measurements for each depicted artifact. Northeast Illinois can be characterized as "resource poor" in terms of both availability and quality of toolstone. This is reflected in the dominance of non-local raw-

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material determinations made on the 11 fluted points depicted by color slide. Of these, two are manufactured of Moline chert, which outcrops near the confluence of the Rock and Mississippi rivers about 200 km to the west (Birmingham and Van Dyke 1981); two are made of Oneota chert from the Starved Rock area of the confluence of the Fox and Illinois rivers 110 km southwest (Ferguson and Warren 1992); four are tentatively identified as Burlington cherts, the closest outcrops of which occur in Knox County, Illinois, approximately 245 km southwest; one is made of Hixton silicified sandstone from the Silver Mound quarries located in Jackson County, Wisconsin, over 400 km northwest (Hill 1994); two are manufactured of unknown materials. Distance to source is also reflected in degree of resharpening, since two of the Burlington and one of the Moline points show extensive reworking. The two points made of Oneota chert, a more regionally available toolstone, are larger (73 and 130 mm long) and display little signs of reworking. The larger of these two fluted points displays *outre passé* biface thinning technique. However, most of the points depicted appear to be typologically similar to those described for the Gainey Complex, a Great Lakes–area Clovis variant (Simons et al. 1984).

The movement of Moline, Burlington, Oneota, and Hixton materials corresponds well with the major river systems of the area. It may be that these patterns of stone movement indicate that there are many local and regional patterns of mobility developing, possibly in relation to seasonal movements, such as described by Stork in the Ontario area (Stork and VonBitter 1989).

The value of David Wenner's efforts in recording and documenting fluted points in Chicago area private collections lies in the preservation of a record that is often lost or dispersed and cannot be relocated. His data make a valuable contribution towards the compilation and synthesis of a diffuse and scattered record that is rapidly disappearing. His work is proof of the contribution that avocational archaeologists can make.

These data would not be available without the foresight of the late David Wenner. Thanks also go to Jim Brown at Northwestern University for his help in tracking down Wenner's notes and slides curated there.

References Cited

Birmingham, R. A., and A. P. Van Dyke 1981 Chert and Chert Resources in the Lower Rock River Valley–Illinois. *The Wisconsin Archaeologist,* 62(3):347–360.

Ferguson, J. A., and R. E. Warren 1992 Chert Resources of Northern Illinois: Discriminant Analysis and an Identification Key. *Illinois Archaeology,* 4(1):1–37.

Gates, S. 1961 An Archaeological Survey of the DuPage River Drainage. In *Chicago Area Archaeology,* Elaine A. Bluhm, editor, pp. 1–6. Urbana: Illinois Archaeological Survey Bulletin 3.

Hill, M. G. 1994 Paleoindian Projectile Points from the Vicinity of Silver Mound (47JA21), Jackson County, Wisconsin. *Midcontinental Journal of Archaeology,* 19(2):223–259.

Hill, M. G., D. S. Amick, and T. J. Loebel 1998 An Inventory of Wisconsin Paleoindian Points at the Milwaukee Public Museum. *Current Research in the Pleistocene,* 15:18–20.

Simons, D. B., M. J. Shott, and H. T. Wright, Jr. 1984 The Gainey Site: Variability in a Great Lakes Paleoindian Assemblage. *Archeology of Eastern North America,* 12:266–270.

Stoltman, J., and K. Workman 1969 A Preliminary Study of Wisconsin Fluted Points. *Wisconsin Archeologist,* 50(4) 189–214.

Stork, P. L., and J. Tomenchuk 1990 An Early Paleoindian Cache of Informal Tools at the Udora Site, Ontario. In *Early Paleoindian Economies in Eastern North America*, edited by K. Tankersley and B. Isaac, pp. 45–93. Research in Economic Anthropology, Supplement 5. JAI Press, Greenwich, CT.

1998 Excavations at the Folsom-type Site (29CX1), New Mexico

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The 1998 investigations at the Folsom site (New Mexico) took place primarily on the western side of the locality (to the west of and adjacent to the 1928 excavations) and covered ca. 15m^2 in two non-contiguous blocks. Nearly 200 *Bison antiquus* skeletal elements were recovered, including two virtually complete crania, a series of mandibles, and many parts of the axial skeleton, including vertebrae, ribs, innominates, and a considerable number of metatarsals, metacarpals, and phalanges. Only a few limb bones were recovered.

The bones proved to be very well preserved (both crania possessed intact horn cores and were complete to their incisives) with little evidence of weathering, but with a moderate amount of root etching. The condition suggests the bone was exposed on the surface only briefly prior to burial and that post-depositional and post-burial transport, if it occurred, was limited in distance and the size of elements involved. The crania may have served as obstacles around which smaller, more mobile skeletal elements collected.

The geologic history of the site helps explain the bone preservation. The bone bed is in upper Unit *f2* (Meltzer et al. 1998), one of several deposits that accumulated in a paleo-arroyo cut into the local shale bedrock. Unit *f2* appears dominantly aeolian in origin. It is a calcareous, light yellowish brown (2.5YR 6/4) silt loam devoid of coarse clastics or other evidence for bedding (except for several widely separated lenses of shale gravel) and identical in physical characteristics to loess. Loess has not yet been identified in the region, but would not be out of place given the proximity of the site to glacial and periglacial processes in the southern Rocky Mountains during the late Pleistocene. The surface on which the bison were killed is not detectable, implying *f2* deposition continued uninterrupted through Folsom time, blanketing the bones soon after the carcasses were deposited. Following *f2* deposition, a 10- to 30-cm lens of imbricated shale gravel washed off the nearby bedrock walls and across the top of the silt. That gravel formed an armor that effectively protected the bones despite subsequent erosion.

Disarticulation of the Folsom bison was extensive: there were only a few

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instances—couplets and triplets of vertebrae, for example—of articulated elements. Cut marks are visible on some elements already examined—one mandible has a series of diagonal marks near the symphysis that suggests tongue removal. Burning or charring was rare. Investigations are underway to evaluate the nature of bone surface conditions, particularly root etching, and the preservation of evidence of butchery.

A comparison of the number of identified specimens (NISP) from the American Museum of Natural History's (AMNH) 1928 excavations (data from Todd and Hofman, in press) and our own demonstrates that the two assemblages are, in fact, highly similar. The only significant differences are in sample size (the AMNH sample is from a much larger excavation area and produced a faunal sample some five times larger) and perhaps in degree of fragmentation. We recovered more complete elements, which may reflect the more destructive nature of the 1928 excavations rather than any taphonomic differences in the two excavation areas.

Combining the AMNH sample with our own, as seems statistically appropriate, gives a fuller picture of the assemblage. The most abundant faunal elements are generally parts that yield little meat and are discarded in butchering. A plot of NISP against bone utility shows that the Folsom faunal assemblage, with the exception of a few highly fragmented outliers (ribs), neatly fits a generalized low-utility curve. Lyman (1985) and others caution that such curves may also reflect differential preservation of high density elements. To test this, NISP and (separately) whole element counts were plotted against bison bone density values (from Kreutzer 1992). The statistical results show no correlation between the two: specimen and element abundance varied independently of bone density (a conclusion not unexpected, given the excellent preservation of fragile bone elements).

Accordingly, the Folsom faunal assemblage appears composed of low-utility parts, having been stripped of the high-yield elements. Processing evidently took place across the site, and there were no spatially discrete butchering, processing, or discard areas, at least none detectable yet.

So far, no butchering tools have emerged in our excavations, but very tiny flakes from use or re-sharpening—presumably produced by the butchering process—were recovered in the water screening. The absence of tools may simply be a function of the size of the excavation area, and more fieldwork—especially if we locate an associated camp—may ultimately yield more artifacts (and perhaps more of the high-utility bone elements). However, Hofman (in press) recently argued tools *ought to be rare* at this site, on the assumption that the relatively dispersed carcasses and cool weather at the time of the kill permitted more thorough processing and greater recovery of tools by the hunters.

Additional work is planned at the site.

Research at the Folsom site involved the help and collaboration of many colleagues and crew, and we are grateful to all. The 1998 work at the site took place under permit from the State of New Mexico, and we thank Dan Reiley for his help in that process. For their gracious hospitality and much appreciated logistical support, we are most grateful to Leo and Wende Quintanilla, and Fred Owensby and family. This work was supported by the Quest Archaeological Research Fund with additional support from the Potts and Sibley Foundation.

References Cited

Hofman, J. in press Folsom Fragments, Site Types, and Assemblage Formation. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. Amick. International Monographs in Prehistory, Ann Arbor.

Kreutzer, L. 1992 Bison and Deer Bone Mineral Densities: Comparisons and Implications for the Interpretation of Archaeological Faunas. *Journal of Archaeological Science*, 19:271–294.

Lyman, R. L. 1985 Bone Frequencies: Differential Transport, in situ Destruction, and the MGUI. *Journal of Archaeological Science* 12:221–236.

Meltzer, D. J., V. T. Holliday, and L. C. Todd 1998 Recent Field Research at the Folsom Site (29CX1), New Mexico. *Current Research in the Pleistocene* 15:42–44.

Todd, L., and J. Hofman in press Variation in Folsom Age Bison Assemblages: Implications for the Interpretation of Human Action. In *Folsom Archaeology*, edited by M. Jodry and D. Stanford. Smithsonian Institution Press, Washington, D.C.

Popular Misconceptions Concerning the Calico Site

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After a conference held in 1970, many archaeologists rejected the Calico site in California for having only an assemblage of naturally broken rock. All opinions were subjective, with little discussion of the physical attributes of the specimens. Despite negative popular opinion, excavations have continued at the Calico site, resulting in a larger collection of lithic specimens. A popular conception of the Calico lithic assemblage is that specimens were produced by large-scale natural fracture of rock by causes such as landslides, tectonic stress, and thermal stress (Haynes 1973:307).

Many visitors have spent short periods examining a few of the Calico lithic specimens, then produced what Dillehay (1997:4) has termed "instant analysis" based on subjective opinion and generally without use of analytical criteria. A widely held perception of the Calico site is that lithic specimens were produced by a giant natural rock-crushing operation. In a 1999 television program entitled "The First Americans," David Meltzer stated that the Calico site has millions of pieces of broken rock. This is not correct.

In working with some of the Calico lithic assemblage, I have been impressed with the difference between this assemblage and the model that forms popular public perception. It is true that a very large number of rocks, predominantly chert, have been excavated at Calico. However, a high percentage of the rock pieces are not broken, but are covered with cortex and lack fracture scars. In the reject rock pile for Master Pit 2 at the Calico site, 97.2 percent of the rock pieces have no evidence of fracture (Patterson et al. 1987:99). What the Calico lithic assemblage really contains is several thousand percussion-made flakes and about an equal amount of lithic shatter, which is common when percussion flaking is being done by humans. Most

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intact flakes have well-defined bulbs of percussion and acute striking platform angles, attributes that are on percussion flakes that are artificial (Patterson et al. 1987). It should be noted that there are no published locations where large-scale percussion fracture of rock by natural forces has occurred. Most large-scale fracture of rock is done by pressure, without producing well-defined bulbs of percussion.

There are also many specimens in the Calico lithic assemblage that have all the attributes of artificial stone tools, such as scrapers, notched tools, and gravers (Simpson 1989; Simpson et al. 1986). Many very large flakes have edge damage diagnostic of chopping use that can be reproduced experimentally (Patterson 1982).

Contrary to popular opinion, specimens in the Calico lithic assemblage were not fractured at higher elevation and then transported to the site by fluvial action or landslides. The Calico site is in primary context. The flake size distribution shows no indication of resorting that would have occurred by fluvial action. The size distribution of Calico flakes is similar to that of flakes made experimentally by hard percussion from the same siliceous minerals found at Calico (Patterson et al. 1987:Figure 3). There is also little indication of edge rounding on flakes that would have been caused by natural transport.

In summary, a high proportion of specimens in the Calico lithic assemblage have all the attributes of artificial tools and debitage. The lithic manufacturing process is represented by both flakes and cores. A lithic assemblage like that at Calico can be adequately analyzed only by using the various criteria for human lithic manufacturing (Patterson 1983).

It should be noted that a major objection to the Calico site is no longer valid. It has been widely commented that early humans could not have been present at the Calico site at an age range of 100,000–200,000 years ago because only modern humans were cold-adapted to cross the severe environment of Siberia to the New World, and then only after about 40,000 years ago (Fagan 1987:71). Research by Russian archaeologists now shows the presence of lower and middle Paleolithic sites in Siberia well before modern man (Derev'anko 1998). Tobias (1995:5) has noted that the south coast of Beringia would have been surprisingly warm, with several time periods when early humans could have crossed the Bering Land Bridge from Northeast Asia to Alaska.

The Calico site has been used here to make two major points. One point is that research on very early human sites in the New World cannot be resolved by subjective voting contests and superficial analysis. The significance of the Calico site will be resolved only by rigorous study of physical attributes of lithic specimens, such as the type of data already presented (Patterson et al. 1987). The other point is that the analytical criteria for distinguishing human-made lithics from naturally broken rock are becoming increasingly important as research explores a greater time depth for early humans in the New World, such as the earliest lithic specimens at the Monte Verde site in Chile (Dillehay 1997:45,460) at over 30,000 yr B.P. More archaeologists should become familiar with the criteria for distinguishing attributes of human-made lithics (Patterson 1983).

References Cited

Fagan, B. M. 1987 *The Great Journey*. Thames and Hudson, New York.

Derev'anko, A. P. (ed.) 1998 *The Paleolithic of Siberia*. University of Illinois Press, Urbana.

Dillehay, T. D. 1997 *Monte Verde: A Late Pleistocene Settlement in Chile*, Vol. 2: The Archaeological Context and Interpretation. Smithsonian Institution Press, Washington.

Haynes, C. V. 1973 The Calico Site: Artifacts or Geofacts? *Science*, 181(4097):305–310.

Patterson, L. W. 1982 Experimental Edge Damage on Flint Chopping Tools. *Bulletin of the Texas Archaeological Society*, 53:175–183.

——— 1983 Criteria for Determining the Attributes of Man-Made Lithics. *Journal of Field Archaeology*, 10:297–307.

Patterson, L. W., L. V. Hoffman, R. M. Higginbotham, R. D. Simpson 1987 Analysis of Lithic Flakes at the Calico Site, California. *Journal of Field Archaeology*, 14:91–106.

Simpson, R. D. 1989 An Introduction to the Calico Early Man Site Lithic Assemblage. San Bernardino County Museum Association Quarterly 36(3).

Simpson, R. D, L. W. Patterson, and C. A. Singer 1986 Lithic Technology of the Calico Mountains Site, Southern California. In *New Evidence for the Pleistocene Peopling of the Americas*, edited by A. L. Bryan, Center for the Study of Early Man, Orono, Maine.

Tobias, P. V. 1995 A New Paradigm on the Peopling of the New World: Early Fall Thoughts on the Calico Mountains Archaeological Site. San Bernardino County Museum Association Quarterly 42(2):1–8.

Evidence of an Early- to Mid-Holocene Denali-Complex Occupation at the Campus Site, Central Alaska

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The Campus site is located on the southeastern tip of the University of Alaska Fairbanks Hill in Central Alaska. The site was discovered in the early 1930s and sporadically excavated until the 1970s (Rainey 1939; Aamodt et al. 1968; Mobley 1991). It contains a microblade industry characterized by small wedge-shaped microblade cores that provided the first archaeological evidence linking Native Americans to Asia (Nelson 1935, 1937). Until the advent of radiometric dating, these technological similarities led many archaeologists to believe that the Campus site was one of the oldest human occupations in the New World (Péwé 1975). The Campus site was subsequently included in West's (1967, 1975) Denali complex, which traces its roots to the Dyuktai culture of Siberia (West 1981).

The site was finally dated by Mobley (1991) using archived charcoal

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samples collected during a 1966–1967 salvage operation. A total of seven dates were measured ranging from modern to 3,500 ± 140 ^{14}C yr B.P. (Beta-6829, Mobley 1991:78). This suggested that the Campus site was a young Holocene occupation and a representative of the disputed late Denali complex (c. 3,500–1,500 ^{14}C yr B.P., Dixon 1985, Mobley 1996). However, reversals in the dating sequence and the presence of modern garbage found deep in some excavation units during the 1960s salvage project (Hosley and Mauger 1967:5; Mobley 1991:68) cast doubts on the integrity of the deposits in the site and the validity of these dates. Therefore the Campus site was re-excavated in order to provide answers to persisting questions regarding the number, age, and cultural affiliation of its cultural components.

Thirteen new units were excavated varying in size from 1 to 2 m^2. Three spatial zones, characterized by different degrees of stratigraphic integrity, were identified and delimited. These zones correspond to radiating waves of disturbance emanating from a road adjacent the site. The area of greatest perturbation is also the highest in elevation and was designated as the Upper Zone. This was followed by an intermediate Middle Zone and finally by a undisturbed Lower Zone farthest from the road towards the edge of the Campus Hill bluff top.

Given that the disturbance observed in the Upper and Middle Zones resulted from a combination of deep anthropogenic perturbation combined with redeposition of mixed sediments, it was important to "date" these events. This is crucial because if they occurred before the 1966–1967 excavations, it might explain the dating reversals observed by Mobley (1991).

Close examination of the side walls of the 1960s excavation units located in the disturbed areas revealed that the salvage operation had, in fact, dug through the mixed sediments. This indicated that the disturbance in the Upper and Middle Zones had occurred before the salvage work. Moreover, we observed that the often cited date of 3,500 ^{14}C yr B.P. was measured from charcoal collected in a disturbed excavation unit located in the Upper Zone (Mobley 1991:79). Archival research confirmed that a major part of the site was destroyed in the late 1950s during the development of the University Campus. Hence, radiocarbon dates derived from charcoal samples collected in the area closest to the road must be interpreted with caution.

A new AMS date of 6,850 ± 70 ^{14}C yr B.P. (Beta-97212) was obtained from charcoal recovered in the Lower Zone, 15 cm below surface, just above the interface between the Bw and B/C horizons. This sample was associated with microblades, a wedge-shaped microblade core, and a microblade core rejuvenation tablet. Both chronometric and stratigraphic data from the undisturbed section of the Campus site indicate an early- to mid-Holocene age for the microblade occupation. We believe there is no compelling evidence for either a late-Pleistocene nor a late-Holocene Denali-complex component at the site. This agrees with Mason et al. (n.d.) who, after calibrating 67 radiocarbon dates, found that Denali occupations peaked in the Alaskan interior 8,500–8,000 cal yr B.P. during the Mesoglacial (Beget 1983) climatic reversal. This period is marked by a decline in spruce, suggesting that Denali hunters may have been following caribou herds.

Although the cultural origin of the charcoal sample dated 6,850 ^{14}C years old remains to be demonstrated, its age is supported by other dated microblade components in similar stratigraphic positions in the Tanana Valley such as Chugwater (Lively 1988), Healy Lake (Cook 1996), Broken Mammoth (Dilley 1998, Holmes 1996), Swan Point (Holmes et al. 1996), and Mead (Yesner 1996), including several dated geological sections in the interior (DeMent 1962). Based on this evidence, we believe the new AMS assay of 6,850 ^{14}C years old to be a reliable date, both as a chronological indicator for the age of the Campus site deposits and its microblade industry.

We are indebted to the following persons and institutions for their assistance and collaboration throughout the project: Charles M. Mobley, Charles E. Holmes, John P. Cook, Michael A. Lewis, Tara A. Keels, Daryl E. Ferguson, Brian Davis, Donald W. Clark, the University of Alaska–Fairbanks Summer Sessions, the University of Alaska Museum, and the Canadian Museum of Civilization. However, the authors alone are responsible for the opinions expressed in this paper including errors and omissions.

Reference Cited

Aamodt, W., W. K. Hao, and K. Humphreys 1968 New Diggings from the University Slag Heap. *Denali, The University of Alaska Yearbook*, pp. 24–29. University of Alaska, Fairbanks.

Beget, J. E. 1983 Radiocarbon-dated Evidence of Worldwide Early Holocene Climate Change. *Geology*, 11:389–393.

Cook, J. P. 1996 Healy Lake. In *American Beginnings*, edited by F. H. West, pp. 323–327. University of Chicago Press, Chicago.

DeMent, J. A. 1962 The Morphology and Genesis of the Subarctic Brown Forest Soils of Central Alaska. Ph.D. dissertation, Cornell University.

Dilley, T. E. 1998 *Late Quaternary Loess Stratigraphy, Soils, and Environment of the Shaw Creek Flats Paleoindian Sites, Tanana Valley, Alaska.* Ph.D. dissertation, Department of Geosciences, University of Arizona.

Dixon, J. E. 1985 Cultural Chronology of Central Interior Alaska. *Arctic Anthropology*, 22(1):47–66.

Holmes, C. E. 1996 Broken Mammoth. In *American Beginnings*, edited by F. H. West, pp. 312–318. University of Chicago Press, Chicago.

Holmes, C. E., R. VanderHoek, and T. E. Dilley 1996 Swan Point. In *American Beginnings*, edited by F. H. West, pp. 319–333. University of Chicago Press, Chicago.

Hosley, E., and J. Mauger 1967 The Campus Site Excavations. Paper presented at the 32nd Annual Meeting of the Society for American Archaeology in 1966, Ann Arbor, Michigan.

Lively, R. A. 1988 A Study of the Effectiveness of a Small Scale Probabilistic Sampling Design at an Interior Alaska Site, Chugwater (FAI-035). U.S. Army Corps of Engineers Report. Anchorage.

Mason, O. K., P. M. Bowers, and D. M. Hopkins n.d. The Early Holocene Milankovitch Thermal Maximum and Humans: Adverse Conditions for the Denali Complex of Eastern Beringia. Ms. in possession of authors.

Mobley, C. M. 1991 *The Campus Site: A Prehistoric Camp at Fairbanks, Alaska.* University of Alaska Press, Fairbanks.

——— 1996 Campus Site. In *American Beginnings*, edited by F. H. West, pp. 296–302. University of Chicago Press, Chicago.

Nelson, N. C. 1935 Early Migration of Man to America. *Natural History*, 35(4)246–251.

——— 1937 Notes on the Cultural Relations Between Asia and America. *American Antiquity*, 2:267-272.

Péwé, T. L. 1975 Quaternary Geology of Alaska. *Geological Survey Professional Paper 835*. United States Government Printing Office, Washington.

Rainey, F. G. 1939 Archaeology in Central Alaska. *Anthropological Papers of the American Museum of Natural History,* 36(4):355–405.

West, F. H. 1967 The Donnelly Ridge Site and the Definition of An Early Core and Blade Complex in Central Alaska. *American Antiquity,* 32(3):360–382.

——— 1975 Dating the Denali Complex. *Arctic Anthropology,* 12(1):76–81.

——— 1981 *The Archaeology of Beringia.* Columbia University Press, New York.

Yesner, D. R. 1996 Human Adaptation at the Pleistocene-Holocene Boundary (circa 13,000 to 8,000 BP) in Eastern Beringia. In *Humans at the End of the Ice Age: The Archaeology of the Pleistocene-Holocene Transition,* edited by L. G. Straus, B. V. Eriksen, J. M. Erlandson, and D. R. Yesner, pp. 255–276. Plenum Press, New York.

Preliminary Report on the Micromorphology of the Cactus Hill Site (44SX202), Sussex County, Virginia

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This article presents preliminary micromorphological observations on the sedimentary context of the Cactus Hill Site (44SX202) in southeastern Virginia. Archaeological investigations conducted independently in separate areas of the site by J. M. McAvoy (McAvoy and McAvoy 1997) and M. F. Johnson (1997) have revealed a nearly continuous cultural sequence from Paleoindian to late Woodland. During the 1993 field season, McAvoy recovered 10 quartzite artifacts and a scatter of charcoal from a level 8 cm beneath a cluster of fluted point fragments dated to c. 10,900 yr B.P. The charcoal later yielded a radiocarbon date of c. 15,000 yr B.P. (Hall 1998; Johnson 1998). In 1996, Johnson recovered seven quartzite artifacts from a level 23 cm below the deepest recognized Clovis level. These finds have convinced some archaeologists that Cactus Hill is a potential pre-Clovis site (Beardsley 1998; Petit 1998). Three elements that must be demonstrated at any site that purports to predate Clovis are 1) evidence of human agency, 2) secure geochronology, and 3) undisturbed stratigraphic context. The Cactus Hill lithics fulfill the first requirement, and ongoing thermoluminescence (TL) dating may help resolve issue two. The work described here addresses the issue of stratigraphic integrity.

The archaeological remains at Cactus Hill have been excavated from the upper 1.5 m of an eolian dune deposit formed as fluvial sand from the Nottoway River accreted against an exposed paleoscarp (Jones and Johnson 1997). The upper portion of the dune sand shows no signs of stratification. Deeper sand is marked by a series of wavy, roughly parallel reddish brown textural bands, or lamellae. The lamellae, 0.5–1.5 cm thick, are more cohesive,

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finer textured, and darker in color than the interlamellae, typically 2–5 cm thick. The possible pre-Clovis artifacts were recovered from this lamellar zone.

The objective of this investigation is to evaluate the stratigraphic integrity of the eolian deposits through the application of micromorphology, supplemented by magnetic susceptibility measurements and standard sedimentary analyses. Artifacts in sandy sites are particularly susceptible to post-depositional disturbance (Peacock and Fant 1998; Thoms 1998), highlighting the need for cautious archaeological interpretations. While textural lamellae of sedimentary origin may provide evidence of undisturbed stratigraphic context, past studies of lamellae indicate that such features can form as a result of geogenic processes such as fluvial deposition (Robinson and Rich 1960; Wurman et al. 1959); pedogenic processes, including clay illuviation (Dijkerman et al. 1967; Folks and Riecken 1956); or a combination of the two (Rawling 1997; Wurman et al. 1959). If the lamellae are primary features—or secondary features that developed as the result of some stratigraphic characteristic of the dune sand—they may be evidence of stratigraphic integrity. If they are of purely pedogenic origin, they cannot be used as an argument against post-depositional disturbance.

Column sediment samples collected at the site in June 1998 were impregnated with polyester resin, cut into 2-by-3-inch slabs, and ground to a thickness of 30 μm. Thin sections were examined using a petrographic microscope, and qualitative descriptions of the microstructure, coarse and fine fractions, and pedogenic features of lamellae and interlamellae were made. Interlamellae are composed of a matrix of well-sorted subangular to subrounded medium quartz sand with weakly oriented clay forming thin (5–50 μm) typic coatings on most grains. Lamellae possess a similar coarse fraction, but are distinguished from interlamellae by a high concentration of moderately to well oriented clay forming typic coatings, bridges between grains, and microlaminated crescentic coatings between grains and at the bottoms of voids. The types of pedofeatures observed within lamellae are characteristic of illuviated clay, indicating that the lamellae are, at least in part, of pedogenic origin (Bond 1986; Dijkerman et al. 1967; Fitzpatrick 1993).

It is not yet clear whether the lamellae are the product of pedogenic processes alone or whether they formed as the result of physical stratification within the eolian sand. Preliminary observations suggest that redeposition of clay in each lamella may have been triggered by a textural discontinuity in the dune sediments, such as a reduction in pore space or an abrupt change in grain size distribution (Dijkerman et al. 1967; Wurman et al. 1959). Such a discontinuity may have caused sieving of clay particles or halted a wetting front laden with suspended clay. To test these hypotheses quantitatively, the physical properties of the lamellae and interlamellae will be evaluated using image analysis. After the data are analyzed for trends with depth and for differences between lamellar and interlamellar zones, it will be compared with the results of other sedimentological analyses.

We thank Mike Johnson for graciously allowing us access to the site, Paul Goldberg and Trina Arpin for assisting us with sample preparation and for granting us access to the Boston University micromorphology laboratory, and Richard Meadow and Larry Flynn for constructive comments on earlier drafts of this note. Funding for the study was provided by the Departments of Anthropology and Earth and Planetary Sciences, Harvard University.

References Cited

Beardsley, T. 1998 Tool Time on Cactus Hill. *Scientific American,* 279(5):34–36.

Bond, W. J. 1986 Illuvial Band Formation in a Laboratory Column of Sand. *Soil Science Society of America Journal,* 50:265–267.

Dijkerman, J. C., M. G. Cline, and G. W. Olson 1967 Properties and Genesis of Textural Subsoil Lamellae. *Soil Science,* 104(1):7–16.

Fitzpatrick, E. A. 1993 *Soil Microscopy and Micromorphology.* John Wiley and Sons, New York.

Folks, H. G., and F. F. Riecken 1956 Physical and Chemical Properties of Some Iowa Soil Profiles with Clay-iron Bands. *Soil Science Society of America Proceedings,* 20:575–580.

Hall, D. A. 1998 Blades Found below Clovis Open Window on Unknown. *Mammoth Trumpet,* 13(3):14–15.

Johnson, M. F. 1997 Additional Research at Cactus Hill: Preliminary Description of Northern Virginia Chapter-ASV's 1993, 1995 and 1996 Excavations. In McAvoy, Joseph M. and Lynn D. McAvoy. *Archaeological Investigations of Site 44SX202, Cactus Hill, Sussex County Virginia.* Virginia Department of Historic Resources, Research Report Series No. 8.

——— 1998 The Cactus Hill Site (44SX202) and Its Implications for the Peopling of the Southeast. Paper presented at the 63rd annual Society for American Archaeology meeting, Seattle, Washington.

Jones, K. B., and G. H. Johnson 1997 Geology of the Cactus Hill Archaeological Site (44SX202), Sussex County, Virginia. In McAvoy, J. M. and L. D. McAvoy. *Archaeological Investigations of Site 44SX202, Cactus Hill, Sussex County Virginia.* Virginia Department of Historic Resources, Research Report Series No. 8.

McAvoy, J. M., and L. D. McAvoy 1997 *Archaeological Investigations of Site 44SX202, Cactus Hill, Sussex County Virginia.* Virginia Department of Historic Resources, Research Report Series No. 8.

Peacock, E., and D. W. Fant 1998 Artifact Translocation in Upland Sandy Soils: An Example from the Holly Springs National Forest, North-central Mississippi. Paper presented at the 63rd annual Society for American Archaeology meeting, Seattle, Washington.

Petit, C. W. 1998 Rediscovering America. *U.S. News & World Report,* 125(14):56–64.

Rawling, J. E. 3rd. 1997 Clay Lamellae in the Upper Mississippi River Valley, Wisconsin. Unpublished M.S. Thesis, Department of Geology, University of Wisconsin-Madison.

Robinson, G. H., and C. I. Rich 1960 Characteristics of the Multiple Yellowish-red Bands Common to Certain Soils in the Southeastern United States. *Soil Science Society of America Proceedings,* 24:226–230.

Thoms, A. V. 1998 Natural Site-formation Processes on Sandy Upland Landforms: Examples from Northwest and South-central North America. Paper presented at the 63rd annual Society for American Archaeology meeting, Seattle, Washington.

Wurman, E., E. P. Whiteside, and M. M. Mortland 1959 Properties and Genesis of Finer Textured Subsoil Bands in Some Sandy Michigan Soils. *Soil Science Society of America Proceedings,* 23:135–143.

New ^{14}C Dates and Obliquely Flaked Projectile Points from a High-Altitude Paleoindian Site, Colorado Rocky Mountains

Bonnie L. Pitblado

The Caribou Lake site (5GA22) is a stratified multi-component camp site located about 30 km west of Boulder, Colorado. Situated on the north shore of Caribou Lake west of the outlet channel for Arapaho Creek at an altitude of 3,400 m ASL, the locality is in the subalpine environmental zone of the southern Rocky Mountains.

James Benedict (1974, 1985) first excavated 5GA22 in 1970–71. In addition to extensive late-Archaic and late-Prehistoric deposits, Benedict encountered a stratigraphically distinct late Paleoindian hearth and associated projectile point base (Figure 1A). Hearth charcoal dated to 8,460 ± 140 yr B.P. (I-5449), and the projectile point was compared with Kersey points (Wheat 1979) of the Cody Complex.

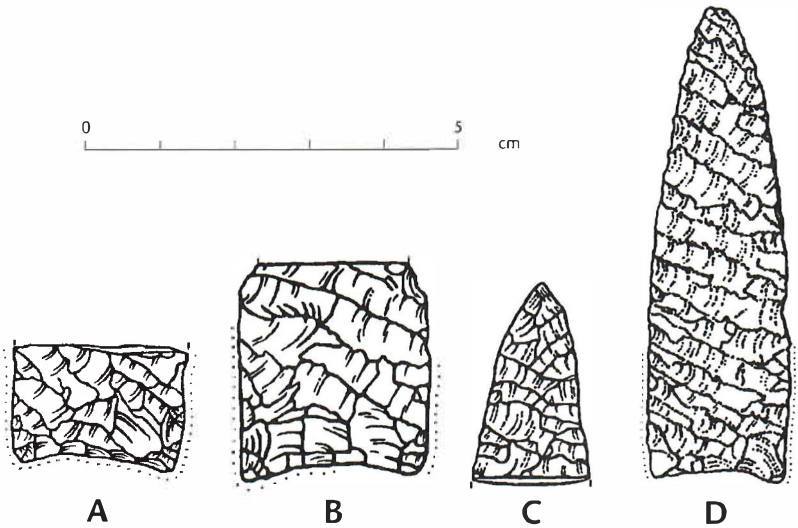

Figure 1. Paleoindian projectile points from the Caribou Lake site (5GA22).

Recent excavations at 5GA22 resulted in the recovery of a second Paleoindian hearth and three additional Paleoindian projectile points/fragments. Located 7 m north of and in the same stratigraphic position as Benedict's fire feature, the newly discovered basin-shaped hearth yielded three AMS ^{14}C dates on wood charcoal: 9,080 ± 75 (AA-18821); 7,985 ± 75 (AA-21984); and 7,940 ± 70 yrs B.P. (AA-26255).

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A fourth AMS assay on a charred spruce needle from hearth fill gave a date of 1,215 ± 45 yr B.P. (AA-26254), an anomaly almost certainly attributable to admixture from an overlying feature. The 1,000-year difference between the 9,080 yr B.P. value and the two c. 7,950 yr B.P. values may be due to "old wood" and suggests that the latter more appropriately dates the feature.

In addition to debitage and a few stone tools, a second projectile point base (Figure 1B), a tip (Figure 1C), and one complete lanceolate point (Figure 1D) were recovered in the vicinity of the two Paleoindian hearths. All three show well-executed parallel-oblique flaking, and even the previously excavated fragment shows a hint of this flaking configuration. Oblique flaking is not characteristic of Kersey or any other Cody-complex point type, and the complete specimen is clearly not Cody.

Instead, the flaking pattern, lanceolate shape, parallel and ground basal sides, concave base, and slender lenticular cross-sections of all four specimens are more consistent with characteristics of the James Allen (Mulloy 1959) and Frederick (Irwin 1968) point types, defined at the James Allen and Hell Gap sites in the nearby Rocky Mountain-High Plains ecotone of southern Wyoming. Radiocarbon dates at the two type sites are 7,900 ± 400 (M-304) and 8,690 ± 380 yrs B.P. (A-501), respectively—both consistent with the Caribou Lake assays.

I am grateful to the following for funding for Caribou Lake excavations and laboratory analyses: the Colorado State University Foundation–Karen S. Greiner Endowment, the American Alpine Club, the Explorers Club, the Colorado Mountain Club, Arizona-Nevada Academy of Sciences, Sigma Delta Epsilon/Graduate Women in Science, the Department of Anthropology at the University of Arizona, NSF–University of Arizona AMS Facility, and the Marshall Foundation of Tucson. Sue Struthers, Bob Nykamp, and the U.S.F.S. Arapaho-Roosevelt National Forest with whom they are both affiliated, were generous with their permission to excavate, as well as with logistical support. The University of Colorado Museum–Anthropology Section provided access to the 1970–71 collections from Caribou Lake. Patty Walker-Buchanan beautifully drafted Figures 1B–D, and Wil Husted kindly critiqued a draft of this manuscript. Finally, I am indebted to Jim Benedict for his encouragement and enthusiasm; to Jean Kindig for her warmth and hospitality; to Sam Richings Germain and Cherie Freeman for untold hours spent wading through data; and to all the highly qualified but severely underpaid (okay, unpaid) excavators who endured a very tough backpacking trip and field conditions to work at Caribou Lake.

References Cited

Benedict, J. B. 1974 Early Occupation of the Caribou Lake Site, Colorado Front Range. *Plains Anthropologist,* 19(63):1–4.

——— 1985 *Arapaho Pass. Glacial Geology and Archaeology at the Crest of the Colorado Front Range.* Center for Mountain Archaeology, Research Report 3. Ward, CO.

Irwin, H. T. 1968 The Itama: Late Pleistocene Inhabitants of the Plains of the United States and Canada and the American Southwest. Unpublished Ph.D. dissertation, Harvard University.

Mulloy, W. 1959 The James Allen Site Near Laramie, Wyoming. *American Antiquity,* 25(1):112–116.

Wheat, J. B. 1979 The Jurgens Site. *Plains Anthropologist Memoir,* 15, v. 24(84), part 2:1–153.

Gearing Up and Moving Out: Folsom Settlement in Western North Dakota

Matthew J. Root, Jeb Taylor, Jerry D. William, and Lisa K. Shifrin

Comparison of Folsom collections from the Missouri River (Lake Sakakawea) and the Knife River flint (KRF) quarry area in western North Dakota suggests a pattern of movement from the south and west, retooling at the quarries, and traveling north to the Missouri River to hunt. We analyzed 50 Folsom and 6 Midland points in private collections that are mainly from the Van Hook Arm of Lake Sakakawea. The Folsom points consist of 16 preforms and 34 finished points. All preforms and Midland points are KRF, as are 31 of the finished Folsom points (Figure 1). Terraces along the river contain KRF cobbles, but these occur in lower density than 80 km south in the quarry area (Root 1992:28). Two finished Folsom points are local brown chert/chalcedony and one is Rainy Buttes silicified wood (RBSW), which occurs 180 km southward (Loendorf et al. 1984). Schneider (1982) previously reported four KRF preforms, one porcellanite, and three finished KRF points from the Moe site near New Town. Thus, 94 percent (60/64) of the points from the Missouri River are KRF, and 69 percent (44/64) are finished.

Recent investigations in the KRF quarry area at the Big Black (William 1999), Young-Man-Chief (Shifrin 1999; Shifrin and William 1996), and Bobtail Wolf (Root et al. 1999) sites reveal different patterns. These sites produced 66 Folsom preforms, 41 finished Folsom points, and four Midland points. Only 65 percent (72/111) are KRF and 41 percent (45/111) are finished tools. Other toolstones include RBSW, moss agate, silicified wood, porcellanite, Tongue River silica, Miocene chert, and orthoquartzite. These occur within 150 km of the sites, especially to the south and west, suggesting movements from those directions.

The dominance of failed preforms in the quarry area reflects the importance of KRF point production as old points were scuttled. The KRF-dominated Missouri River sample suggests that Folsom hunters had been in the KRF source area long enough to have discarded most non-KRF points before entering the Missouri River valley. The dominance of finished points suggests the importance of hunting, though the private collections may be biased against preforms. We propose that hunting in the Missouri River valley occurred, in part, after gearing up in the quarry area. Travels from the north or east into the Missouri River valley and KRF source area are difficult to detect because those regions have few distinctive toolstones. The presence of KRF Folsom points in the Canadian prairies (e.g., Kehoe 1966), however, indicates northern travel out of the source area and suggests southward returns.

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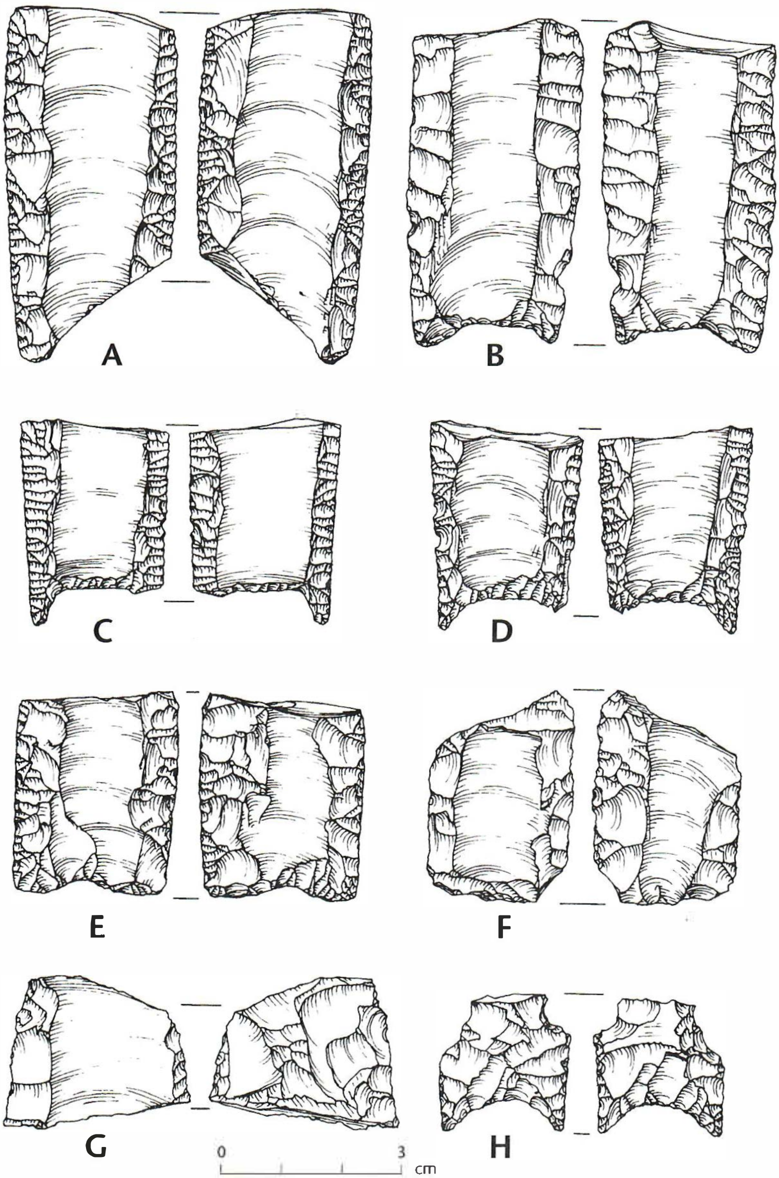

Figure 1. Projectile points from the Missouri River Valley. **A–E,** Folsom points; **F–G,** Folsom point preforms; **H,** reworked Midland point.

We thank Sarah Moore of Illustration Services for her excellent line drawings.

References Cited

Kehoe, T. F. 1966 The Distribution and Implications of Fluted Points in Saskatchewan. *American Antiquity*, 31:530–539.

Loendorf, L. L., D. D. Kuehn, and N. F. Forsman 1984 Rainy Buttes Silicified Wood: A Source of Lithic Raw Material in Western North Dakota. *Plains Anthropologist,* 29:335–338.

Root, M. J. 1992 *The Knife River Flint Quarries: The Organization of Stone Tool Production.* Ph.D. dissertation, Washington State University, Pullman. University Microfilms, Ann Arbor.

Root, M. J., J. D. William, and A. M. Emerson 1999 Stone Tools and Flake Debris. In *The Archaeology of The Bobtail Wolf Site (32DU955A),* edited by M. J. Root. Washington State University, Center for Northwest Anthropology, Contributions in Cultural Resource Management 61. Submitted to the U.S. Fish and Wildlife Service, Denver, and the University of North Dakota, Grand Forks. Cooperative agreement No. 14-48-0010-93-901 (in press).

Schneider, F. 1982 A Preliminary Investigation of Paleo-Indian Cultures in North Dakota. *Manitoba Archaeological Quarterly,* 6(4):16–43.

Shifrin, L. K. 1997 Analyses of Excavated Materials. In *Young-Man-Chief (32DU955D): A Folsom, Late Plains Archaic, and Late Prehistoric Site,* compiled by L. K. Shifrin. Bilby Research Center, Northern Arizona University, Flagstaff. Submitted to the U.S. Fish and Wildlife Service, Denver, and the University of North Dakota, Grand Forks. Cooperative agreement No. 14-48-0010-93-901 (in press).

Shifrin, L. K., and J. D. William 1996 Investigations at Young-Man-Chief, a Folsom Site in Western North Dakota. *Current Research in the Pleistocene,* 13:42–44.

William, J. D. 1999 Folsom Stone Tools. In *The Big Black Site (32DU955C): A Folsom Complex Workshop in the Knife River Flint Quarry Area, North Dakota,* compiled by J. D. William. Bilby Research Center, Northern Arizona University, Flagstaff. Submitted to the U.S. Fish and Wildlife Service, Denver and the University of North Dakota, Grand Forks. Cooperative agreement No. 14-48-0010-93-901 (in press).

Identifying Clovis Sites by Blade Technology: A Cautionary Note

Donna C. Roper

Blades were added to the previously defined Llano complex in 1962 when an apparent cache of 17 specimens was recovered at the Clovis site in New Mexico (Green 1963). Blade core tablets were added in 1980 when one was found at the Pavo Real site in Texas (Henderson and Goode 1991:27; see also Stanford 1991:5). Additional instances of blades and polyhedral blade cores in Clovis context have since been reported, and at least one additional instance of a core tablet in secure Clovis context is known (Ferring 1990:11). The recent literature also contains a number of reports of sites—caches in all the cited instances—assigned a Clovis age solely on the basis of the presence of blades (e.g., Hammatt 1970; polyhedral blade cores [Goode and Mallouf 1991], or a core tablet [Ballenger 1996]).

An apparent core tablet flake and numerous blades (Figure 1) were recovered in 1995 from a lithic workshop area on 25FT30 in the Medicine Creek valley of southwest Nebraska. The core tablet flake is ca. 84 mm in maximum

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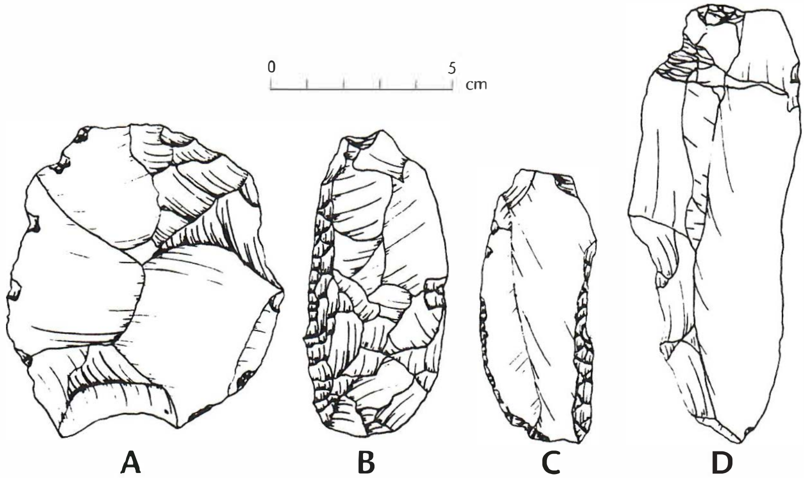

Figure 1. **A,** core tablet flake; **B–C,** retouched blades; **D,** unretouched blade from 25FT30.

diameter. The 14 unbroken blades range from 36 to 128 mm long, with a median of 74.5 mm. All objects are of Smoky Hill jasper (also called Republican River or Niobrara jasper), but definitely represent several cores. The specimens resemble blades and a core rejuvenation tablet illustrated in the literature cited above. The important difference between the other sites and this one, however, is that 25FT30 is attributable to the Upper Republican phase and is datable to ca. A.D. 1100–1350. It lies atop a Holocene terrace, stratigraphically well above any Clovis-age surface. There is no chance that this assemblage is mixed. Further, although blades and related objects are concentrated in the workshop context, the contents of the 25FT30 assemblage are not unique among Upper Republican phase sites in the valley.

The association of blades and other evidence of blade technology with Clovis sites certainly is not disputed, nor is it suggested that any site cited above is incorrectly identified. It is, however, asserted that a core and blade technology is not exclusive to Clovis, at least on the Plains. Possibly a detailed comparison of certain Clovis artifacts and similar specimens from known later context could establish the more subtle attributes that would reliably identify specimens from the numerous instances where neither corroborating evidence for cultural affiliation nor an appropriate radiometric age is available.

The 1995 excavations in the Medicine Creek valley were conducted under a cooperative agreement between the Bureau of Reclamation and Kansas State University. Additional support came from the Kansas Archaeological Field School (Kansas State University and University of Kansas). The artifact drawings are by Cindy LaBarge.

References Cited

Ballenger, J. A. M. 1996 The Wichita Cache: A Core Rejuvenation Tablet from Southwest Oklahoma. *Current Research in the Pleistocene,* 13:53–55.

Ferring, C. R. 1990 The 1989 Investigations at the Aubrey Clovis Site. *Current Research in the Pleistocene,* 7:10–12.

Goode, G. T., and R. J. Mallouf 1991 The Evant Cores: Polyhedral Blade Cores from North-Central Texas. *Current Research in the Pleistocene,* 8:67–70.

Green, F. E. 1963 The Clovis Blades: An Important Addition to the Llano Complex. *American Antiquity,* 29(2):145–165.

Hammatt, H. H. 1970 A Paleo-Indian Butchering Kit. *American Antiquity,* 35(2):141–152.

Henderson, J., and G. T. Goode 1991 Pavo Real: An Early Paleoindian Site in South-Central Texas. *Current Research in the Pleistocene,* 8:26–28.

Stanford, D. 1991 Clovis Origins and Adaptations: An Introductory Perspective. In *Clovis: Origins and Adaptations,* edited by Robson Bonnichsen and Karen L. Turnmire, pp. 1–13. Center for the Study of the First Americans, Department of Anthropology, Oregon State University, Corvallis.

1998 Excavation of Xiaochangliang, an Early-Pleistocene Site in Northern China

Chen Shen and Chun Chen

Xiaochangliang is located on an ancient lake margin, now a hilltop some 1,000 meters ASL in the Nihewan Basin of northern China, about 120 km west of Beijing. Dated on paleomagnetic grounds to between 0.97 and 1.67 mya (Jia 1985; Li and Wang 1985; Tang et al. 1995), Xiaochangliang is one of few lower Paleolithic sites of the early Pleistocene yet unearthed in China. Since its initial identification in the late 1970s, many lithic artifacts and faunal remains have been recovered from the site (You et al. 1978). Unfortunately, the precise provenience of these materials was not duly recorded, making difficult any investigation of site functions, formation, and taphonomy. A Chinese-Canadian research team revisited the site July–August 1998 and conducted a systematic excavation. This short paper briefs our initial observation and provides firsthand data obtained as a result of our collaboration while a full-length report is in preparation. For detailed descriptions of the site and its research history, readers are referred to articles by Jia (1985) and Pope and Keates (1992).

Our 1998 excavation exposed 16 contiguous square meters of cultural deposit from Nihewan Early-Pleistocene sediments. Submerged during a period of lake expansion no later than 700 kya (Xia 1992), 2–3 m of fluviolacustrine clay overlie gray silty sediments some 80 cm thick. More than 4,000 stone tools and bone fragments were recovered from this cultural deposit. The provenience of all pieces greater than 10 mm in size were recorded in situ.

The lithic technology of Xiaochangliang is representative of the northern "small flake tool tradition" (Huang 1985; You 1983), as opposed to the "large

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core/pebble tradition" found in southern China (Wang 1997). Small flakes and irregular chunks predominate the 901 lithic artifacts recovered. Flake tools average 25.7 mm long by 19.3 mm wide; only 7 pieces (<1 percent) display secondary retouch. Cores account for about 8 percent of the assemblage. Our preliminary observations, with aid of flintknapping experiment, lead us to believe that the small size and irregularity of the flake tools may be a function of the poor quality of raw materials. Red or yellow rough-grained, highly fractured cherts are the most common of more than a dozen kinds of lithic material utilized by site inhabitants. The primitive cognitive capabilities of *Homo erectus,* we believe, may have limited their strategic exploitation of resources (e.g., toolmaking materials). We find no evidence of standardized manufacture of flake tools at Xiaochangliang. A lithic use-wear analysis is required in order to retrieve information about use-patterning of the stone tools.

A total of 3,291 bone fragments were recovered, 454 in situ, the rest during sieving. Although most of these bones cannot be identified to taxon, a previous study of Xiaochangliang faunal material indicates an assemblage composed of typical Plio-Pleistocene forms (Tang et al. 1995). Some 138 fragments were examined for obvious surface modifications in the field. Of these, 43 were selected for a subsequent low-power microscopic examination in order to identify the origin of the marks. Although our analysis is far from complete, preliminary observations suggest carnivores, possibly hyenas, may be responsible for a majority of the modifications observed (Peterson n.d.). Of the marks examined, none met established criteria for positive identification as stone tool cutmarks.

It is unlikely that the excavated area at Xiaochangliang represents a primary context activity area as previously reported (Pope and Keates 1994:551). Circular and semicircular horizontal formations of yellowish sandy soil that permeate the cultural deposit indicate regular disturbance of the site by hydrodynamic processes. Many artifacts, some deposited vertically, were recovered in situ near the outer margins of these "soil stains," evidence of their relocation under influence of moving water. Plotting lithic debris also points to an even distribution across test-squares as a possible result of depositional formation. The taphonomic history of the site, however, is likely more complicated than this, and the site is still under investigation. We suggest that since the area excavated in 1998 was once close to the archaic lake margin, we should concentrate on areas further back, searching for living floors or activity areas in our future investigations.

Asia's earliest stone tools and hominid remains, dated ca. 2 mya, were recently excavated from Longgupou Cave in southern China (Huang et al. 1995). Further systematic study of early Pleistocene sites in the Nihewan Basin—at least four such sites have been identified—will provide new insight into the origins and migrations of early hominids in Asia.

This project was made possible with financial support from the Bishop White Curatorship Fund of the Royal Ontario Museum Foundation. We acknowledge the kind assistance and support of Chen Wanrong, Tang Yinjun, and Wei Qi of the Institute of Vertebrate Paleontology and Paleoanthropology, Beijing. The microscopic examination of faunal assemblage was done by Christ Peterson at University of Toronto.

References Cited

Huang, W. W. 1985 On the Stone Industry of Xiaochangliang. *Acta Anthropologica Sinica,* 4:301–307. (in Chinese)

Huang, W. P., R. Ciochon, Y. Gu, R. Larick, Q. R. Fang, H. Schwarcz, C. Yonge, J. Vos, and W. Rink 1995 Early *Homo* and Associated Artifacts from Asia. *Nature,* 378:275–278.

Jia, L. 1985 China's Earliest Palaeolithic Assemblages. In *Palaeoanthropology and Palaeolithic Archaeology in the People's Republic of China,* edited by R. Wu and J. W. Olsen, pp. 135–145. Academic Press, Orlando.

Li, H., and J. Wang 1985 Magnetostratigraphic Study of Several Typical Geological Sections in North China. In *Quaternary Geology and Environment of China,* edited by D. S. Liu, pp. 33–38. China Ocean Press, Beijing.

Peterson, C. E. n.d. Taphonomy of an Early Pleistocene Faunal Assemblage from Xiaochangliang, Nihewan Basin, PRC. Unpublished manuscript in the Department of Anthropology, University of Toronto.

Pope, G. G., and S. G. Keates 1994 The Evolution of Human Cognition and Cultural Capacity: A View from the Far East. In *Integrative Paths to the Past: Paleoanthropological Advances in Honor of F. Clark Howell,* edited by R. S. Curruccini and R. L. Ciochon, pp. 531–568. Prentice Hall, Englewood Cliffs.

Tang, Y., Y. Li, and W. Chen 1995 Mammalian fossils and the age of Xiaochangliang Palaeolithic site of Yangyuan, Hebei. *Vertebrata Palasiatica,* 23(1):74–83. (in Chinese)

Wang, Y. 1997 *Pleistocene environment and Palaeolithic cultures of southern China.* Beijing University Press, Beijing. (in Chinese)

Xia, Z. 1992 The Study of the Change of Ancient Lake Shore in the Datong-Yangyan (Nihewan) Basin. *Geographical Research,* 11(2):52–59. (in Chinese)

You, Y. 1983 New Data from the Xiaochangliang Palaeolithic Site in Hebei and Their Chronology. *Prehistory,* 1:46–50. (in Chinese)

You, Y., Y. Tang, and Y. Li 1978 Palaeolithic Discoveries in the Nihewan Formation. *Chinese Quaternary Research,* 1(5):1–13. (in Chinese)

The Final-Paleolithic Sites of Suvorovo III and Suvorovo IV in the Maritime Region, Russian Far East

Andrei V. Tabarev, Alexander A. Krup'anko, Laura B. Niven, and Craig M. Lee

Although many reports about Stone Age sites from the Russian Far East were published during the 1990s (i.e., Dyakov 1997; Kononenko et al. 1995; Kuzmin

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and Jull 1997; Kuznetsov 1994; Tabarev 1993, 1994, 1997; West 1996), a complete picture of stone tool industries from this region has not yet been presented. Finds from recent archaeological investigations at the Suvorovo III and IV sites (Ustinovka Industry) add to this picture and are critical when studying such problems as human migrations, evolution of lithic technology at the final Pleistocene/early-Holocene boundary, and fishing and hunting.

The Suvorovo III and IV sites are in the coastal zone of the Maritime region in the Russian Far East (44°15′ N, 135°19′ E). Excavations were conducted from 1982 to 1990. A new phase of investigations begun in 1997 is being conducted by a joint team from Russia and the United States (Institute of Archaeology and Ethnography, Novosibirsk, Far Eastern State University, Vladivostok, and University of Wyoming).

In 1997 and 1998 30 m^2 was excavated at Suvorovo III. Excavators recovered a diverse tool kit consisting of unifacial knives, bifacial instruments, scrapers, and fragments of thin pressure-retouched points made from local and imported obsidian, flinty tuff, and chert (Figure 1). The assemblage represents several percussion systems of manufacture (micro- and sub-prismatic cores, wedge-shaped microcores), and contains little debitage. Based on these investigations, Suvorovo III reflects evolution of the Northeast Asian late Paleolithic industry (wedge-shaped microcores, transverse burins, bifaces) into the Initial Neolithic industry (points, unifaces, and possible use of pressure blade technique) during the period 11,500–11,000 yr B.P. Radiocarbon dates from charcoal samples obtained from cultural levels at Suvorovo III are not yet available.

Also in 1997 and 1998 57 m^2 was excavated at Suvorovo IV, a site interpreted as a seasonal salmon fishing camp. The Suvorovo IV assemblage contains a variety of woodworking tools (adzes, axes, gravers) and substantial amounts of debitage. These artifacts illustrate the use of subprismatic direct percussion and use of local raw material sources such as flinty tuff. Radiocarbon dates of 15,300 ± 140 yr B.P. (Ki-3502) and 15,105 ± 110 yr B.P. (AA-9463) were obtained from charcoal (Kuzmin et al. 1994), and additional samples were collected in the past two seasons of excavation.

Ongoing research at Suvorovo III–IV adds significantly to our understanding of stone tool industries in the prehistoric Russian Far East and is important for investigating the influence of Far eastern cultures on the peopling of the New World.

References Cited

Dyakov, V. I. 1997 The Oldest Habitation Site on the West Coast of the Sea of Japan. *Current Research in the Pleistocene,* 14:20–22.

Kononenko, N. A., A. A. Krup'anko, and A. V. Tabarev 1995 Ustinovka-VI Site: Recent Investigations of the Microblade Industries in the Maritime Region, Russian Far East. *Wyoming Archaeologist,* 39(1-2):1–5.

Kuzmin, Y. V., and A. J. T. Jull 1997 AMS Radiocarbon Dating of the Paleolithic-Neolithic Transition in the Russian Far East. *Current Research in the Pleistocene,* 14:46–48.

Kuzmin, Y. V., L. A. Orlova, L. D. Sulerzhitsky, and A. J. T. Jull 1994 Radiocarbon Dating of the Stone and Bronze Age Sites in Primorye (Russian Far East). *Radiocarbon,* 36:359–366.

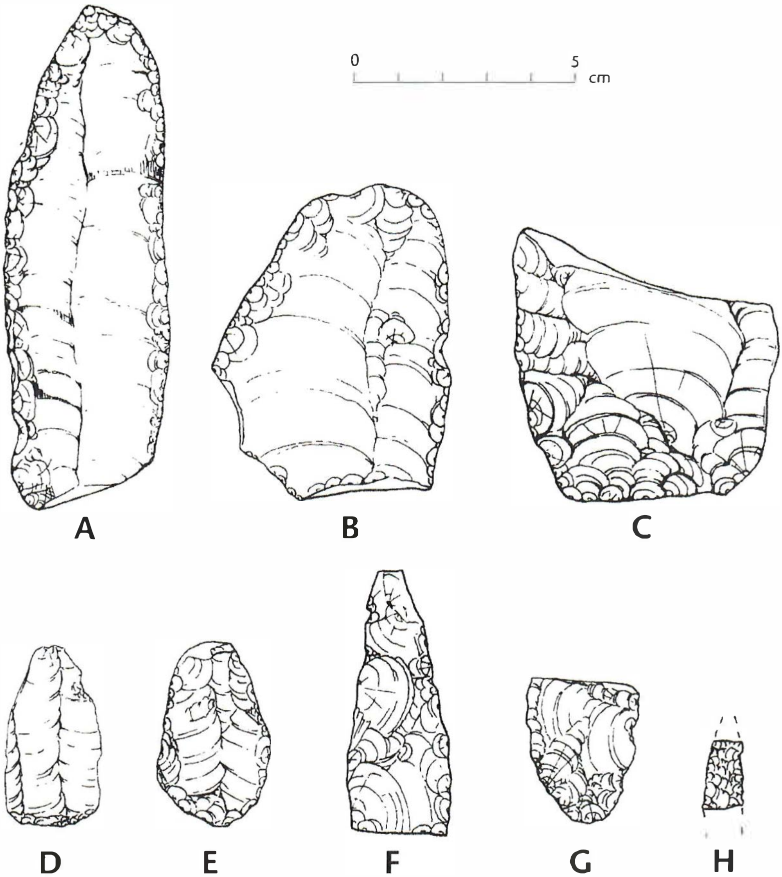

Figure 1. Stone artifacts from Suvorovo III, Russian Far East. **A–C,** knives; **D–E,** scrapers; **F,** bifacial point fragment; **G,** biface fragment; **H,** point fragment. Illustrations by Julia Tabareva.

Kuznetsov, A. M. 1994 Paleolithic of the Russian Far East: A Geoarchaeological Aspect of the Problem. *Current Research in the Pleistocene,* 11:140–144.

Tabarev, A. V. 1993 Preceramic Industries of the Maritime Region. *Journal of the Korean Ancient Historical Society,* 14:261–294.

——— 1994 The Ustinovka Industry in the Stone Age of the Russian Far East: 40 Years of Discoveries. *Lithic Technology,* 19(1):21–34.

——— 1997 Paleolithic Wedge-Shaped Microcores and Experiments with Pocket Devices. *Lithic Technology,* 22(2):139–149.

West, F. H. 1996 *American Beginnings: The Prehistory and Palaeoecology of Beringia.* University of Chicago Press, Chicago.

Radiocarbon Dating of a Paleoindian Projectile Point from Sheriden Cave, Ohio

Kenneth B. Tankersley and Brian G. Redmond

A Paleoindian flaked-stone projectile point (Figure 1) was exposed in late-Pleistocene geological contexts during the 1998 archaeological excavation of Sheriden Cave, Wyandot County, Ohio (Tankersley and Landefeld 1998). The artifact was discovered at a depth of 27 cm below the Holocene-Pleistocene boundary in excavation square S1W3. This unit is adjacent to the western wall of the cave and approximately 10 m beneath the surface. Chert microdebitage, wood charcoal, the disarticulated bones of extinct and extralimital species, a cervical vertebra of a snapping turtle (*Chelydra sepentina*) displaying cutmarks, and a beveled, cross-hachured, split-bone point were also recovered from this 1-by-1-m square (Barans et al. 1998). The biface was recovered 25 cm below the split-bone point at a horizontal distance of 70 cm.

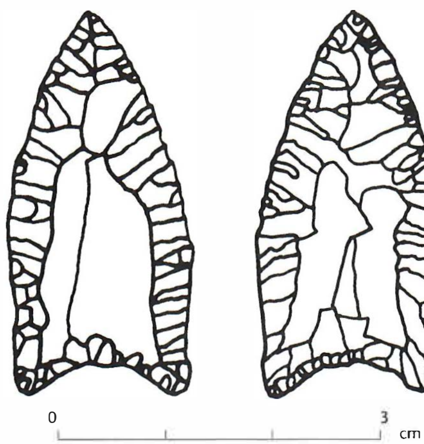

Figure 1. Obverse and reverse of a Paleoindian flaked-stone projectile point from late-Pleistocene contexts in Sheriden Cave.

The complete and heavily reworked flaked-stone projectile point is 3.62 cm long, 1.65 cm wide, and 4.5 mm thick. Stylistically, the biface is similar to small, thin pressure-flaked bifaces recovered from the Gainey and Holcombe Beach sites in Michigan (Fitting et al. 1966; Simons et al. 1984). Radiocarbon dates from the Arc and Hiscock sites in western New York suggest that Gainey points date ca. 10,800–11,200 yr B.P. (Tankersley 1998; Tankersley et al. 1998). Sites with Holcombe points, however, have never been precisely radiocarbon dated. On the basis of beach ridges, their age estimations range from more than 11,000 to 10,000 radiocarbon yr B.P. (Ellis et al. 1998:154;

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Fitting et al. 1966:100). To complicate the issue of typology, it is quite possible that the projectile point is manufactured from the broken, distal end of a larger biface.

Nine new AMS age determinations were obtained on wood charcoal from the culture-bearing late-Pleistocene strata of Sheriden Cave: 10,550 ± 70 yr B.P. (Beta-117604) on conifer without resin ducts; 10,570 ± 70 yr B.P. (Beta-117605), 10,600 ± 60 yr B.P. (Beta-117603), and 10,970 ± 70 yr B.P. (Beta-117607) on Salicaceae (i.e., willow/poplar); 10,620 ± 70 yr B.P. (Beta-117606), 10,850 ± 70 yr B.P. (Beta-117602), and 10,940 ± 70 yr B.P. (Beta-117601) on Salicaceae and conifer with resin ducts, and 10,840 ± 80 yr B.P. (Beta-127909) and 10,960 ± 60 yr B.P. (Beta-127910) on an unidentified charcoal lens at the same depth as the projectile point. These dates are consistent with two previously reported AMS dates obtained on wood charcoal from the upper 30 cm of late-Pleistocene strata: 10,470 ± 70 yr B.P. (AA-21712) and 10,680 ± 80 yr B.P. (AA-21710) (Tankersley and Landefeld 1998).

The new AMS radiocarbon dates from Sheriden Cave overlap with those obtained from Vail/Debert sites in the Northeast and Dalton/Cumberland sites in the Southeast (Anderson and Sasaman 1996; Tankersley 1998; Tankersley et al. 1998). The presence, of a Gainey/Holcombe–like point in the Sheriden Cave deposits may indicate that Paleoindian co-traditions, or at least multiple technological complexes, were present in eastern North America during the late-Pleistocene epoch.

The 1998 interdisciplinary team at Sheriden Pit Cave included: Robert Brackenridge (Dartmouth College, geologist), Frances King (Cleveland Museum of Natural History, paleobotanist), Patrick J. Munson (Indiana University, geoarchaeologist), and Gregory McDonald (National Park Service, paleontologist). The 1998 field work at Sheriden Cave was funded by a research grant to the senior author from the National Science Foundation (SBR9707984).

References Cited

Anderson, D. G., and K. E. Sassaman 1996 *The Paleoindian and Early Archaic Southeast.* University of Alabama Press, Tuscaloosa.

Barans, P. J., P. Cossentino, E. Dowd, L. L. Morris, G. Summers, C. Szafranski, M. Willaman, and R. Willaman 1998 Small Point: Huge Find at Sheriden Cave (33Wy252). *Ohio Archaeologist,* 48:20–21.

Ellis, C., A. C. Goodyear, D. F. Morse, and K. B. Tankersley 1998 Archaeology of the Pleistocene-Holocene Transition in Eastern North America. *Quaternary International,* 49/50:151–166.

Fitting, J. E., J. Devisscher, and E. J. Wahla 1966 *The Paleoindian Occupation of the Holcombe Beach.* Anthropological Papers, No. 27, Museum of Anthropology, The University of Michigan, Ann Arbor.

Tankersley, K. B. 1998 Variation in the Early Paleoindian Economies of Late Pleistocene Eastern North America. *American Antiquity,* 63:7–20.

Tankersley, K. B., and C. S. Landefeld 1998 *Current Research in the Pleistocene,* 15:136–138.

Tankersley, K. B., K. D. Schlecht, and R. S. Laub 1998 Fluoride Dating of Mastodon Bone from an Early Paleoindian Spring Site. *Journal of Archaeological Science,* 25:805–811.

Late-Paleoindian and Archaic Archaeological and Geoarchaeological Research along Leon Creek, San Antonio, Texas

Cynthia L. Tennis, C. Britt Bousman, Lee C. Nordt, and Robert J. Hard

Investigations at 41BX47 in the upper Leon Creek Valley, Bexar County, Texas, documented numerous late Paleoindian through late-Archaic occupations in five terrace deposits along Leon Creek (Tennis 1996). Test excavations exposed 78 burned-rock features. Based on feature density and site size, an estimated 4,000–5,000 burned-rock features probably exist on this 1,500,000-m^2 site in the floodplain of Leon Creek.

We identified five alluvial land forms (T0–T4 terraces) and five alluvial units (I–V) (Figure 1). The highest terrace (T4) is 5–6 m above the low-water channel. Two units (I and II) compose the T4 terrace fill. Carbonate morphology of the sediments in the upper portion of Unit I suggests a late-Pleistocene age. One ^{14}C assay on Unit II channel sediments and associated buried soil inset into Unit I dates to 5,810 ± 50 yr B.P. (Beta-81546).

The T3 terrace fill, 4.5–5 m above the channel, consists mainly of Unit II sediments. Channel deposits in the T3 terrace fill, a facies of Unit II sediments, date to 7,440 ± 100 yr B.P. (Beta-81547). We discovered burned-rock features at two depths in this same channel. Charcoal from a burned-rock hearth 175 cm below the surface dates to 7,920 ± 50 yr B.P. (Beta-82227). Lying 50 cm above this hearth were two other circular clusters of burned rocks. Midway between these two hearth features was a Texas Angostura point base (Turner and Hester 1993). The point is 34 mm long and terminates with a transverse snap fracture. Grinding extends 16–17 mm from the base along both sides.

Higher in the T3 terrace fill, a large number of early-Archaic hearths were discovered; a smaller number of middle- to late-Archaic hearths, rock ovens, and burned-rock middens were present even higher in the profile. Charcoal in one of the middle-Archaic hearths returned a radiocarbon assay of 4,390 ± 50 yr B.P. (Beta-82228). No archaeological materials were recovered from the other terraces.

References Cited

Tennis, C. L. 1996 *Archaic Land Use of Leon Creek Terraces: Archaeological Testing in Northern Bexar County, Texas.* Archaeological Survey Report, No. 234. Center for Archaeological Research, The University of Texas at San Antonio.

Turner, E. S., and T. R. Hester 1993 *A Field Guide to Stone Artifacts of Texas Indians.* Second Edition. Gulf Publishing, Houston.

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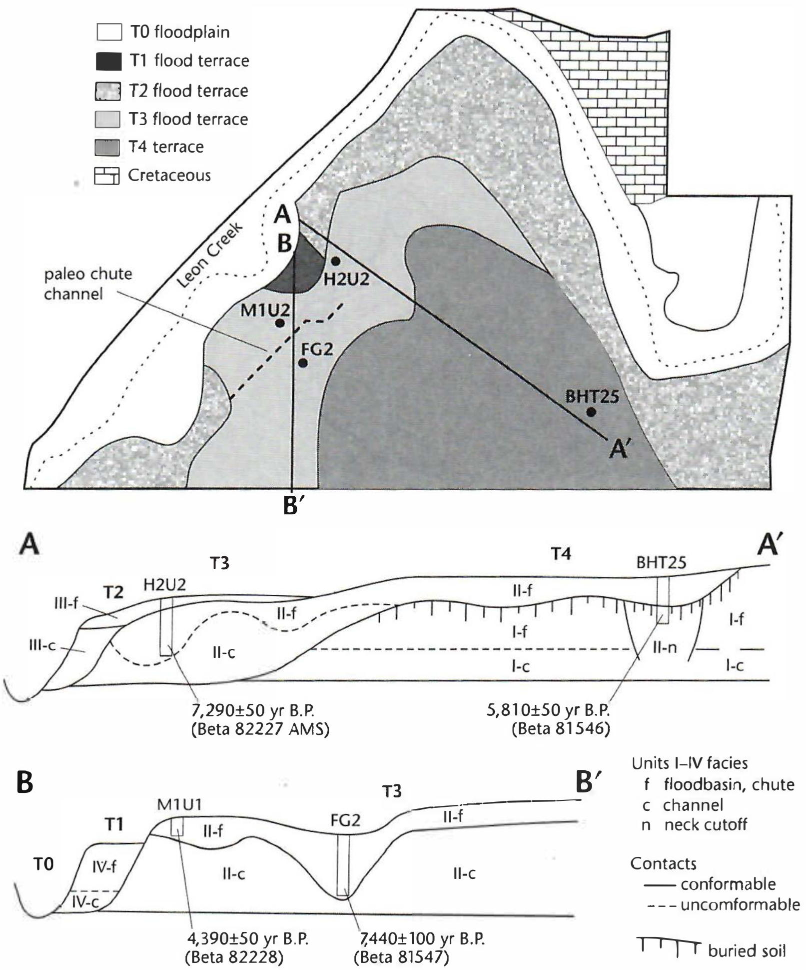

Figure 1. Geomorphic map and composite stratigraphic cross section.

A Multiple-fluted Folsom Manufacture Failure from South Texas

Steve A. Tomka

An unusual Folsom point, recently recovered from site 41MV127 in south Texas, is described in detail. The point is an unfinished manufacture-broken

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specimen (Figure 1). Its obverse face (Figure 1A) has a broad (14 mm) channel scar that overshot and removed a small portion of the tip of the point. A second channel flake, centered on the first, was removed from the same face. It is 18 mm long and terminates in a shallow step fracture at a small "hump" along the left edge of the point.

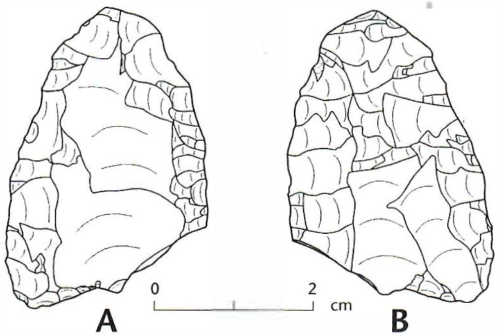

Figure 1. Obverse (**A**) and reverse (**B**) faces of multiple-fluted Folsom point from 41MV127, South Texas.

The first of two channel flakes removed from the reverse face is narrow (10 mm) and relatively short (17 mm; Figure 1B). It terminates in a shallow step fracture. A second channel flake was removed tangentially to the first scar. The right corner of the base served as the platform, and this removal also step fractured. Finally, a third removal was attempted from the left corner of the base. The corner broke, and at this stage the specimen was discarded. Overall, the earliest manufacture stage exhibited by the point is Bradley's Stage 4, while the last is Stage 9 (Frison and Bradley 1980:46–52).

This point is unusual because while the majority of the previous Folsom finds in the state (cf. Chandler 1997; Chandler and Hindes 1995; Chandler and Kumpe 1994; Chandler and Rogers 1996) are isolated finished specimens apparently lost during hunting (Amick 1994), this point is a manufacture failure. In combination with a spurred end scraper and a number of blade fragments, the finds are indicative of a Paleoindian camp or lithic tool manufacture station. The point also is unusual from a technological point of view since it exhibits multiple fluting attempts on both faces. The majority of Folsom points have single flutes (Boldurian 1990:91) on each face. Although by no means the only Folsom with multiple fluting scars (see Bettis 1997: Figure 3a; Frison and Bradley 1980: Figure 36; Jodry 1987:167; Wilmsen and Roberts 1978:101), this specimen is more reminiscent of the multiple-fluted Clovis tradition (Howard 1990). The multiple flutes indicate that Folsom knappers did not adhere to strict morphological templates but rather were opportunistic and flexible, using various strategies to solve technological problems faced during manufacture.

References Cited

Amick, D. S. 1994 Technological Organization and the Structure of Inference in Lithic Analysis: An Examination of Folsom Hunting Behavior in the American Southwest. In *The Organization of*

North American Prehistoric Chipped Stone Tool Technologies, edited by P. J. Carr, pp. 9–34. International Monographs in Prehistory, Archaeological Series 7, Ann Arbor.

Bettis, A. C. Jr. 1997 Chipped Stone Artifacts from the Killiam Ranch, Webb County, Texas. TARL Research Notes 5(2):3–23.

Boldurian, A. T. 1990 Lithic Technology at the Mitchell Locality of Blackwater Draw: A Stratified Folsom Site in Eastern New Mexico. *Plains Anthropologist*, Memoir 24, 35(130):1–115.

Chandler, C. K. 1997 Folsom Points from Llano and Midland Counties, Texas. *La Tierra*, 24(1):42–44.

Chandler, C. K., and K. Hindes 1995 Folsom Points from Atascosa, Frio, Live Oak, and McMullen Counties. *La Tierra* 22(3):4–9.

Chandler, C. K., and D. Kumpe 1994 Folsom Points from Deep South and Southwest Texas. *La Tierra*, 21(3):6–9.

Chandler, C. K., and D. Rogers 1996 Folsom Points from Bell, Cochran, Limestone and Milam Counties, Texas. *La Tierra*, 23(4):51–53.

Frison, G. C., and B. A. Bradley 1980 *Folsom Tools and Technology at the Hanson Site, Wyoming*. University of New Mexico Press, Albuquerque.

Howard, C. D. 1990 The Clovis Point: Characteristics and Type Description. *Plains Anthropologist*, 35(129):255–262.

Jodry, M. A. 1987 Stewart's Cattle Guard Site: A Folsom Site in Southern Colorado. A Report of the 1981 and 1983 Field Seasons. Unpublished Master's Thesis, Department of Anthropology, The University of Texas, Austin.

Wilmsen, E. N., and F. H. H. Roberts, Jr. 1978 Lindenmeier: 1934-1974: Concluding Report on Investigations. Smithsonian Contributions to Anthropology No. 24, Washington D.C.

Exotic Lithics Confirm Human Presence at Stranded Paleoshoreline on Barbuda, West Indies

David R. Watters

Watters et al. (1992) document the presence on Barbuda of an inland paleoshoreline, a 3-km-long lithified ridge progressively stranded from mid- to late-Holocene time by progradation of the beach ridges composing the Palmetto Point formation. Barbuda and Antigua, the only emergent features on the expansive Antigua-Barbuda bank in the northern Lesser Antilles, are separated by a 40-km-wide water passage. Brasier and Donahue (1985) document Pliocene to Holocene limestone sequences in surficial geologic formations in Barbuda, all representing deposition in moderate to shallow-water environments.

The paleoshoreline is named *Strombus* line in recognition of the accumulations of conch shells (mainly *S. gigas*) extending along the ridge. Accumulations are dispersed and distributed discontinuously; frequencies and densities vary in different sectors of the ridge. The shells undoubtedly correlate

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with the lithified ridge. Shells are distributed almost entirely on the ridge itself; they are scarce on terrain adjacent to both sides of the *Strombus* line.

In the 1992 article, archaeologist Watters and geologist Donahue present their respective arguments on the issue of the means by which conch shells came to be deposited on the *Strombus* line. In what was role reversal, Watters argues for natural deposition while Donahue argues for cultural deposition. The disagreement centered on three points: 1) the implications of the taxonomic uniformity of the shells, 2) the conditions of fragmented and whole shells, and 3) the absence of prehistoric artifacts on the *Strombus* line (Watters et al. 1992:35–36).

Subsequent field research has verified a human presence at the *Strombus* line. Confirmation of that finding came not from shell material but instead from flaked-stone artifacts dispersed along the paleoshoreline. The recovery of lithic tools or debitage at nine localities contradicts and invalidates Point 3. Lithics were abundantly represented at two sites, Goat Pen (n = 361) and River (n = 297); they occurred sparsely (n ranging from 6 to 30) at the other seven localities.

Systematic surface sampling in a square-meter grid at Goat Pen verified the distribution of lithics in relationship to the ridge. They predominate on the interior (inland) side, where slightly lower terrain adjoins the backslope of the ridge. The backslope itself yielded few lithics, but some of those were associated with conch shells. Lithics were absent on the crest of the ridge and foreslope (seaward side).

More significant than the mere presence of lithic remains is that the flake tools and debitage were made from chert, a rock known not to be present in Barbuda geologic formations. Chert is known in geologic formations of Antigua; it is the only island in the northern Lesser Antilles with documented geologic deposits of this rock. Hence, *Strombus* line cherts are exotic to Barbuda and their logical source is Antigua. In color and texture, the paleoshoreline cherts are indistinguishable from specimens of Antigua chert seen in more recent sites on both Barbuda and Antigua that date to the Ceramic Age. Transport by humans is the only means by which the exotic lithics could have been brought to Barbuda; this entailed use of watercraft to cross the intervening passage.

The conch shells, the central elements of Points 1 and 2 in the 1992 publication, remain problematic. Definite shell tools, in the form of celts unquestionably manufactured by humans, were recovered only at the River site, at the southern terminus of the paleoshoreline. Indubitable tools have not been identified from the fragmented shells recovered anywhere along the *Strombus* line, including at the other eight localities where chert was found. This situation presents a classic methodological concern for archaeologists—distinguishing cultural from natural breakage patterns for shells.

Radiocarbon analysis of two celts from the River site and of 12 whole or fragmented conchs from elsewhere on the *Strombus* line indicates that the shell dates fall within the span of the preceramic Archaic Age in the Lesser Antilles, ca. 4,000–2,000 yr B.P. (Watters et al. 1992). No ceramics were found anywhere along the paleoshoreline. None of the *S. gigas* shells exhibited the "punch hole" in its apex (spire), a technique for extracting the animal from its shell that seems to be temporally restricted to the later Ceramic Age (Watters 1999).

In summary, exotic chert tools and debitage have proven to be a more reliable indicator of an Archaic Age presence at the *Strombus* line than have shell remains, apart from the undisputed shell celts from a single locality, the River site. Barbuda's stranded Holocene shoreline bears on other issues, such as changing sea level and the prograding of Palmetto Point, that are beyond the scope of discussion in this brief contribution.

References Cited

Brasier, M., and J. Donahue 1985 Barbuda, An Emerging Reef and Lagoon Complex on the Edge of the Lesser Antilles Island Arc. *Journal of the Geological Society of London,* 142:1101–1117.

Watters, D. R. 1999 Composition of the Molluscan Fauna at the Gravenor Bay Shell Ridge, Barbuda. *Proceedings of the 17th International Congress for Caribbean Archaeology,* Bahamian Field Station, San Salvador (in press).

Watters, D. R., J. Donahue, and R. Stuckenrath 1992 Paleoshorelines and the Prehistory of Barbuda, West Indies. In *Paleoshorelines and Prehistory: An Investigation of Method,* edited by Lucille Lewis Johnson, pp. 15–51 CRC Press, Boca Raton.

Radiocarbon Dates for the Near Islands, Aleutian Islands, Alaska

Dixie West, Christine Lefevre, Debra Garland Corbett, and Arkady Savinetsky

The international and multi-disciplinary Western Aleutian Archaeological and Paleobiological Project (WAAPP) is conducting a research program in the westernmost part of the Aleutian chain. The Aleutians consist of a string of islands separating the North Pacific Ocean from the Bering Sea. The archipelago stretches 2,000 km from the Alaska Peninsula to the Near Islands—the last group of five islands before the Commander Islands and Kamchatka. One priority of this research is establishing a chronological framework for their human settlement (Corbett et al. 1997).

Scholars generally agree that colonization of the chain commenced from

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the Alaskan mainland westward (Liapunova 1996; McCartney 1984); however, very few radiocarbon dates are available to support this premise. The earliest evidence of human occupation in the Aleutians is found at Anagula, north of Umnak Island, around 8,000 yr. B.P. (Laughlin 1980). Archaeological investigations at Amchitka (Rat Islands) indicated that humans reached the western central part of the archipelago by 2,550 ± 95 yr B.P. (I-4735; Desautels et al. 1979:384). Subsequent work by the Bureau of Indian Affairs on Amchitka suggests earlier occupation, with dates between 4750 and 4300 B.P. (Corbett et al. 1997b). West of this area, Krugloi Point on Agattu Island provided the first dates for the colonization of the Near Islands: 2,500 ± 300 and 2,630 yr B.P. (Michigan Memorial-Phoenix Project Radiocarbon Laboratory, Spaulding 1962:12).

More data became available for the Near Islands when Corbett (1990) and the WAAPP project (Siegel-Causey 1995) sampled sites on Shemya Island. Two dates of 3,540 ± 60 yr B.P. (Beta-39104) and 3,096 ± 155 yr B.P. (IEMAE-1175) moved the human colonization back one millennium. These dates, 1,000 years younger than those from the Rat Islands, indicate a block to Aleut westward movement. Paleoenvironmental data from c. 9,000 yr B.P. peat deposits on Shemya Island indicate a climatic amelioration around 3,500 yr B.P., which may have improved conditions and made possible the first long sea voyages required to settle the westernmost Aleutians.

In 1998, the WAAPP project conducted a survey on Attu Island, visiting and mapping 22 sites (West et al. 1998). Nineteen samples from nine sites were submitted to Beta Analytic for dating (Table 1). The earliest date, 2,210 ± 60 yr B.P. (Beta-121087) is more than 1,000 years younger than the oldest dates obtained from Shemya to the east. The easternmost point of Attu is only 30 km from Shemya, with Nizki and Alaid between. If people were able to reach Shemya 3,500 years ago they should have colonized Attu as well, and future excavations should someday reveal an older occupation of Attu—the last island in the chain.

The Near Islands compose the westernmost part of North America and were probably the last area of the continent to be colonized. The WAAPP project will continue to work in the Near Islands, trying in particular to document contacts and influences from Asia.

References Cited

Corbett, D. G. 1990 *Archaeological Survey and Testing on Shemya Island, Western Aleutians, Alaska in June 1990.* Final Report for The Geist Fund, Alaska State Museum, Fairbanks.

Corbett, D. G., C. Lefevre, and D. Siegel-Causey 1997a The Western Aleutians: Cultural Isolation and Environmental Change. *Human Ecology,* 25(3):459–479.

Corbett, D. G., C. Lefevre, T. J. Corbett, D. West, and D. Siegel-Causey 1997b Excavation at KIS-008, Buldir Island: Evaluation and Potential. *Arctic Anthropology* 34(2):100–117.

Desautels, R. J., A. J. McCardy, J. D. Flyn, and R. R. Ellis 1970 *Archaeological Report, Amchitka Island, 1969-1970.* Archaeological Research, Inc., U.S. Atomic Energy Commission Report TID-25481.

Laughlin, W. S. 1980 *Aleuts: Survivors of the Bering Land Bridge.* Holt, Rinehart and Winston, New York.

Table 1. Radiocarbon dates from Attu, Western Aleutian Islands.

Site number[a]	Feature number	Unit	Level	yr. B.P.	Beta number
199	19			230 ± 60	121084
19	204	1	3	280 ± 70	121081
197	76	1		360 ± 60	121083
190	16	1		390 ± 50	121100
19	194	1	2	430 ± 60	121098
19	194	8	1–3	490 ± 60	121094
197	79	1	3	540 ± 80	121082
19	194	9	5	950 ± 100	121092
199	20			960 ± 60	121085
183				1030 ± 60	121101
195	89	3		1030 ± 80	121091
19	73	1	3	1190 ± 70	121095
19	194	7	110–113 cm	1310 ± 100	121093
195	24	1	berm	1320 ± 70	121090
19	73	1	5–7	1590 ± 70	121097
192	6	1	1	1630 ± 60	121088
14				1860 ± 70	121102
193	43	1	3	1860 ± 70	121086
193	44		3	2210 ± 60	121087

[a]Alaska Heritage Resources Survey

Liapunova, R. G. 1996 *Essays on the Ethnography of the Aleuts.* Translated by J. Shelest with the editorial assistance of W. B. Workman and L. T. Black. University of Alaska Press, Fairbanks.

McCartney, A. P. 1984 Prehistory of the Aleutian Region. In Arctic, edited by D. Damas, pp. 119–135. *Handbook of North American Indians,* vol. 5, W. C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Siegel-Causey, D., D. G. Corbett, C. Lefevre, and S. Loring 1995 Report of the Western Aleutian Archaeological Project. Shemya Island Excavations, August 1994. Manuscript on File, National Geographic Society, Washington, D.C.

Spaulding, A. 1962 Archaeological Investigations on Agattu, Aleutian Islands. *Anthropological Papers of the Museum of Anthropology* No. 18. University of Michigan, Ann Arbor.

West, D., D. G. Corbett, and C. Lefevre 1998 The Western Aleutians Archaeological and Paleobiological Project: Annual Report for 1998. Manuscript on File, National Science Foundation, Washington, D.C.

Physical Anthropology

The Kennewick Man: A First Multivariate Analysis

James C. Chatters, Walter A. Neves, and Max Blum

In 1996, the nearly complete, superbly preserved skeleton of an adult human male with discrete features dissimilar from modern Amerinds and northeast Asian Mongoloids was found along the Columbia River in Kennewick, Washington (Chatters 1997). A radiocarbon date of 8,410 ± 60 yr B.P. (UCR-3476/ CAMS-29578; Taylor et al. 1998) was obtained on a bone from the left hand and has been corroborated by preliminary geoarchaeological studies and the early Cascade style of the projectile point found embedded in the pelvis (Chatters et al. 1999). Newspaper reports that confused the description of the remains as "Caucasoid-like" with an assertion that the skull was European led to speculation that this find suggested migration of people directly from Europe to North America in the latest Pleistocene or early Holocene (e.g., Lahr 1997). To quell speculation, explore the possible affinities of the Kennewick man with modern human populations, and gain initial insight into the implications of his features for theories about the peopling of the Americas, we conducted a multivariate comparison between this skull and a sample of modern human groups.

Materials and Methods

We carried out the assessment of the morphological affinities between the Kennewick skull and the modern populations of Howells (1989) using Principal Components analysis (size and shape, and shape alone) on the SPSS software program. For the analysis based on shape only, we applied the size correction method proposed by Darroch and Mosimann (1985).

In 1996, one of us (JCC) measured the original skull following Bass (1987) and in 1998 measured a first-generation high-resolution polyurethane cast following Howells's (1973, 1989) specifications (Chatters et al., 1999). Comparable skull and cast measurements were consistent to within 1 mm, so we

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deemed the cast measurements to be suitable for this analysis. In all, 41 variables could be matched between this skull and the 19 modern populations included in the comparison. Of those populations, 18 are the groups asserted by Howells (1989) to represent the core of human cranial variation on the planet and thus suitable for comparative analysis. In this work we have added one more population, the Ainu, because of reported similarities between this population and other Paleoamerican skulls (e.g., Jantz and Owsley 1997) and the general similarity of appearance between the Kennewick skull and Jomon material.

Results and Final Remarks

The results are depicted in Figure 1. In Figure 1A, Principal Component 1 (PC1) primarily expresses information about size. Mastoid Width (MDB), Nasion-Subtense Fraction (FRF) and Malar Length Inferior (IML) are the most influential variables on Principal Component 2 (PC2). Together, these two components explain 46.13 percent of the original information and show

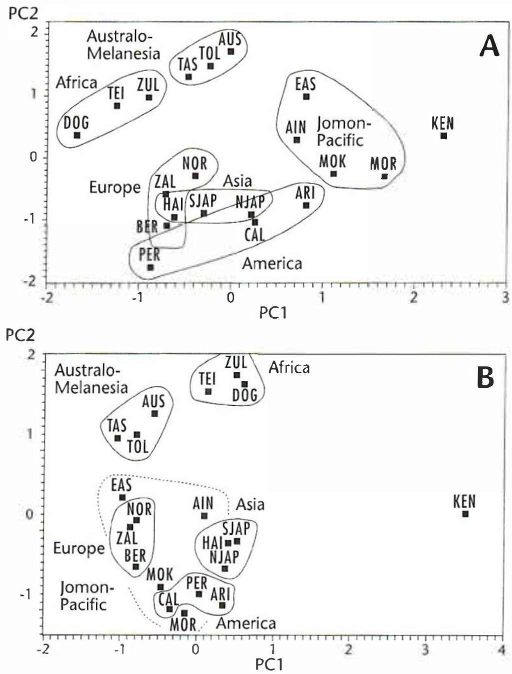

Figure 1. Two-dimensional plots comparing Kennewick Man (KEN) with 19 modern populations: **A,** Plot of Principal Component scores (PC1 and PC2) based on size and shape; **B,** Plot of Principal Component scores based on shape information alone. Variables: GOL (Glabello-Occipital Length); NOL (Nasio-Occipital Length); BNL (Basion-Nasion Length); BBH (Basion-Bregma Height); XCB (Maximum Cranial Breadth); ZYB (Bizygomatic Breadth); AUB (Biauricular Breadth); WCB (Minimum Cranial Breadth); BPL (Basion-Prosthion Length); NPH (Nasion-Prosthion Height); NLH (Nasal Height); JUB (Bijugal Breadth); NLB (Nasal Breadth); MAB (Palate Breadth); MDB (Mastoid Width); OBH (Orbit Height, left); OBB (Orbit Breadth, left); DKB (Interorbital Breadth); NDS (Naso-Dacryal Subtense); ZMB (Bimaxillary Breadth); SSS (Zygomaxillary Subtense); FMB (Bifrontal Breadth); NAS (NaisoFrontal Subtense); EKB (Biorbital Breadth); IML (Malar Length Inferior); XML (Malar Length Maximum); MLS (Malar Subtense); WMH (Cheek Height); SOS (Supraorbital Projection); GLS (Glabella Projection); STB (Bistephanic Breadth); FRC (Nasion-Bregma Chord); FRS (Nasion-Bregma Subtense); FRF (Nasion-Subtense Fraction); PAC (Bregma-Lambda Chord); PAS (Bregma-Lambda Subtense); PAF (BregmaSubtense Fraction); OCC (Lambda-Opisthion Chord); OCS (Lambda-Opisthion Subtense); OCF (Lambda-Subtense Fraction); FOL (Foramen Magnum Length). Populations: Norse (NOR), Zalavar (ZAL), Berg (BER), Teita (TEI), Dogon (DOG), Zulu (ZUL), Australians (AUS), Tasmania (TAS), Tolai (TOL), Mokapu (MOK), Peru (PER), Easter Island (EAS), Arikara (ARI), Ainu (AIN), South Japan (SJAP), North Japan (NJAP), Hainan (HAI), Moriori (MOR) and Santa Cruz (CAL).

a strong tendency for geographic grouping. A clear association can be seen between the Kennewick skull (KEN) and the Jomon-Pacific cluster (MOK, MOR, EAS, AIN; Brace and Hunt 1984).

When shape alone is considered (Figure 1B), Principal Component 1 (PC1) is mainly influenced by Lambda-Opisthion Chord (OCC), Orbit Height (OBH) and Bijugal Breadth (JUB). Principal Component 2 (PC2) is mainly influenced by cranial breadth (Biauricular Breadth [AUB], parietal length (Bregma-Lambda Chord–PAC) and Nasal Breadth (NLB). These two factors together explain 47.26 percent of the original information. Except for the Jomon-Pacific cluster, the geographic groups are more discrete than they were with size included. In this case, the Kennewick skull can be seen as a clear outlier.

The morphological affinities among the Kennewick skull, Polynesian populations (EAS, MOK, MOR) and the Ainu (AIN) suggest an alternative interpretation for the colonization of the Americas. The hypothesis proposed by Turner (1983) and Greenberg et al. (1986) is not sufficient to explain the new findings of non-Mongoloid or generalized Mongoloid biological stocks in the hemisphere (Lahr, 1995; Neves and Pucciarelli, 1989, 1991; Neves et al., 1996a, 1996b, 1997, 1998; Powell and Steele, 1992; Steele and Powell, 1992, 1993). In this context, the Kennewick specimen, featuring a morphology close to the Polynesians when size and shape are considered (Figure 1A) and being an outlier when shape alone is studied (Figure 1B), joins information from other Paleoamerican skeletons in indicating that a more complex model for the peopling of the Americas is needed. On the other hand, our analysis dismisses the idea that Kennewick Man represents an early European immigrant, since the Kennewick skull does not show any cranial morphological affinities with Europeans, at least when quantitative analysis based on metric variation is performed.

References Cited

Brace, C. L., and K. D. Hunt 1990 A Nonracial Craniofacial Perspective on Human Variation: A(ustralia) to Z(uni). *American Journal of Physical Anthropology*, 82:341–360.

Chatters, J. C. 1997 Encounter with an Ancestor. *Anthropology Newsletter*, 38(1):9–10.

Chatters, J. C., et al. 1999 The Recovery and First Analysis of an Early Holocene Human Skeleton from Kennewick, Washington. Submitted to *American Antiquity*, March, 1999.

Darroch, J. N., and J. E. Mosimann 1985 Canonical and Principal Components of Shape. *Biometrika*, 72:241–252.

Greenberg, J. H., C. G. Turner, and S. L. Zegura 1986 The Settlement of the Americas: A Comparison of Linguistic, Dental and Genetic Evidence. *Current Anthropology*, 27:477–497.

Howells, W. W. 1973 *Cranial Variation in Man. A Study of Multivariate Analysis of Patterns of Difference Among Human Populations.* Papers of the Peabody Museum of Archaeology and Ethnology. Harvard University Press, Cambridge.

——— 1989 *Skull Shapes and the Map. Craniometric Analysis in the Dispersion of Modern Homo.* Papers of the Peabody Museum of Archaeology and Ethnology. Harvard University Press, Cambridge.

Jantz, R. L., and D. W. Owsley 1997 Pathology, Taphonomy, and Cranial Morphometrics of the Spirit Cave Mummy. *Nevada State Historical Quarterly*, 40:62–84.

Lahr, M. M. 1995 Patterns of Modern Human Diversification: Implications for Amerindian Origins. *Yearbook of Physical Anthropology*, 38:163–198.

——— 1997 History in the Bones. *Evolutionary Anthropology*, 6:2–6.

Neves, W. A., D. Meyer, and H. M. Pucciarelli 1996a Early Skeletal Remains and the Peopling of the Americas. *Revista de Antropologia*, 39:121–139.

Neves, W. A., D. Munford, and M. C. Zanini 1996b Cranial Morphological Variation and the Colonization of the New World: Towards a Four Migration Model. *American Journal of Physical Anthropology*, Supplement 22:176.

Neves, W. A., J. F. Powell, A. Prous, and E. G. Ozolins 1998 Lapa Vermelha IV, Hominid 1: Morphological Affinities of the Earliest Known American. *American Journal of Physical Anthropology*, Supplement 26:169.

Neves, W. A., and H. M. Pucciarelli 1989 Extracontinental Biological Relationships of Early South American Remains: A Multivariate Analysis. *Ciencia e Cultura*, 41:566–575.

——— 1991 Morphological Affinities of the First Americans: An Exploratory Analysis Based on Early South American Human Remains. *Journal of Human Evolution*, 21:261–273.

Neves, W. A., M. C. Zanini, D. Munford, and H. M. Pucciarelli 1997 ● Povoamento da America Luz da Morfologia Craniana. *Revista USP*, 34:96–105.

Steele, D. G., and J. F. Powell 1992 Peopling of the Americas: The Paleobiological Evidence. *Human Biology*, 64:303–336.

——— 1993 Paleobiology of the First Americans. *Evolutionary Anthropology*, 2:138–146.

Taylor, R. E., D. L. Kirner, J. R. Southon, and J. C. Chatters 1998 Radiocarbon Dates of Kennewick Man. *Science* 280:1171–1172.

Turner, C. G. 1983 Dental Evidence for the Peopling of the Americas. In *Early Man in the New World*, edited by Richard Shutler, Sage Publications, Beverly Hills, pp. 147–157.

Were the Fuegians Relicts of a Paleoindian Nonspecialized Morphology in the Americas?

Walter A. Neves, Max Blum, and Lyvia Kozameh

For the last decade, one of us (WAN) has been generating mounting evidence for the presence in South America of a morphologically nonspecialized group that migrated to the continent prior to colonizers showing classical Mongoloid morphology (Neves and Pucciarelli 1989, 1991; Neves et al. 1996a, 1996b, 1998). Physical anthropologists working with North American ancient material have found similar results (Powell and Steele 1992; Steele and Powell 1992, 1993, 1994).

The hypothesis that two or more different waves of migration came to the Americas in early times received an important contribution by Lahr (1995),

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who has shown that a nonspecialized Mongoloid morphology survived until recently in Tierra del Fuego. In this paper we explore the cranial morphology of the Fuegians, comparing them with local Paleoindian and archaic populations and also with Howells's (1989, 1973) reference populations.

The assessment of the morphological affinities among these skeletal samples was carried out using principal components analysis (SPSS software program). The means used for three Fuegian groups (Yámana, Kawéskar and Selk'nam) were taken from Hernández et al. (1997). The Haush data, also from Tierra del Fuego, is unpublished and was collected by two of us (WAN and LK) last year in National University of Rosário, Argentina, while the Palli Aike (late South America Paleoindian, 8,639 ± 450 yr B.P.) and the Cerro Sota (archaic South American, 3,755 ± 65 yr B.P.) specimens were measured by one of us (WAN) in 1996 in the American Museum of Natural History. All the measurements followed Howells's specifications (1989, 1973).

The results are depicted in Figure 1. Principal Component 1 expresses mainly the information about size: high positive values mean large skulls and vice-versa. Principal Component 2 is influenced mainly by cranial length and cranial breadth: high positive values for PC2 mean longer and narrower skulls. A clear cluster can be seen containing the four Fuegian groups and two of the Polynesian populations (MOR, MOK). A second cluster is formed by African and Australian populations (TEI, TOL, ZUL, TAS, AUS) plus Palli Aike, while a third cluster is formed mainly by Mongoloid groups (HAI, PER, SCR, ARI) plus Cerro Sota.

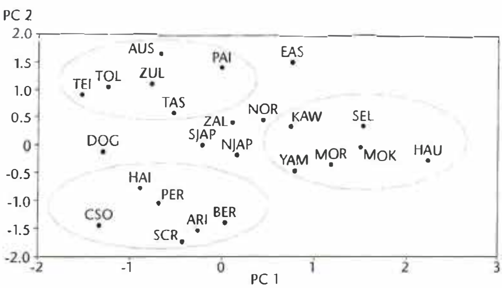

Figure 1. Morphological affinities of the studied samples along the first two principal components (explaining 74.3 percent of the original information). *Population legends*: HAU, Haush; SEL, Selk'nam; KAW, Kawéskar; YAM, Yámana; PAI, Palli Aike; CSO, Cerro Sota; MOK, Mokapu; MOR, Moriori; EAS, Easter Island; NOR, Norse; ZAL, Zalavar; SJAP, South Japan; NJAP, North Japan; DOG, Dogon; HAI, Hainan; PER, Peru; BER, Berg; ARI, Arikara; SCR, Santa Cruz; AUS, Australia; ZUL, Zulu; TAS, Tasmania; TOL, Tolai; TEI, Teita. *Cranial measurements used*: GOL, Glabello–occipital length; XCB, Maximum cranial breadth; AUB, Biauricular breadth; FRC, Frontal chord; PAC, Parietal chord; OCC, Occipital chord

The affinities of the Palli Aike skull with modern Africans and Australians and of Cerro Sota with Mongoloids seem to confirm the idea defended by Neves that South America was occupied by at least two different populations in ancient times, with non-Mongoloids arriving prior to the typical Mongoloids. As for the Fuegians, they do show a distinct morphology when compared with Amerindians. However, the same is true when they are compared with local Paleoindians. Three scenarios can be proposed to explain their unique morphology: First, they could be derived from the amply accepted

Mongoloid migration to the Americas and have suffered in situ extreme biological adaptations due to the harsh conditions they lived under, as suggested by Hernández (1997). Second, as apparently favored by Lahr (1995), their distinctive features could be due to a migration characterized by individuals showing generalized Mongoloid morphology, similar to the Polynesians. And third, we add, late Fuegians could be the result of interbreeding between the two different morphologies present in Tierra del Fuego in prehistoric times followed by a late microevolutionary process leading to size increase.

Unfortunately we cannot tell what force produced what we observed, and more data will be required to clarify this matter along with the question of the peopling of the Americas.

References Cited

Hernández M., C. L. Fox, and C. García-Moro 1997 Fuegian Cranial Morphology: The Adaptation to a Cold, Harsh Environment. *American Journal of Physical Anthropology,* 103:103–117.

Howells, W. W. 1973 Cranial Variation in Man. A Study of Multivariate Analysis of Patterns of Difference among Recent Human Populations. Papers of the Peabody Museum of Archaeology and Ethnology. Harvard University Press, Cambridge.

——— 1989 *Skull Shapes and the Map. Craniometric Analysis in the Dispersion of Modern Homo.* Papers of the Peabody Museum of Archaeology and Ethnology. Harvard University Press, Cambridge.

Lahr, M. M. 1995 Patterns of Modern Human Diversification: Implications for Amerindian Origins. *Yearbook of Physical Anthropology,* 38:163–198.

Neves, W. A., D. Meyer, and H. M. Pucciarelli 1996b Early Skeletal Remains and the Peopling of the Americas. *Revista de Antropologia,* 39:121–139.

Neves, W. A., D. Munford, and M. C. Zanini 1996a Cranial Morphological Variation and the Colonization of the New World: Towards a Four Migration Model. *American Journal of Physical Anthropology,* Supplement 22:176.

Neves, W. A., J. F. Powell, A. Prous, and E. G. Ozolins 1998 Lapa Vermelha IV, Hominid 1: Morphological Affinities of the Earliest Known American. *American Journal of Physical Anthropology,* Supplement 26:169.

Neves, W. A., and H. M. Pucciarelli 1989 Extra-continental Biological Relationships of Early South American Human Remains: A Multivariate Analysis. *Ciência e Cultura,* 41:566–575.

——— 1991 Morphological Affinities of the First Americans: An Exploratory Analysis Based on Early South American Human Remains. *Journal of Human Evolution,* 34:219–222.

Powell, J. F., and D. G. Steele 1992 A Multivariate Craniometric Analysis of North American Paleoindian Remains. *Current Research in the Pleistocene,* 9:59-62.

Steele, D. G., and J. F. Powell 1992 Peopling of the Americas: Paleobiological Evidence. *Human Biology,* 64:303–336.

——— 1993 Paleobiology of the first Americans. *Evolutionary Anthropology,* 2:138–146.

——— 1994 Paleobiological Evidence of the Peopling of the Americas: A Morphometric View. In *Method and Theory for Investigating the Peopling of the Americas,* edited by R. Bonnichsen and D. G. Steele, Center for the Study of the First Americans, Corvallis.

Lithic Studies

Morphofunctional Variability among Graving-Tool Subassemblages from Paleoindian Occupation Sites, Southwest Montana

Leslie B. Davis, Marvin Kay, and Troy C. Helmick

"Graving" implements have long been suggested as a Paleoindian diagnostic (Nero 1957), with characteristic occurrence since demonstrated at some Great Plains Paleoindian sites (Irwin and Wormington 1970). Particular emphases are indicated for the Goshen/Plainview (Akoshima and Frison 1996), Hell Gap (Frison 1974), Cody (Frison 1987), Folsom (Frison and Bradley 1980), Agate Basin (Frison and Stanford 1982), and Pryor-Stemmed (Frison and Grey 1980) complexes. Rogers (1986) has used the occurrence of gravers in stratified contexts as Paleoindian-occupation markers.

Intensive analytical efforts (cf. Keeley 1980; Lynott 1975), using microwear to define or validate the function or multiple functions of morphologically distinctive sets of "gravers" in Paleoindian lithic artifact assemblages, have proven insightful. For instance, low-power microscopy (Tomenchuk and Storck 1996, 1997) differentiated single- and double-scribe compass and coring gravers within a lithic artifact assemblage from southern Ontario Paleoindian sites. Recognition and recovery of numerous potential gravers in surface-collected lithic artifact collections from annually resurrected inundated surfaces at the southern extremity of Canyon Ferry Lake, upper Missouri River drainage, by Helmick (Davis and Helmick 1982; Greiser 1986) fostered microwear analysis. Collected annually with systematic spatial attribution from Localities and Sublocalities IIa, Va, Va-North, Vc, and Va-South, and Ve, these artifacts include 68 notched and narrow, steeply resharpened unifaces with projections as potential graving tools, produced from microcrystalline quartzite and secondarily from chert. Kay subjected 24 to microwear analysis (for methodology, see Kay 1996, 1997).

For comparison, similarly analyzed were potential flake graving tools from Paleoindian occupation sites located in mountain-foothills settings in west-central and southwestern Montana: Folsom Complex (24BW626) at Indian Creek (Davis and Greiser 1992; Davis et al. 1985); Hardinger Complex

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(24MA171) at Barton Gulch (Davis et al. 1989; Greiser n.d); and Alder Complex (24JF292) at Sheep Rock Spring (Wilson and Davis 1994).

Of the 33 flake tools evaluated for microscopic wear traces, 4 had not been employed as gravers. The remaining 29 tools (6 from Indian Creek, 2 from Barton Gulch, 20 from Canyon Ferry Lake, 1 from Sheep Rock Spring) indicate use on a medium hard to hard contact material by all gravers. These represent three discrete types of graving tools: 1) graver tips used as individual engraving implements to bore, slot, or pierce. Identified use-wear indicates both rotary motion at the tip plus pushing and pulling of the tip through the contact material. Some of these tools are single graver spurs, while others are multi-spurred and were used in a serial fashion—one spur at a time, in which process dulled spurs were abandoned, not maintained; 2) compass gravers, following criteria of Tomenchuk and Storck (1997), also along with others used as individual graving spurs. The key element of compass gravers is the use of paired graver spurs, in which one served as a pivot point and the other as an engraving scribe, which together created engraved circles, rings, or disks. The compass graver use-wear is asymmetrical in distribution and concentrates on the inner sides of the two paired tips; rotary motion is clear on one of the paired tips, while the other appears to have been dragged across a worked surface; and 3) parallel gravers consisting of two or more graving spurs, all showing the same use-wear orientation. A consistent single or bidirectional movement of the graving spurs across an inscribed surface is indicated. This motion would have created narrow, parallel-sided engraved lines, strips, or ribbons from the contact material.

Microscopic evidence of prehension and of hafting is also present in this sample. A schematic breakdown of this evidence for the three functional graver categories showed that individual and serial gravers, or Group 1, were mostly hand-held. Compass gravers, or Group 2, were more likely to have been attached to a handle. The two parallel gravers, or Group 3, were employed in both modes, but are too few to discern any consistent patterning for having been hand-held or hafted.

Microwear analysis is required to infer detailed task-related functions. While the absence of graved raw materials and products from these assemblages is a limitation imposed by archaeological record survival, it will be nevertheless tempting to speculate about the factors that selected against this aspect of the Paleoindian hunter-gatherer tool kit among later peoples.

The Canyon Ferry Lake Collection is held at the Museum in behalf of the U.S. Bureau of Reclamation. Microwear analysis by Kay was funded by the Kokopelli Archaeological Research Fund, which supports the Paleoindian Research Program directed by Davis for the Museum of the Rockies, private contributions, and cost-sharing with KayMicrowear.

References Cited

Akoshima, K., and G. C. Frison 1996 Lithic Microwear Studies of the Mill Iron Site Tools. In *The Mill Iron Site*, edited by G. C. Frison, pp. 71–86. University of New Mexico Press, Albuquerque.

Davis, L. B., S. A. Aaberg, W. P. Eckerle, J. W. Fisher, Jr., and S. T. Greiser 1989 Montane Paleoindian Occupation of the Barton Gulch Site, Ruby Valley, Southwestern Montana. *Current Research in the Pleistocene* 6:7–9.

Davis, L. B., and S. T. Greiser 1992 Indian Creek Paleoindians: Early Occupation of the Elkhorn Mountains' Southeast Flank, West-Central Montana. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 225–283. Denver Museum of Natural History and University Press of Colorado.

Davis, L. B., S. T. Greiser, and N. Toth 1985 Use-Wear Analyses of Paleoindian Unifaces from the Initial Occupation at the Indian Creek Site. *Current Research in the Pleistocene*, 2:45–46.

Davis, L. B., and T. Helmick 1982 Inundated Prehistoric Occupation Sites along Canyon Ferry Lake. *Archaeology in Montana*, 23(3):41–84.

Frison, G. C. 1974 Archeology of the Casper Site. In *The Casper Site: A Hell Gap Bison Kill on the High Plains*, edited by G. C. Frison, pp. 1–111. Academic Press, Inc., New York.

——— 1987 The Tool Assemblage, Unfinished Bifaces, and Stone Flaking Material Sources for the Horner Site. In *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by G. C. Frison and L. C. Todd, pp. 233–278. Academic Press, Inc., New York.

Frison, G. C., and B. A. Bradley 1980 *Folsom Tools and Technology at the Hanson Site, Wyoming*. University of New Mexico Press, Albuquerque.

Frison, G. C., and D. C. Grey 1980 Pryor Stemmed: A Specialized Paleo-Indian Ecological Adaptation. *Plains Anthropologist*, 25(87):27–46.

Frison, G. C., and D. J. Stanford 1982 *The Agate Basin Site: A Record of the Paleoindian Occupation of the Northwestern High Plains*. Studies in Archaeology. Academic Press, Inc., New York.

Greiser, S. T. 1986 Artifact Collections from Ten Sites at Canyon Ferry Reservoir. *Archaeology in Montana* (1&2):1–190.

——— in prep. Alder Complex Bifacial and Unifacial Lithic Artifacts. In: *Paleoindian Foragers of the Northern Rockies: The Barton Gulch Site, Upper Ruby Valley, Southwest Montana*, edited by L. B. Davis.

Irwin, H. T., and H. M. Wormington 1970 Paleo-Indian Tool Types in the Great Plains. *American Antiquity*, 35:24–34.

Kay, M. 1996 Microwear Analysis of Some Clovis and Experimental Chipped Stone Tools. In *Stone Tools: Theoretical Insights Into Human Behavior*, edited by G. H. Odell, pp. 315–344. Plenum Press, New York.

——— 1997 Imprints of Ancient Tool Use at Monte Verde. In *Monte Verde: A Late Pleistocene Settlement in Chile, Volume II: The Archaeological Findings*, edited by T. E. Dillehay, pp. 649–660. Smithsonian Institution Press, Washington, D.C.

Keeley, L. H. 1980 *Experimental Determination of Stone Tool Uses: A Microwear Analysis*. University of Chicago Press.

Lynott, M. J. 1975 Explanation of Microwear Patterns on Gravers. *Plains Anthropologist* 20(68): 121–128.

Nero, R. W. 1957 A "Graver" Site in Wisconsin. *American Antiquity*, 22:300–304.

Rogers, R. A. 1986 Spurred End Scrapers As Diagnostic Paleoindian Artifacts: A Distributional Analysis on Stream Terraces. *American Antiquity*, 51:338–341.

Tomenchuk, T., and P. L. Storck 1996 Use-Wear Studies at an Early Paleoindian Source of Toolstone, Southern Ontario. *Current Research in the Pleistocene* 13:66–67.

——— 1997 Two Newly Recognized Paleoindian Tool Types: Single- and Double-Scribe Compass Gravers and Coring Gravers. *American Antiquity*, 62:508–522.

Wilson, M. C., and L. B. Davis 1994 Late Quaternary Stratigraphy, Paleontology, and Archaeology of the Sheep Rock Spring Site (24JF292), Jefferson County, Montana. *Current Research in the Pleistocene*, 11:100–102.

Obsidian Sourcing of Paleoindian Points from the Sevier Desert, Utah

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Sourcing of two Paleoindian obsidian projectile points from central Utah found both were made from local materials. The points are attributed to 42MD300, a site near the ancient confluence of the Beaver and Sevier Rivers west of Delta, Utah, and a documented source of lanceolate points, crescents, and fluted forms (Simms and Lindsay 1989). Both points were illustrated by Simms and Lindsay (1989:59); Copeland and Fike (1988:12, Figure 3) provided some metrics of the Folsom. The artifacts were borrowed from the West Millard Great Basin Museum and Historical Society in Delta, Utah.

The specimens include a Folsom (Figure 1A) and a Meserve point (Simms and Lindsay 1989) (Figure 1B). Both specimens are heavily hydrated. The Folsom is complete and measures 4.8 cm long, 2.4 cm wide, 0.45 cm thick, and 1.6 cm across the flute. Flutes extend nearly to the distal end on both faces; distal resharpening is clearly evident. Very little basal or margin grinding is present.

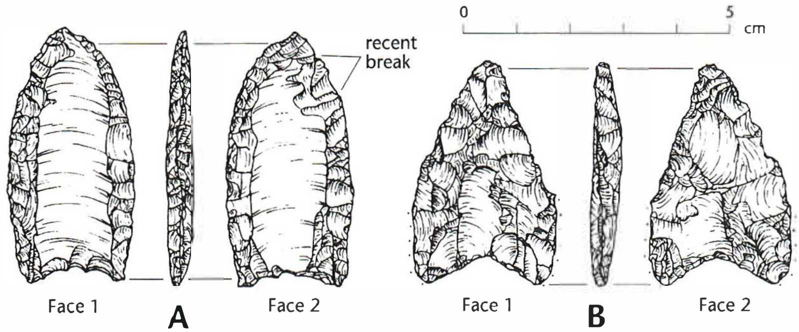

Figure 1. Fluted projectile points from 42MD300 in western Utah: **A**, Folsom; **B**, reworked Clovis or Meserve.

The second point, which has been extensively reworked, is 4.3 cm long, 2.7 cm wide, and 0.55 cm thick. Blade margins are roughly parallel for about 1.5 cm, then abruptly taper. Shallow flutes are present on both faces. The distal end has been roughly reworked with alternate retouch resulting in a beveled appearance. The lower blade margins are well ground and some basal grinding is present. Technologically and morphologically this specimen resembles a reworked Clovis.

The two obsidian artifacts were analyzed without destruction or modification. The only sample preparation was to clean each with acetone. The analysis was conducted by placing the artifact directly in the rhodium X-ray

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beam of a Siemens SR-303 wavelength dispersive X-ray fluorescence spectrometer. The fluorescent X-rays were then measured using wavelength dispersive detection. Ratios of different elements were compared with ratios of the same elements from geologic sources of obsidian for source identification. The analysis found the Folsom obsidian is from the School Mine area of the Mineral Mountains; the Meserve or Clovis point obsidian is most similar to the Black Rock Desert flow. Both sources are found in west central Utah (Nelson and Holmes 1979).

These data add modestly to our knowledge of Paleoindian use of Utah obsidian. A review of Utah fluted points reveals that obsidian was not the preferred toolstone (Copeland and Fike 1988; Larson 1990). Twenty-four percent of fluted points from the state are obsidian; all came from west of the Wasatch Front.

References Cited

Copeland, J. M., and R. E. Fike 1988 Fluted Projectile Points in Utah. *Utah Archaeology*, 1988:5–28.

Larson, V. 1990 A Fluted Point from Clear Creek Canyon, Central Utah. *Utah Archaeology*, 1990:133–138.

Nelson, F. W., Jr., and R. D. Holmes 1979 *Trace Element Analysis of Obsidian Sources and Artifacts from Western Utah*. Antiquities Section Selected Papers, vol. 6 (15). Utah Historical Society, Salt Lake City.

Simms, S. R., and L. W. Lindsay 1989 42MD300, An Early Holocene Site in the Sevier Desert. *Utah Archaeology*, 1989:56–76.

Geochemical Source Analysis of Archaeological Obsidian in Primorye (Russian Far East)

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From 1992 to 1996 we conducted a geochemical investigation of archaeological obsidian in the Primorye (Maritime) Province of the Russian Far East using both Energy Dispersive X-Ray Fluorescence (EDXRF) and Instrumental Neutron Activation Analysis (INAA) (Shackley et al. 1996). In 1996–1998

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we obtained additional data from geological sources using INAA. In total, 160 samples of volcanic glass from 23 prehistoric sites and 24 outcrops, located in central and southern Primorye and on the border between China and North Korea, were analyzed. As a consequence of this study, we can now identify the main sources of archaeological obsidian in the Primorye for several prehistoric cultures, including the Late Paleolithic, ca. 15,000–8,000 yr B.P., Neolithic, ca. 8,000–3,000 yr B.P., and Bronze and Early Iron Ages, ca. 3,000–1,500 yr B.P. (Kuzmin et al. 1998). Statistical groupings, based on bivariative and 3-D plots, cluster, and discriminant classification analyses (Glascock et al. 1998), indicate three major geochemical groups reflecting the main sources of archaeological obsidian in the region.

Source 1 originates from late-Tertiary basalt lava flows on two plateaus in southern Primorye, Shkotovo and Borisovka (Shufan). As a result of water erosion, high-quality obsidian pebbles were concentrated on the floodplains of rivers draining both plateaus. There are at least 19 prehistoric sites, ranging from the late Paleolithic to Early Iron Age, with obsidian artifacts from Source 1. The artifacts can be subdivided into two groups representing both 10 local and 9 remote sites. The local group is situated near the basalt outcrops. A majority of the remote sites consist of a cluster of Ustinovka late-Paleolithic culture sites in the Zerkalnaya River basin, about 170–300 km from the obsidian source. Our results clearly show that no local obsidian sources were exploited there during the late Paleolithic, supporting an earlier conclusion made by Vasilievsky and Gladyshev (1989).

Source 2 is represented by a medium-quality rhyolithic glass from Tertiary dikes and small extrusive domes in the Ryazanovka and Vinogradnaya River basins in extreme southwestern Primorye. Three prehistoric sites correlate with this source. The distance between source and site varies from 30 to 380 km.

Source 3 is located on the modern Paektu San volcano along the Chinese–North Korean border. High-quality obsidian from the Paektu San source was found at nine sites, with the distance between source and site varying from 230 to 615 km. Our discovery that the prehistoric inhabitants of Primorye used the Paektu San obsidian beginning with the final Paleolithic (ca. 10,000 yr B.P.) and increased through the Zaisanovka culture of late Neolithic (ca. 5,700–3,000 yr B.P.) is important. On the Korean Peninsula, widespread use of Paektu San obsidian in prehistory is also known, with the distance from source to utilization site up to 350–450 km (Pokee and Shin 1991).

Sources 1 and 2 may be considered as local; Source 3 is considered an exotic source for the Primorye. For the first time in the Russian Far East, we have established on the basis of geochemical data a wide use of exotic obsidian from the Pleistocene volcano Paektu San, along with local obsidian sources such as the Miocene-Pliocene basalts and rhyoliths. There is clear evidence of intensive long-distance exchange (and possibly trade) of obsidian within Primorye and with adjacent territories of Northeastern Asia since final Paleolithic, ca. 11,500 yr B.P.

This study was partly supported by grants from USA NSF (SBR-9503035), Russian RGNF (# 95-06-17515), and Russian RFFI.

References Cited

Glascock, M. D., G. E. Braswell, and R. H. Cobean 1998 A Systematic Approach to Obsidian Source Characterization. In *Archaeological Obsidian Studies: Method and Theory*, edited by M. S. Shackley, pp. 15–65. Plenum Press, New York.

Kuzmin, Y. V., A. J. T. Jull, L. A. Orlova, and L. D. Sulerzhitsky 1998 Radiocarbon Chronology of the Stone Age Cultures, Russian Far East: An Assessment of Chrono-Cultural Boundaries. *Radiocarbon*, 40(1):675–686.

Shackley, M. S., M. D. Glascock, Y. V. Kuzmin, and A. V. Tabarev 1996 Geochemical Characterization of Archaeological Obsidian from the Russian Far East: A Pilot Study. *International Association for Obsidian Studies Bulletin*, 17:16–19.

Pokee, S., and S. Shin 1991 A Shell Midden on the Island Sangnodaedo: A Neolithic Site off the Southern Coast of Korea. *Bulletin of the Indo-Pacific Prehistory Association*, 10:109–117.

Vasilievsky, R. S., and S. A. Gladyshev 1989 *Upper Paleolithic of Southern Primorye*. Nauka Publishers, Novosibirsk (in Russian).

Results of Additional XRF Analysis of New Mexico Folsom Obsidian Artifacts

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This paper is the fourth in a series presenting results of the only systematic study of obsidian Folsom artifacts from New Mexico (LeTourneau and Baker 1999; LeTourneau et al. 1996, 1998). The study was undertaken to provide reliable toolstone source information for Folsom artifacts and to document the scale of obsidian transport and use during this period.

The previous papers discussed both XRF and macroscopic analyses of 164 obsidian Folsom points, preforms, and channel flakes from 30 sites. Although obsidian accounts for only a small fraction of all artifacts in the greater Southwest and Southern Plains, it accounts for roughly 15 percent of all diagnostic Folsom artifacts from central New Mexico. Of the 164 obsidian artifacts, 22 were analyzed by XRF; four known sources and one unknown source were identified. All four known sources are in central New Mexico: Cerro Toledo Rhyolite, El Rechuelos Rhyolite, and Valle Grande Member in the Jemez Mountains; and Grants Ridge/Horace Mesa near Mount Taylor. Macroscopic analysis of the remaining 142 obsidian artifacts indicated that the same four sources were represented, and that 93 percent of all 164 were from the Valle Grande Member source.

In this paper, we present results of a recent XRF analysis of 13 New Mexico

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obsidian Folsom artifacts (Kunselman 1998). These 13 are from 10 sites in the Albuquerque and Estancia Basins and are a subset of the 164 obsidian artifacts discussed above. Of these, 11 had been previously analyzed only macroscopically, while the remaining 2 had also previously been analyzed by XRF. We chose these pieces primarily to check the dominance of the Valle Grande Member seen in the previous analyses and to test the possibility that Cerro Toledo Rhyolite artifacts were being misidentified as Valle Grande Member. Thus, 11 pieces were selected that looked like Valle Grande Member or exhibited colors that overlap those of Cerro Toledo Rhyolite (LeTourneau et al. 1997; Vierra 1993:161). The two artifacts we reanalyzed were chosen to compare XRF results; one of these is the previous "unknown," and the other was previously assigned to the Grants Ridge/Horace Mesa source. Of the 11 assigned macroscopically to the Valle Grande Member, XRF determined that all but one are, in fact, Valle Grande Member; the single exception is a Cerro Toledo Rhyolite point from the Estancia Basin. The unknown artifact was also assigned to the Valle Grande Member source. The assignment of the final artifact to the Grants Ridge/Horace Mesa source was confirmed.

Obsidian from all but the Valle Grande Member source has been documented in secondary deposits. While secondary sources are closer to the sites than the primary sources, only Grants Ridge/Horace Mesa clasts reach usable size (>10 cm) in those deposits. Therefore, the Grants Ridge/Horace Mesa obsidian was the only one not necessarily procured from primary sources; artifacts of this material occur at an average distance of 20 km from the secondary sources. The small size (<10 cm) of Cerro Toledo Rhyolite and El Rechuelos Rhyolite clasts in secondary deposits leads us to suspect Folsom use of the primary sources. Artifacts of these two obsidian varieties occur at average distances of 165 km and 45 km, respectively, from the primary sources. The artifact farthest removed from its source is a point of Cerro Toledo Rhyolite obsidian 370 km away on the Llano Estacado. Valle Grande Member artifacts occur at an average distance of 100 km from the primary source. The average distances over which Cerro Toledo Rhyolite and Valle Grande Member obsidians were transported as seen in this study contradict earlier conclusions that most Folsom obsidian procurement in central New Mexico was largely local (LeTourneau et al. 1996:60). Compared with other time periods, Folsom use of obsidian in central New Mexico is very similar to that of the rest of the Paleoindian period as well as the early-Archaic period; this is true both in terms of the sources used and the frequency of obsidian use for point manufacture.

Our new data confirm the patterns seen in our previous analyses: four central New Mexico sources are represented in New Mexico Folsom assemblages, Valle Grande Member obsidian dominates, and average distances for artifacts from the four sources range from 20 to 165 km. There are hints of a pattern of long-distance movement of Cerro Toledo Rhyolite obsidian to the east of the Albuquerque Basin in that the only obsidian points from the Estancia Basin and Llano Estacado are both from that source. The 33 Folsom artifacts from 16 New Mexico sites thus far analyzed by XRF account for 20 percent of all 164 obsidian artifacts in the study. Work continues on documenting the occurrence of Folsom obsidian artifacts as well as the geology of New Mexico obsidian sources.

References Cited

Kunselman, R. 1998 UWXRF Letter Report 98.1. Report to Tony Baker, February 5.

LeTourneau, P. D., S. Aby, and R. Kunselman 1997 Lithic Resources of the Jemez Mountains. In *OLE Volume II: Artifacts*, edited by J. C. Acklen, pp. 1–29. Public Service Company of New Mexico, Albuquerque.

LeTourneau, P. D., and T. Baker 1999 Folsom Use of Obsidian in the Southwest. Paper presented at the Folsom Conference II, March 4, Austin.

LeTourneau, P. D., M. S. Shackley, and T. Baker 1998 Folsom Period Obsidian Use in New Mexico. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, March 28, Seattle.

LeTourneau, P. D., M. S. Shackley, J. M. Warnica, and J. Cummings 1996 Analysis of Folsom Obsidian Artifacts from New Mexico. *Current Research in the Pleistocene,* 13:59–61.

Vierra, B. J. 1993 Lithic Resource Variation across the Colorado Plateau. In *Across the Colorado Plateau: Anthropological Studies for the Transwestern Pipeline Expansion Project, Volume 17: Architectural Studies, Lithic Analyses, and Ancillary Studies,* edited by B. J. Vierra, T. W. Burchett, K. L. Brown, M. E. Brown and C. J. Phagan, pp. 157–167. Office of Contract Archaeology and Maxwell Museum of Anthropology, University of New Mexico, Albuquerque.

Modeling Folsom Point Manufacture: Theme and Variations

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Since their initial discovery with *Bison antiquus* in New Mexico, Folsom points and their method of manufacture have fascinated generations of archaeologists (Amick 1994; Boldurian and Hubinsky 1994; Bradley 1982:186–194; Frison and Bradley 1980, 1981; Hofman 1992; Judge 1970; Renaud 1931; Roberts 1935; Tunnell 1977; Wormington 1957:37–38). This fascination led to diverse experiments and sometimes acrimonious discussions about how to properly replicate the distinctive form, dimensions, and flaking patterns of Folsom points (Crabtree 1966; Flenniken 1978; Gryba 1988, 1989; Sollberger 1985, 1989). Based on unfinished, often broken specimens from places like Lindenmeier, Adair-Steadman, and several central New Mexico sites, a model of Folsom projectile point manufacture has emerged and prevailed (Judge 1970; Roberts 1935; Tunnell 1977; Wormington 1957:37–38). This model posits that Folsom knappers used soft hammers to remove large, thin flakes from large biface cores. Once removed, these flake blanks were bifacially

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chipped (by pressure) into relatively wide elliptical preforms, which were biconvex in cross section. Then the selected base was beveled and shaped to produce a prominent central projection that became the platform for fluting one face. Once that face was fluted, the base was re-beveled and a second fluting platform prepared and utilized to flute the opposite face. Enough Folsom points broken in manufacture have been reported to substantiate this model as the prevailing method used by Folsom residents on the Northern, Central, and Southern Plains. However, specimens representing exceptions to this construct do exist (Hofman 1993: Figure 6; Hofman et al. 1990: Figure 4). Recently, one was found in north-central Oklahoma, and it is reported here.

Made from yellow-brown patinated Wreford chert, this broken artifact (Figure 1) was found in the Arkansas River below Kaw Dam, a Corps of Engineers impoundment in Kay County, Oklahoma. The Kaw Reservoir lies just west of the Flint Hills extension into north-central Oklahoma. Banks (1984: Figure 3.4) plots the Wreford Formation in the uplands east of the river, but prehistoric quarries in the Florence Formation, which caps parts of these uplands, are better known (Banks 1984, 1990:96–101; Gould 1898, 1899; Vehik 1982).

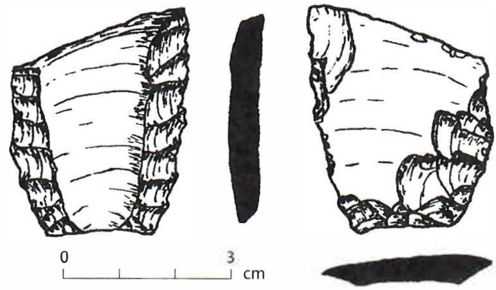

Figure 1. Both faces of the unfinished Folsom point found in the Arkansas River in Kay County, Oklahoma. The raw material is Wreford chert.

Although incomplete, the specimen in Figure 1 measures 4.1 cm in maximum length, 3.2 cm in maximum width, 0.52 cm in maximum thickness, 0.3 cm in thickness where fluted, and 7.2 g in weight. A brief examination of this specimen reveals that it was made from a wide, thin flake. The lateral edges display flake scars 0.3–0.9 cm wide that invade the ventral face to a depth of 0.9–1.1 cm. Fully three-quarters of this face retains the fracture mirror of the original flake, and its bulb of force was largely removed by basal and lateral flake scars. The slightly concave base on this ventral face has continuous short (0.5 cm), steep flake scars that form a platform angle of 54 degrees. On the opposite face, this platform was the initiation point of an expanding fluting scar that truncated continuous lateral flake scars and that ended in an *outre passe* termination that carried off the end of the specimen. The lateral flake scars are 0.45–0.6 cm wide and lie 10–15 degrees diagonal to the longitudinal axis of the specimen.

From its morphology, dimensions, and flaking patterns, this Oklahoma find has to be attributed to the Folsom material culture. Folsom points do occur in north-central Oklahoma (Hofman 1993), and even more are noted

(Hofman 1994) in Kansas north and east of this find. So, our Kay County, Oklahoma, specimen is not beyond the known distribution of Folsom points. Most importantly, this Oklahoma find bears witness to the fact that Folsom points could be made by laterally flaking and fluting one face at a time rather than sequentially fluting convex faces bifacially chipped onto a flake blank. Yes, this Oklahoma find does attest to the fact that the knapper's individual approach was unsuccessful. But if this individual successfully fluted the dorsal face and then laterally flaked and fluted the ventral face, how would we recognize that knapping sequence? Clearly, rather than impose a model on the data, we should let the archaeological materials inform us about Folsom knapping strategies in different regions.

My thanks to Barry Splawn for loaning me this artifact for study and to Jesse Ballenger for critically reviewing a draft of this manuscript.

References Cited

Amick, D. S. 1994 Technological Organization and the Structure of Inference in Lithic Analysis: An Examination of Folsom Hunting Behavior in the American Southwest. *The Organization of North American Chipped Stone Tool Technologies*, edited by P. J. Carr, pp. 9–34. International Monographs in Prehistory, Archaeology Series 7. Ann Arbor.

Banks, L. D. 1984 Lithic Resources and Quarries. *Prehistory of Oklahoma*, edited by R. E. Bell, pp. 65–95. Academic Press, Orlando.

——— 1990 *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Sources in the Trans-Mississippi South, the Southern Plains, and Adjacent Southwest.* Oklahoma Anthropological Society, Memoir 4.

Boldurian, A. T., and S. M. Hubinsky 1994 Preforms in Folsom Lithic Technology: A View from Blackwater Draw, New Mexico. *Plains Anthropologist*, 39(150):445–464.

Bradley, B. A. 1982 Lithic Technology: 1, Flaked Stone Technology and Typology. *The Agate Basin Site, A Record of Paleoindian Occupation of the Northwestern High Plains*, edited by G. C. Frison and D. J. Stanford, pp. 181–208. Academic Press, New York.

Crabtree, D. E. 1966 A Stoneworker's Approach to Analyzing and Replicating the Lindenmeier Folsom. *Tebiwa*, 9(1):3–39.

Flenniken, J. J. 1978 Reevaluation of the Lindenmeier Folsom: A Replication Experiment in Lithic Technology. *American Antiquity*, 43(3):473–480.

Frison, G. C., and B. A. Bradley 1980 *Folsom Tools and Technology at the Hanson Site, Wyoming.* University of New Mexico Press, Albuquerque.

——— 1981 Fluting Folsom Projectile Points: Archeological Evidence. *Lithic Technology*, 10(1):13–16.

Gould, C. N. 1898 The Timbered Mounds of the Kaw Reservation. *Transactions of the Kansas Academy of Science*, 15:78–79.

——— 1899 Additional Notes on the Timbered Mounds of the Kaw Reservation. *Transactions of the Kansas Academy of Science*, 16:282.

Gryba, E. M. 1988 A Stone Age Method of Folsom Fluting. *Plains Anthropologist*, 33(119):53–66.

——— 1989 A Mousetrap 10,000 Years Too Late. *Plains Anthropologist*, 34(123):65–68.

Hofman, J. L. 1992 Recognition and Interpretation of Folsom Technological Variability on the Southern Plains. *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 193–224. Denver Museum of Natural History and University Press of Colorado, Niwot, Colorado.

——— 1993 An Initial Survey of the Folsom Complex in Oklahoma. *Bulletin of the Oklahoma Anthropological Society*, 41:71–105.

——— 1994 The Occurrence of Folsom Points in Kansas. *Current Research in the Pleistocene,* 11:37–39.

Hofman, J. L., D. S. Amick, and R. O. Rose 1990 Shifting Sands: A Folsom-Midland Assemblage from a Campsite in Western Texas. *Plains Anthropologist,* 35(129):221–253.

Judge, W. J. 1970 Systems Analysis and the Folsom-Midland Question. *Southwestern Journal of Anthropology,* 26(1):40–51.

Renaud, E. B. 1931 *Prehistoric Flaked Points from Colorado and Neighboring Districts.* Proceedings of the Colorado Museum of Natural History 10(2).

Roberts, F. H. H. 1935 *A Folsom Complex: Preliminary Report on Investigations at the Lindenmeier Site in Northern Colorado.* Smithsonian Miscellaneous Collections 94(4).

Sollberger, J. B. 1985 A Technique for Folsom Fluting. *Lithic Technology,* 14(1):41–50.

——— 1989 Comment on: A Stone Age Pressure Method of Folsom Fluting by Eugene M. Gryba. *Plains Anthropologist,* 34(123):63–64.

Tunnell, C. 1977 Fluted Projectile Point Production as Revealed by Lithic Specimens from the Adair-Steadman Site in Northwest Texas. *The Museum Journal,* 170:140–168. Lubbock.

Vehik, S. C. 1982 Kay Count Flint Distribution in North Central Oklahoma during the Plains Village Period. University of Oklahoma, Department of Anthropology, *Papers in Anthropology,* 23(1):69–90.

Wormington, H. M. 1957 *Ancient Man in North America.* Denver Museum of Natural History, Popular Series 4.

Methods

A Casting Technique Suitable for High-Power Microwear Analysis

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One problem associated with lithic microwear analysis is access to collections when museums are reluctant to allow their collections to be transported or shipped to the place of analysis. It is impractical to transport the microscope and equipment needed for a high-power analysis to the location where a collection is curated. These two constraints can make the analysis of some collections impossible. This is the case with many sites of Pleistocene age where the lithic artifacts are far too valuable, in terms of research, to be allowed to leave the collections. This paper describes a method for producing high-resolution silicon casts, suitable for high-power microwear analysis, at the institution where a collection is curated.

The idea of casting is not new to microwear analysis, and a number of techniques have been described in the literature (Beyries 1981; Knutsson and Hope 1984; Moss 1983; Plisson 1983). These techniques involve making peels of an artifact surface. Despite their ease, peels produce a negative cast of the artifact surface which makes the identification and interpretation of microwear features difficult. There is also some uncertainty as to how long such casts will maintain their integrity. The use of "Coltène-Whaledent President Plus Regular Body" dental silicon gel to cast artifact surfaces solves these problems.

To my knowledge, the methodology described below has not been used by archaeologists but has been employed by paleoanthropologists (Rose 1983; Teaford and Oyen 1989; Ungar 1994). The method utilizes "Coltène-Whaledent President Plus Regular Body" dental silicon gel to make a negative cast of an artifact surface, which is later used to create a positive epoxy cast. This silicon gel will reproduce features that are visible up to 10,000x magnification (Ungar 1997, pers. comm.) and will maintain its integrity indefinitely (Coltène-Whaledent product literature).

Before the casting is performed, it is necessary to clean the artifact. Unless the artifact is extensively covered with carbonates, acid is not needed. Instead,

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the artifact can be placed in a plastic bag containing a mixture of water and alcohol-based window cleaner. The bag is placed in an ultrasonic cleaner for 20–30 minutes, after which time the artifact can be rinsed and allowed to dry.

The first step in casting is to dispense the needed amount of silicon onto a piece of paper. Next, the artifact surface is pressed into the dispensed gel, making sure that no air pockets are present between the artifact and silicon. The gel and artifact are left to cure for a few minutes, after which time the artifact can be removed, thus leaving a negative cast of the artifact's surface. This negative silicon cast can be transported to the researcher's lab for the creation of positive epoxy casts, which are subjected to the microwear analysis.

To make the positive cast, a mixture of epoxy and catalyst is poured into the negative silicon mold and placed in a vacuum chamber. The epoxy is subjected to multiple vacuum events to remove any air bubbles, making sure that it does not boil in the process. The silicon mold containing the epoxy is removed from the vacuum chamber, leaving the epoxy to harden in the silicon negative. Once cured, the positive epoxy cast can be removed from the silicon mold and is ready to be viewed under the microscope.

The above method is advantageous because it produces casts that replicate microwear features with high resolution, the negative silicon casts maintain their resolution indefinitely, and multiple positive epoxy casts can be made from a single negative cast. Another advantage of casting is the elimination of glare while examining patinated artifacts, which makes possible accurate identification of polishes on such artifacts (Moss 1983:15).

I am using this casting technique to study microwear features preserved on Mousterian and Upper Paleolithic lithic materials from the Solutré site in east-central France. The technique, though, is applicable to Paleoindian assemblages that cannot be removed from the institutions that curate them, or to patinated specimens. This casting technique makes it possible to investigate such assemblages with high-power microwear methods, thereby achieving more detailed understandings of prehistoric lithic economies.

This research would not be possible without the support and advice provided by Dr. Anta Montet-White, Dr. Marvin Kay, Dr. Jean Combier, Dr. Yves Pautrat, Genevieve Lagardere, Catherine Varlot, and Helene Raoult.

References Cited

Beyries, S. 1981 Etude de Traces d'utilisation sur des Empreintes en Latex. *Bulletin de la Société Préhistorique Française* 78(7):198–199.

Knutsson, K., and R. Hope 1984 The Application of Acetate Peels in Lithic Usewear Analysis. *Archaeometry*, 26(1):49–61.

Moss, E. H. 1983 *The Functional Analysis of Flint Implements: Pincevent and Pont d'Ambon, Two Case Studies from the French Final Paleolithic*, vol. 177. BAR International Series, Oxford.

Plisson, H. 1983 An Application of Casting Techniques for Observing and Recording of Microwear. *Lithic Technology*, 12(1):17–21.

Rose, J. J. 1983 A Replication Technique for Scanning Electron Microscopy: Applications for Anthropologists. *American Journal of Physical Anthropology*, 62:255–261.

Teaford, M. F., and O. J. Oyen 1989 Live Primates and Dental Replication: New Problems and New Techniques. *American Journal of Physical Anthropology*, 80:73–81.

Ungar, P. S. 1994 Incisor Microwear of Sumatran Anthropoid Primates. *American Journal of Physical Anthropology*, 94:339–363.

Fluoride/Radiocabon Dating of Late-Pleistocene Bone from Sheriden Cave, Ohio

Kenneth B. Tankersley

Accurate chronologies are essential to demonstrating contemporaneity in late-Pleistocene fossil assemblages containing extinct, extralimital, and non-analog vertebrate species (Semken et al. 1998). Radiocarbon, in specific non-degraded amino acids of collagen and atomically counted with accelerator mass spectrometry (AMS), is the single best method to directly date bone (Stafford et al. 1991). Even high-precision AMS radiocarbon dates, however, are reported with a one-sigma statistical error, that is, a minimum age estimation. Given that a two-sigma error provides a more probable assay of time, patterns in the synchroneity of certain species may simply be a by-product of the limitations of our best dating method.

An important aspect of any comprehensive approach to chronological problems is age verification by a combination of dating techniques (Haynes 1992; Taylor et al. 1996). A more precise chronology can be made by plotting two independent measures of time. For almost 200 years, paleontologists have used fluoride content analysis as a method to provide a relative geological age of vertebrate fossils (Cook 1960; Middleton 1844). Today, fluoride concentrations can be measured in bone, dentin, or enamel using an Ion Selective Electrode (ISE).

By comparing ISE fluoride content analysis with the results of direct high-precision AMS radiocarbon dating of non-degraded amino acids, we can better evaluate the age of late-Pleistocene species. For such comparisons, it is crucial that all radiocarbon dates first be calibrated because fluctuations and plateaus in atmospheric ^{14}C during the late Pleistocene make radiocarbon years appear compressed, representing less time in calendar years (Taylor et al. 1996). Ideally, the curve of the calibrated radiocarbon dates should be linear with the logarithm of the concentration of fluoride.

For this study, I used AMS radiocarbon dates obtained on the bone collagen of three extinct species from Sheriden Cave, Ohio: 10,850 ± 60 yr B.P. (CAMS-26783) on *Castoroides ohioensis*; 11,130 ± 60 yr B.P. (CAMS-33970) on *Platygonus compressus*; and 11,570 ± 50 yr B.P. (CAMS 33968) on *Arctodus simus* (Semken et al. 1998). ISE fluoride age determinations were also obtained for these individuals following the procedures outlined by Schurr (1989) and Tankersley et al. (1998). Fluoride content was measured in solution at the parts-per-

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million (ppm) and reported here in percentage (Figure 1). A linear relationship is illustrated between the log of the percent fluoride concentration and the calibrated radiocarbon dates. Given that the slope is time dependent, it may provide a calibration curve for future fluoride dates obtained on other species from this cave.

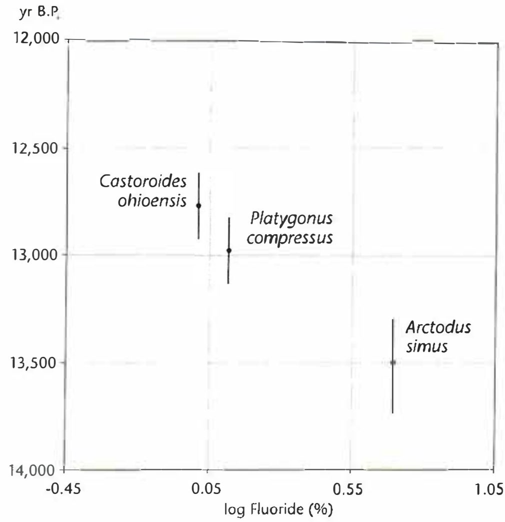

Figure 1. A plot of the calibrated radiocarbon dates with the logarithm of the concentration of fluoride in three extinct species from the late-Pleistocene deposits of Sheriden Cave, Ohio.

This investigation was funded by a research grant to the author from the National Science Foundation (SBR97●7984).

References Cited

Cook, S. F. 1960 Dating Prehistoric Bone by Chemical Analysis. In *The Application of Quantitative Methods in Archaeology*, edited by R. Heizer & S. Cook, pp. 223–245, New York: Wenner-Gren Foundation.

Haynes, C. V. 1992 Contributions of Radiocarbon Dating to the Geochronology of the Peopling of the New World. In *Radiocarbon Dating After Four Decades*, edited by R. E. Taylor, A. Long, and R. S. Kra, pp. 355–374, Springer-Verlag, New York.

Middleton, J. 1844 On Fluorine in Bones, its Source, and its Application to the Determination of the Geological Age of Fossil Bones. *Proceedings of the London Geological Society*, 4:431–433.

Schurr, M. R. 1989 Fluoride Dating of Prehistoric Bone by Ion Selective Electrode. *Journal of Archaeological Science*, 16:265–270.

Semken, H. A., T. W. Stafford, and R. W. Graham 1998 Contemporaneity of Megamammal Extinctions and the Reorganization of Non-analog Micromammal Associations During the Late Pleistocene of North America. Final Program and Abstracts of the 8th International Congress of the International Council for Archaeozoology 8:257.

Stafford, T. W., P. Hare, L. Curie, A. Jull 1991 Accelerator Radiocarbon Dating at the Molecular Level. *Journal of Archaeological Science*, 18:35–72.

Tankersley, K. B., K. D. Schlecht, and R. S. Laub 1998 Fluoride Dating of Mastodon Bone from an Early Paleoindian Spring Site. *Journal of Archaeological Science*, 25:805–811.

Taylor, R. E., C. V. Haynes, and M. Stuiver 1996 Clovis and Folsom Age Estimates: Stratigraphic Context and Radiocarbon Calibration. *Antiquity*, 70-515–525.

Paleoenvironments: Plants

A Preliminary Investigation of a Late Glacial Green Algae Sequence from Shannon Lake, St. Louis County, Minnesota

James K. Huber

Preliminary phycological investigations of green algae (Chlorophycophyta) from late glacial sediments recovered from Shannon Lake, St. Louis County, Minnesota, indicates an association of high nutrient influx to the lake with the late glacial spruce (*Picea*) zone. Shannon lake is located approximately 40 km west northwest of Virginia, Minnesota (92° 58′ 18″ N, 47° 37′ 48″ W). A prehistoric archaeological site is located on Shannon Lake.

A core 790 cm long was retrieved from the lake. Currently, only preliminary analysis of the lowermost 90 cm has been undertaken. The sediment from this portion of the core is composed of gray silty clay. The pollen sequence from the same section of core indicates a shift from the late glacial spruce zone to one dominated by pine (*Pinus*) and deciduous taxa dating between approximately 10,600–9,200 yr B.P. (Bjorck 1990) in this area.

The sequence from Shannon Lake has been divided into two algae zones (Figure 1). *Tetraedron* (mostly *Tetraedron minimum*) dominates Zone 1. *Tetraedron minimum* is a true free-floating plankton commonly found in both deep open water and among vegetation in shallow water near shore (Prescott 1962). *Scenedesmus*, an indicator of high nutrient concentration (Cronberg 1982) and *Pediastrum boryanum*, an indicator of lake eutrophication (Cronberg 1982) are also abundant in Zone 1.

The decline of *Tetraedron* in Zone 2 is associated with the decline in spruce and increase in pine. Zone 2 is also characterized by an increase in abundance of *Scenedesmus* and *P. boryanum* and a small maxima of *P. kawraiskyi*, also a free-floating species (Figure 1). Nonsiliceous algae occurring in trace amounts are combined as other *Pediastrum* and other algae.

Crisman (1978) found that the late glacial spruce zone at six sites in Minnesota was characterized by an associated peak in *Pediastrum*, which he

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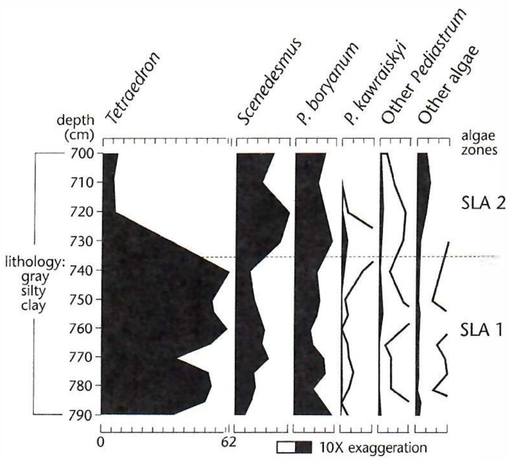

Figure 1. Algae percentage diagram of selected taxa, Shannon Lake, St. Louis County, Minnesota.

interpreted as indicating increased productivity. This association has also been recorded from lakes in Minnesota by Huber (1988, 1989, 1996). The abundance of *Tetraedron*, *Scenedesmus*, and *Pediastrum boryanum* correlates well with the late glacial *Picea* maxima as described by Crisman (1978). Continued use of green algae microfossils in future paleoecological investigations and reconstructions will provide valuable information to interpret changing paleoenvironmental conditions.

References Cited

Bjorck, S. 1990 Late Wisconsin History North of Giants Range, Northern Minnesota, Inferred from Complex Stratigraphy. *Quaternary Research*, 33:18–36.

Crisman, T. L. 1978 Algal Remains in Minnesota Lake Types: A Comparison of Modern and Late-glacial Distributions. *Verhandlungen der Internationale Vereinigung fur Theoretische und Angewandte*, 20:445–451.

Cronberg, G. 1982 *Pediastrum* and *Scenedesmus* (Chlorococcales) in Sediments from Lake Vaxjosjon, Sweden. *Archiv fur Hydrobiologie Supplement*, 60:500–507.

Huber, J. K. 1988 Use of Green Algae Abundances for Augmenting Palynological Interpretation. *Current Research in the Pleistocene*, 5:48–50.

Huber, J. K. 1989 A Preliminary Investigation of Green Algae in Reservoir Lakes Bog 2 Core, Northeastern Minnesota. *Current Research in the Pleistocene*, 6:56–57.

——— 1996 A Postglacial Pollen and Nonsiliceous Algae Record from Gegoka Lake, Lake County, Minnesota. *Journal of Paleolimnology*, 16: 23–35.

Prescott, G. W. 1982 *Algae of the Western Great Lakes Area*. Otto Koeltz Science Publishers, Koenigstein, West Germany.

The Middle-Wisconsin "El Pedregal" Interstadial in the Venezuelan Andes: Palynological Record

V. Rull, M. Bezada, and W. C. Mahaney

The oldest glacial oscillation palynologically documented so far in the Venezuelan Andes is the "El Caballo" stadial, which occurred at 16.5 ^{14}C ka B.P. (Rull, 1998; Rull & Vegas-Vilarrúbia, 1996). Recently older sediments including organic clays and peats have been found in the same location (Mahaney et al., 1997), called "El Pedregal," at about 3,500 m elevation within the páramo vegetation belt. A peat layer at about 30 m depth, overlying a glacial till that represents the Early Stage of the Mérida Glaciation (middle-Wisconsin), gave ages of 58,350 ± 2,790 (top) and >60,000 (middle) ^{14}C yr B.P. (Mahaney et al., in press). The present report shows the results of a high-resolution pollen analysis within this peat layer.

Samples were taken at 2-cm intervals and submitted to KOH, acetolysis, and HF digestion after the introduction of *Lycopodium* tablets. Counting was done until the saturation of diversity (Rull, 1987). The interpretation was based on altitudinally calibrated modern analogs (Salgado-Labouriau, 1979; Salgado-Labouriau et al., 1988). Especially significant is the abundance of tree pollen from the upper Andean forests, which allows distinguishing among subpáramo (c. 2,800 to 3,100 m elevation), páramo proper (c. 3,100 to 4,000), and superpáramo (>4,000 m) vegetation belts (Salgado-Labouriau, 1984). Temperature estimates were made using the modern lapse rate of -0.6 °C/ 100 m altitude.

Pollen and spore concentrations show an increasing trend from the base to the middle of the diagram, where maximum values are attained (Figure 1A), suggesting a progressive increase in the vegetation cover. Minimum concentration values at the top indicate a subsequent decrease in the plant density. Tree pollen percentages allow interpreting the sequence in terms of altitudinal displacement of ecological zones (Figure 1B). Superpáramo vegetation was dominant throughout the entire sequence, but the increase in arboreal pollen toward the middle of the deposit indicates the site was near the páramo proper-superpáramo transition. This equates the present-day situation at about 500 m above the sampling site. Therefore average temperatures were 3° C lower than today. A significant lowering occurred later (58.4 ka B.P.), and the corresponding vegetation was similar to that found nowadays in the upper superpáramo levels, c. 1,200 m upwards, where average temperature was around 7° C lower than in the sampling site. Therefore, after a middle-Wisconsin glacier advance represented by the underlying till, an interstadial (El Pedregal) occurred, followed by a subsequent temperature lowering. These trends significantly enhance the Venezuelan Andes glacial

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chronology and fit well with the paleoclimatic signal found in the oxygen-isotope records from Greenland ice cores (Figure 1C).

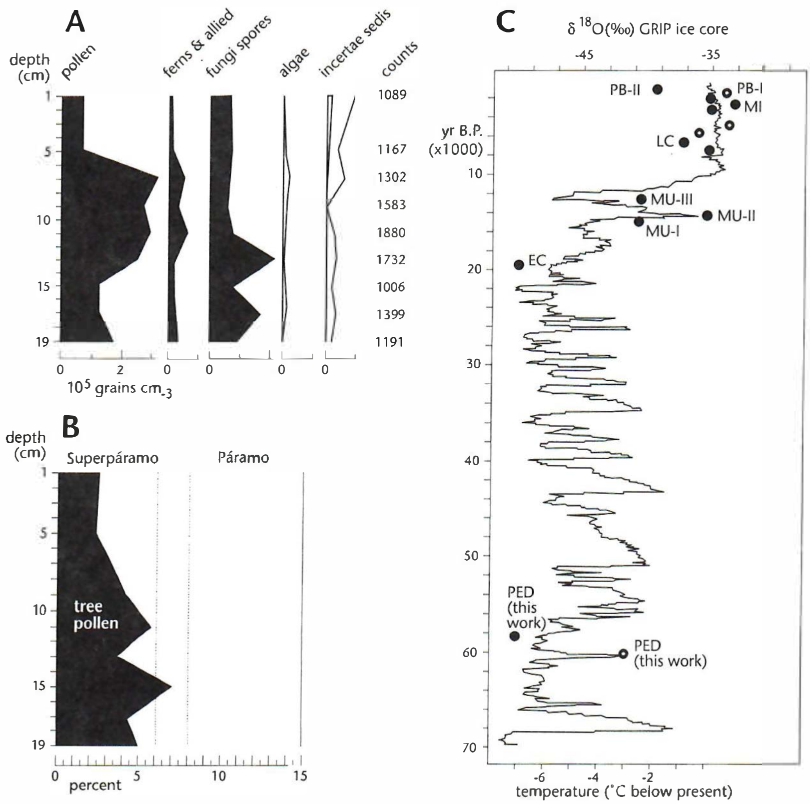

Figure 1. A) Summary of the concentration pollen diagram. Depth is in respect to the top of the peat layer. B) Relative abundance of tree pollen; altitudinal differentiation according to Salgado-Labouriau (1984). C) Paleoclimatic records from the Venezuelan Andes in the frame of the oxygen isotope curve of the GRIP ice core. Data from Venezuela according to Rull (1996,1998) and Salgado-Labouriau (1989). GRIP data from the IRI/LDEO Climatic Library (http://ingrid.ldgeo.columbia.edu)

References Cited

Mahaney, W., V. Kalm and M. Bezada 1997 Estratigrafía del Cuaternario Tardío en un ambiente proglacial en el area de Mucubaji, Mucuchaché, El Pedregal. Andes centrales venezolanos. *Memorias del I Congreso Latinoamericano de Sedimentología* I:417–424.

Rull, V. 1987 A Note on Pollen Counting in Palaeoecology. *Pollen et Spores,* 29(4):471–480.

——— 1996 Late Pleistocene and Holocene Climates of Venezuela. *Quaternary International,* 31: 85–94.

——— 1998. Paleoecology of Pleniglacial Sediments from the Venezuelan Andes. Palynological Record of the El Caballo Stadial, Sedimentation Rates and Glacier Retreat. *Review of Palaeobotany and Palynology, 99:* 95–114.

Rull, V., and T. Vegas-Vilarrúbia 1996 Palynological Evidence for the Last Glacial Maximum in the Venezuelan Andes: Preliminary Results. *Current Research in the Pleistocene,* 13:89–91.

Salgado-Labouriau, M. L. 1979 Modern Pollen Deposition in the Venezuelan Andes. *Grana,* 18(1):53–68.

——— 1984. Late-Quaternary Palynological Studies in the Venezuelan Andes. Erwissenshaftliche Forschung, XVIII:279–293.

——— 1989 Late Quaternary Climatic Oscillations in the Venezuelan Andes. *Biology International,* 18:12–14.

Salgado-Labouriau, M. L., V. Rull, C. Schubert and S. Valastro 1988 The Establishment of Vegetation after Late Pleistocene Deglaciation in the Páramo Miranda, Venezuelan Andes. *Review of Palaeobotany and Palynology,* 55:5–17.

Paleoenvironments: Vertebrates

A Newly Discovered Mexican Locality for Pleistocene Birds

Eduardo Corona-M. and Oscar J. Polaco

Recently, a new fossiliferous locality was found in the north of San Luis Potosí state, Mexico. This locality, a cave named "La Presita," was formed by the dissolution of Cretaceous limestone. At present it has two vertical entrances 6 m deep that lead to a main passage oriented north-south. The cave is 21.4 km south of Matehuala, San Luis Potosí, and about 150 m west of federal highway 57 Mexico-Nuevo Laredo (Polaco and Butrón M, 1997).

The material of study was recovered in 1980 and 1987. Fossiliferous deposits found at the north side were formed by stratified and interdigited layers indicating the existence of entrances now closed. A sample of 3 kg of the matrix was taken from these layers. The sample was washed, sifted, and deposited in the Laboratorio de Paleozoología's Collection.

About 300 bones and shells were drawn from the matrix or taken from the cave floor. Five animal taxa are represented: mollusks, amphibians, reptiles, birds and mammals. From the last group 35 taxa were identified; 10 are extinct forms, and one is a new species of carnivore (Polaco and Butrón M, 1997).

Bird bones are scarce—only 16 bones representing three taxa. The arrangement and names follow the American Ornithologist's Union checklist (1983). These taxa are:

Falconiformes: Cathartidae

Taxon *Cathartes aura* (Linnaeus, 1758)

Material One left humerus proximal fragment from a juvenile specimen; one left tibiotarsus distal fragment; one right humerus proximal fragment; two tarsal phalanges.

Remarks The bones are similar to the recent species. This is the first record for the species in the Mexican Pleistocene. Another locality where the same species was found is Rancho La Amapola, El Cedral, San Luis Potosí, but the report of this material is under study (Corona-M, unpublished data). Both localities are approximately 50 km from La Presita.

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Galliformes: Phasianidae

Taxon *Dendrortyx macroura* (Jardine and Selby, 1828)

Material One skull, one tarsal phalanx.

Remarks The bones are similar to the recent species. This is the first record for this species, remarkable because this taxon is associated with temperate areas and La Presita cave is in the Chihuahuan Desert.

Passeriformes: Fringillidae

Material One left tibiotarsus.

Remarks The material is insufficient for identification to species level because the bones in this group are very similar.

There are also eight unidentified bones, which include a dentary fragment, probably of a species of passeriforme bird.

The fauna identified in La Presita cave belong to the late Pleistocene (Polaco and Butrón M, 1997). Therefore the partridge is the first recorded for this age in Mexico. Future research in this locality could bring an increased bird diversity, since the sample now studied is very small. La Presita cave is quite near two another important Pleistocene localities: El Cedral, at San Luis Potosí; and San Josecito Cave, at Nuevo León. Faunal comparisons among these three localities would improve our regional view of the late Pleistocene.

References Cited

American Ornithologist's Union 1983 *Checklist of North American Birds*, American Ornithologist's Union, Allen Press, Lawrence, KS, 877 pp.

Polaco, O. J. and L. Butrón M. 1997 Mamíferos pleistocénicos de la cueva "La Presita," San Luis Potosí, México (279-296) In *Homenaje al profesor Ticul Álvarez*, coordinado por Arroyo-Cabrales, J. y O. J. Polaco, Colección Científica, Instituto Nacional de Antropología e Historia, México, 391 pp.

A 30,000-Year-Old Megafauna Dung Layer from Gruta del Indio (Mendoza, Argentina)

Alejandro Garcia and Humberto A. Lagiglia

Gruta del Indio (34° 45′ S, 68° 22′ W) is a rockshelter located south of the city of Mendoza, in the Central Western region of Argentina. Previous research at the site revealed evidence of probable Pleistocene human presence and exploitation of extinct megafauna, along with a palynological record ranging mainly from terminal Pleistocene to present (D'Antoni 1983; Lagiglia 1956,

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1979; Semper et al. 1968). New studies are directed toward finding additional evidence for more accurate analysis of these issues. The main focus is a dung layer produced by extinct megafauna that was partially preserved by massive falls of basaltic rocks from the ceiling of the rockshelter. This dung layer has been interpreted as the stratigraphic marker of the Pleistocene/Holocene transition. One set of dates grouped between 11,800 and 9,600 ^{14}C yr B.P. and another date, at first considered erroneous, gave a result of c. 23,500 ^{14}C yr B.P. (Lagiglia 1979). The zooarchaeological record included *Mylodon sp.*, *Megatherium sp.*, and probably *Equus sp.*, but it is not clear yet which of these species produced the excrement.

Recent excavations have indicated that the time interval represented by this stratum is not restricted to the Pleistocene/Holocene transition but is significantly broader. Five radiocarbon dates were run at Latyr (Universidad de la Plata). All samples were extinct megafauna dung extracted from upper, lower, and intermediate portions of the layer. Two dates for its initiation are 30,800 ± 700 (LP 918) and 30,200 ± 800 (LP 929) ^{14}C yr B.P. The stratigraphic position of the oldest date is ca. 10 cm from the base of the layer. Two dates for the middle portion of the layer are 28,670 ± 720 (LP 1072) and 24,140 ± 510 ^{14}C yr B.P. (LP 1075). Analysis of the highest sample yielded 8,990 ± 90 ^{14}C yr B.P. (LP 925).

These dates suggest that accumulation of the layer spanned the interval from ca. 31,000 to 9,000 ^{14}C yr B.P. Review of the entire set of dates shows a main cluster between c. 11,800 and 9,000 ^{14}C yr B.P., and an earlier group ranging from ca. 31,000 ^{14}C yr B.P. to probably c. 24,000 ^{14}C yr B.P. Thus, rather than resulting from continuous deposition, the layer seems to represent at least two main periods of deposition. If this were the case, the biological record of this layer would represent a notable opportunity to analyze paleoecological changes that occurred after the Last Glacial Maximum.

With respect to megafaunal extinction, the later date recently obtained shows that some of those species did not become extinct until ca. 9,000 ^{14}C yr B.P. Considering that humans have been present in the region since ca. 11,000 ^{14}C yr B.P. (Garcia 1995; Lagiglia 1979), humans and Pleistocene megaherbivores could have coexisted for 2,000 years.

Nevertheless, no reliable evidence of a human/megafauna association was obtained. Seven small pieces of lithic debris (all of them <20 mm long) appeared at different levels in the dung layer, but they were not associated with other cultural material. Furthermore, discovery of rodent dung and bones point out that bioturbation may be responsible for the presence of the lithics in the layer. The low visibility of evidence for bioturbation may reflect the action of some process of homogenization.

The dung layer at Gruta del Indio is the chronologically most extensive of those known in Argentina (Borrero 1994), offering a ca. 20,000-year history of late-Pleistocene paleoecological information. Data about presumably critical shifts in the diet of megafauna would be valuable for studying environmental changes during the regional process of extinction. Future field work will deal with this subject, as well as searching for evidence of late-Pleistocene human presence.

Field work was supported by the SeCyT (UNC) grant 978/96. Facultad de Filosofia y Letras (UNC) and Museo de Historia Natural (San Rafael) provided logistical assistance. Authors are deeply indebted to an anonymous reviewer for his corrections and clarifications of the English.

References Cited

Borrero, L. A. 1994 Arqueología y Paleoecologia en Última Esperanza: Notas para su Integración Regional. *Cuadernos del Instituto Nacional de Antropología y Pensamiento Latinoamericano,* 15:185–198.

D'Antoni, H. 1983 Pollen Analysis of Gruta del Indio. *Quaternary of South America and Antarctic Peninsula,* (1):83–104.

Garcia, E. A. 1995 Agua de la Cueva Rockshelter and its Relationship to the Early Peopling of Central West Argentina. *Current Research in the Pleistocene,* 12:13–14

Lagiglia, H. 1956 Estudios arqueológicos en el Rincón del Atuel (Dpto. San Rafael, Mendoza). *Anales de Arqueología y Etnología,* XII: 227-2 87.

——— 1979 Dinámica Cultural en el Centro Oeste y sus Relaciones con Áreas Aledañas Argentinas y Chilenas. In *Actas del VII Congreso de Arqueología de Chile,* 11:531–560. Altos de Vilches.

Semper, J., and H. Lagiglia 1968 Excavaciones Arqueológicas en el Rincón del Atuel (Gruta del Indio). *Revista Científica de Investigaciones* I (4):89–158. Museo de Historia Natural, San Rafael.

Radiocarbon Geochronology of Strata Containing *Mammuthus* (Mammoth), Red Rock River, Montana

Christopher L. Hill

The biostratigraphic record near the Red Rock River in Centennial Valley, Montana, consists of fossils of *Mammuthus* (mammoth), other Pleistocene-age vertebrates, and invertebrates (Dundas et al. 1996). If radiocarbon measurements accurately reflect the age of the fossils and surrounding sediments, the sequence contains evidence of middle- and late-Wisconsin paleoenvironments. The older strata may date from about 50,000 to 32,500 yr B.P. Fossils are in secondary taphonomic provenience; they have been redeposited under various sedimentological conditions. The upper part of the sequence dates to perhaps 20,000 yr B.P., since the sediments contain an assemblage of fossils in secondary context ranging from about 25,000 to 20,000 yr B.P.

The lowermost exposed Pleistocene set of sediments is designated as Stratum A (cf. Albanese et al. 1995). Elements of *Mammuthus* found in these sediments include a patella recovered in 1987 that contained no collagen (residue after HCl application). A *Mammuthus* limb bone was observed in the upper 1 m of Stratum A (Bump 1989), and fossils have been found along its upper boundary with overlying Stratum B.

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Disarticulated elements of *Mammuthus* and other vertebrates have been recovered in the paludal and swamp-like deposits of Stratum B. This stratum decreases in thickness along the margins of the paleobasin. Collagen (residue after HCl and NaOH application) from tusk recovered in the lower part of Stratum B dates to 32,470 ± 270 yr. B.P. (B-111325). Another date of 36,500 ± 710 yr. B.P. (B-74032) was obtained from organic sediments recovered from HCl-treated *Mammuthus* limb bone (Albanese et al. 1995). Collagen from a *Mammuthus* fibula from this deposit had an age >33,990 yr B.P. (B-36206, Dundas 1992), while an age of >41,900 yr. B.P. (B-83614, Dundas et al. 1996) was obtained from humates (residue after HCl/NaOH/HCl washes). One scenario that could account for these measurements would include initial deposition of organics within the paleobasin prior to 40,000 yr B.P., with continued accumulation of sediments and vertebrate remains until about 32,000 yr B.P.

The center of the paleobasin contains organic-rich sediments (Stratum B) overlain by a sedimentary series consisting of interbedded silts and coarser clastics (Stratum C). Several erosional surfaces are present, and the upper section contains secondary carbonates. A distinct boundary typically separates these deposits from the overlying Holocene colluvium.

Closer to the edge of the paleobasin, Test Pit C/94 contains the same upper section stratigraphy dominated by silts, secondary carbonates, and colluvium. Below the sediments of Stratum C are several erosional surfaces separating deposits of fine sands, silts, and clay and some isolated lenses of coarser clastics. The absence of organic-rich deposits and the presence of several erosional surfaces make correlations with the central basin stratigraphy somewhat speculative. The erosional surfaces may separate facies of Stratum C, or the lower deposits could be stratigraphically related to Stratum A or perhaps deposits not present in the central basin. *Mammuthus* collagen (residue after HCl treatment) from the lower part of the sequence dates to 49,350 ± 150 yr B.P. (B-116519). It is from a fossil recovered directly below an erosional surface that may mark the "upland" stratigraphic boundary between Stratum C and older sediments. If so, the fossil could have accumulated in deposits older than Strata B and C, providing an indication of the age of the lower part of the sequence. Pleistocene vertebrates within the Test Pit C/94 sequence are in secondary context; thus, while the date can be presumed to provide an estimate of the minimum age of the specimen (cf. Stafford et al. 1991), it may have been redeposited in younger sediments.

Stratum C and the younger colluvium are traceable to the north escarpment, where they appear to overlie a concentration of limestone and quartzite cobbles and boulders mixed with *Mammuthus* and other vertebrates. This assemblage overlies a mollusc-bearing sand that may be a subfacies of Stratum A. The fossils appear to be younger than Stratum A and older than the uppermost part of Stratum C. The vertebrates are in secondary context and thus provide a maximum age for the associated sediments. Collagen (HCl and NaOH-treated residue) dates are 25,030 ± 520 (B-36205, on a *Mammuthus* metatarsal, Dundas 1992), 21,500 ± 100 (B-11875), and 19,310 ± 90 (B-77826, Albanese et al. 1995) yr B.P.

The radiocarbon dates within the Centennial Valley sequence range from about 50,000 to 19,000 yr B.P. and reflect the age of Strata A–C, assuming that the fossils are approximately contemporaneous with the sediments. This chronology may be tested by methods like TL, which directly date the time since sediment deposition. The dates imply that the fossil assemblages date to the middle and late Wisconsin.

Field studies were conducted under a cooperative agreement between the Bureau of Land Management (BLM) and the Museum of the Rockies under a permit to L. B. Davis. Funds for radiocarbon dates were provided by the BLM, a MONTS-EPSCOR grant, and the Kokopelli Archaeological Research Fund. Thanks to John Albanese, David Batten, Robert Dundas, Mark Sant and Robert Bump for useful discussions and collaboration with the field research.

References Cited

Albanese, J. P., C. L. Hill, and L. B. Davis 1995 Upper Pleistocene Geology of the Merrell Site (24BE1659), Centennial Valley, S.W. Montana. *Current Research in the Pleistocene,* 12:107–109.

Bump, R. 1989 *Soil Formation and Paleoenvironmental Interpretation at the Merrell Pleistocene Site; Centennial Valley, Beaverhead County, Montana.* Unpublished report, Bureau of Land Management, Dillon, Montana.

Dundas, R. G. 1992 A Scimitar Cat (*Homotherium serum*) from the Late Pleistocene Merrell Locality, Southwestern Montana. *Paleobios,* 14(1):9–12.

Dundas, R. G., C. L. Hill, and D. C. Batten 1996 Late Pleistocene Fauna from the Merrell Locality, Centennial Valley, Montana: Summary of the Vertebrate Remains from the 1994 and 1995 Excavations. *Current Research in the Pleistocene,* 13:103–105.

Stafford, T. W., Jr., P. E. Hare, L. Curries, and A. J. T. Jull 1991 Accelerator Radiocarbon Dating at the Molecular Level. *Journal of Archaeological Sciences,* 18:35–72.

Mammoth (*Mammuthus*) from the Doeden Gravels, Eastern Montana: Biometric and Molecular Analyses

Christopher L. Hill and Mary Schweitzer

Morphological studies of fossils and immunological analyses of proteins can provide a clearer understanding of the phylogenetic relationships of Pleistocene vertebrates (Joger et al. 1995; Lowenstein 1985; Shoshani et al. 1995), as well as assist in interpreting paleobiotic, chronologic, and geospatial patterns. Here we summarize results of biometric and preliminary immunological examinations of *Mammuthus* (mammoth) from terrace deposits along the Yellowstone River in eastern Montana.

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The specimen studied is a nearly complete *Mammuthus* cranium. It is part of a Pleistocene vertebrate collection at the Museum of the Rockies (MOR) representing the Rancholabrean age Doeden local fauna (Wilson, in Kurtén and Anderson 1980:71; MOR Fossil Locality No. PL-084). Besides *Mammuthus,* the collection includes *Mammut* (mastodon), *Megalonyx* (ground sloth), *Equus* (horse), and *Camelops* (camel) (Hill 1998a). The deposits containing the fossils are estimated to be over 100,000 years old, based on geomorphic correlations within the Yellowstone basin (cf. Chadwick et al. 1997; Heinrichs 1988).

Biometric attributes (Agenbroad 1994; Saunders and Daeschler 1994; Lister 1996) were used to evaluate the taxonomic status of the Doeden specimen (MOR 604). Both maxillary molars fall within the populations of M6(M3) measured in *Mammuthus columbi* based on plots of width vs. length and length vs. number of plates (Agenbroad 1998; Agenbroad and Brunelle 1994; Graham 1986). With a lamellar frequency (Lf) of 7-10 and 20 plates, characteristics of the more complete right maxillary M6(M3) are within the range of *M. columbi* (Magilio 1973:67). The Lf is similar to *M. columbi jeffersonii* (Jefferson's mammoth) from Montana reported by Dudley (1988) and the Lf of a specimen from the South Fork Deer Creek drainage with attributes of both *M. columbi* and *M. imperator* (Imperial mammoth) (Hill and Davis 1998). The specimen falls within the *M. columbi* group as established by Whitmore et al. (1967).

Nine samples from *Mammuthus, Mammut,* and *Camelops* from the Doeden local fauna were tested to determine whether they contained a separable collagen fraction. Most of the samples contained no collagen. However, bone and tooth samples from MOR 604 yielded residue thought to consist of very degraded collagen and associated organics.

Bone was tested for the presence of protein fragments that can be used to help evaluate phylogenetic relationships of proboscideans (Lowenstein and Shoshani 1996; Shoshani, Lowenstein et al. 1985; Shoshani, Walz et al. 1985). Albumin and collagen in the tissue of mammoths preserved under different taphonomic contexts are known to persist to at least 50,000 years (Lowenstein and Shoshani 1996). The geomorphic and taphonomic context of MOR 604 appears to indicate an age of at least 100,000 years, thus providing an opportunity to conduct molecular studies on *Mammuthus* from the middle or early late Pleistocene. Extracts of *Mammuthus* bone tissues from MOR 604 were used as an immunogen to generate polyclonal antisera. These antibodies demonstrated positive reactivity with *Mammuthus* bone extracts, while the pre-immune sera were negative. Based on antibody reactions with extractions of bone polyclonal antisera from various taxa, some phylogenetic information may be conserved in MOR 604 bone protein. Antisera raised against *Mammuthus* bone extracts reacted most strongly with other *Mammuthus,* then elephant and equid, and less strongly with canid or felid, results that would be predicted on the basis of other phylogenetic studies (Lowenstein and Shoshani 1996; Lowenstein et al. 1981; Shoshani et al. 1995).

The antiserum generated against specimen MOR 604 then was tested against *Mammuthus* bone (MOR specimen 91.72.134) dated to around 12,000 yr B.P. (Hill 1998b). Strong reactivity was seen. In a second experiment, antibody reactivity was reduced by at least 50 percent when the extracts were digested first with collagenase, then exposed to the antisera. Based upon these results it seems reasonable to assume that at least some of the preserved epitopes are collagen-derived.

Thus the Doeden mammoth cranium appears to contain genetic information (in the form of protein fragments or epitopes) that may be used in conjunction with morphological attributes to help evaluate the phylogeny of *Mammuthus* in western interior North America.

Several other fossils found within the Yellowstone basin have been attributed to *M. columbi.* These include finds near Rosebud (Winchell 1882), in the vicinity of the Tongue River (Hay 1924, Bass 1932), along the Powder River (Hay 1924), near Glendive (Hay 1914), and near the Bighorn River (Graham 1986; Madden 1978), as well as a specimen from the uplands of the South Fork of Deer Creek with biometeric traits of both *M. columbi* and *M. imperator* (Hill and Davis 1998). These fossils appear to indicate the persistence of at least one species of *Mammuthus* within the basin during the late Pleistocene and perhaps since the middle Pleistocene, an idea perhaps testable with further immunological studies. The use of a combination of biometric attributes and immunological analyses has the potential of advancing our understanding of the phylogenetic status of *Mammuthus,* especially when specimens can be placed in paleogeographic, taphonomic, and chronologic context.

We thank Jack Hornor, Curator of Paleontology at the Museum of the Rockies, for permission to study MOR 604.

References Cited

Agenbroad, L. D. 1994 Taxonomy of North American *Mammuthus* and biometrics of the Hot Springs Mammoths. In *The Hot Springs Mammoth Site: A Decade of Field and Laboratory Research in Paleontology, Geology, and Paleoecology*, edited by L. D. Agenbroad and J. I. Mead, pp. 158–207. Fenske Printing, Inc., Rapid City.

——— 1998 Columbian Mammoths (*M. columbi*) and Pygmy Mammoths (*M. exilis*): A comparison. In *International Conference of Mammoth Studies*, p. 1–15. University of Kansas, Lawrence, Kansas.

Agenbroad, L. D., and A. R. Brunelle 1994 *Analysis of Mammoth Dentition.* Mammoth Site of Hot Springs, Hot Springs, South Dakota.

Bass, N. W. 1932 *The Ashland Coal Field, Rosebud, Powder River and Custer Counties, Montana.* United States Geological Survey Bulletin 831-B:19–105.

Chadwick, O. A., R. D. Hall, F. M. Phillips 1997 Chronology of the Pleistocene Glacial Advances in the Central Rocky Mountains. *Geological Society of America Bulletin,* 109:1443–1452.

Dudley, J. P. 1988 Dental Metrics of *Mammuthus* in the Non-Glacial Regions of North America. *Current Research in the Pleistocene,* 5:68–69.

Graham, R. 1986 Descriptions of the Dentitions and Stylohyoids of *Mammuthus columbi* from the Colby Site. In *The Colby Mammoth Site: Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming,* pp. 171–190. University of New Mexico Press, Albuquerque.

Hay, O. P. 1914 The Pleistocene Mammals of Iowa, *Iowa Geological Survey Annual Report, 1912, with Accompanying Papers,* XXIII.

——— 1924 *The Pleistocene of the Middle Region of North America and its Vertebrated Animals.* Carnegie Institution of Washington, Washington.

Heinrichs, H. E. 1988 *Surficial Geology of the Sheridan 30'X60' Quadrangle, Wyoming and Montana.* United States Geological Survey Bulletin 1816.

Hill, C. L. 1998a American Mastodon (*Mammut americanum*) from the Doeden Gravels, No. 2 Terrace, Lower Yellowstone River. In *American Quaternary Association Program and Abstracts of the 15th Biennial Meeting,* p. 180. Puerto Vallarta, Mexico.

——— 1998b Geomorphic, Stratigraphic, and Taphonomic Context of Mammoth Fossils Within the Upper Missouri and Yellowstone Drainages, Rocky Mountains and Great Plains. *Geological Society of America Abstracts with Program,* 30(7):A386.

Hill, C. L., and L. B. Davis 1998 Stratigraphy, AMS Radiocarbon Age, and Stable Isotope Biogeochemistry of the Lindsay Mammoth, Eastern Montana. *Current Research in the Pleistocene,* 15:109–111.

Joger, U., J. Hauf, and F. K. Zimmerman 1995 Protein and Nucleic Acid of Mammoth Tissues and the Phylogenetic Position of *Mammuthus* within the Elephantidae. In *First International Mammoth Symposium Abstracts,* edited by G. Baryschnikov, I. Kuzmina, and J. Saunders, p. 677. Russian Academy of Science, St. Petersburg, Russia.

Kurtén, B., and E. Anderson 1980 *Pleistocene Mammals of North America.* Columbia University Press, New York.

Lister, A. M. 1996 Evolution and Taxonomy of Eurasian mammoths. In *The Proboscidea: Evolution and Paleoecology of Elephants and Their Relatives,* edited by J. Shoshani and P. Tassy, pp. 202–213. Oxford University Press, Oxford.

Lowenstein, J. M. 1985 Molecular Approaches to the Identification of Species. *American Scientist,* 73(6):541–547.

Lowenstein, J. M., V. M. Sarich, and B. J. Richardson 1981 Albumin Systematics of the Extinct Mammoth and the Tasmanian Wolf. *Nature,* 291:409–411.

Lowenstein, J. M., and J. Shoshani 1996 Proboscidean Relationships Based on Immunological Data. In *The Proboscidea: Evolution and Paleoecology of Elephants and Their Relatives,* edited by J. Shoshani and P. Tassy, pp. 49–54. Oxford University Press, Oxford.

Madden, C. 1978 Mammoths (*Mammuthus*) from the Colby Site. In *Prehistoric Hunters of the High Plains,* by G. C. Frison, pp. 391–401. Academic Press, New York.

Magilio, V. J. 1973 The Origin and Evolution of the Elephantidae. *Transactions of the American Philosophical Society,* 63: Part 3.

Saunders, J. J., and E. B. Daeschler 1994 Descriptive Analyses and Taphonomical Observations of Culturally Modified Mammoths Excavated at "The Gravel Pit," near Clovis, New Mexico in 1936. *Proceedings of the Academy of Natural Sciences of Philadelphia,* 145:1–28.

Shoshani, J., E. M. Golcberg, and H. Yang 1995 Phylogeny of Elephantine Taxa (*Mammuthus, Elephas,* and *Loxodonta*) Employing *Mammut* as an Outgroup: Morphological Versus New Molecular Data. In *First International Mammoth Symposium Abstracts,* edited by G. Baryschnikov, I. Kuzmina, and J. Saunders, p. 703. Russian Academy of Science, Saint Petersburg, Russia.

Shoshani, J., J. M. Lowenstein, D. A. Walz, and M. Goodman, M. 1985 Proboscidean Origins of Mastodon and Woolly Mammoth Demonstrated Immunologically. *Paleobiology,* 11:429–237.

Shoshani, J., D. A. Walz, M. Goodman, J. M. Lowenstein, and W. Prychodko 1985 Protein and Anatomical Evidence of the Phylogenetic Position of *Mammuthus primigenius* within the Elephantidae. *Acta Zoologica Fennica,* 170:237–40.

Whitmore, F. C., K. O. Emery, H. B. S. Cooke, and D. J. P. Swift 1967 Elephant Teeth from the Atlantic Continental Shelf. *Science,* 156:1477–1481.

Winchell, N. H. 1882 *Tenth Annual Report of the Geological Survey of Minnesota.* St. Paul.

Did Female Mastodons Have Mandibular Tusks?

Richard S. Laub

Besides their long, curving premaxillary tusks, some American mastodons (*Mammut americanum*) bore a pair of short, cylindrical tusks in the symphysis of the mandible. Most authors consider these latter to be male attributes (Kurtén and Anderson 1980:345). Some believe they are found in females as well (Haynes 1991:322).

Pelvic structure (see Lister 1996) was used to determine the sex of six mounted mastodon skeletons, none younger than 30 African-elephant years (Laws 1966). Two were judged to be female and four male. The inferred females also had distinctly narrower premaxillary tusks and a generally smaller size than the inferred males of equivalent age.

Where the mandibular symphysis was preserved, including both inferred females, a pair of alveoli occur. Did females have mandibular tusks? To gain insight into this question, Computer-Aided Tomography (CAT-scanning) was used to produce a series of vertical transaxial radiographs at 3-mm intervals through the mandibles of several proboscideans. From these were derived the diagrams in Figure 1.

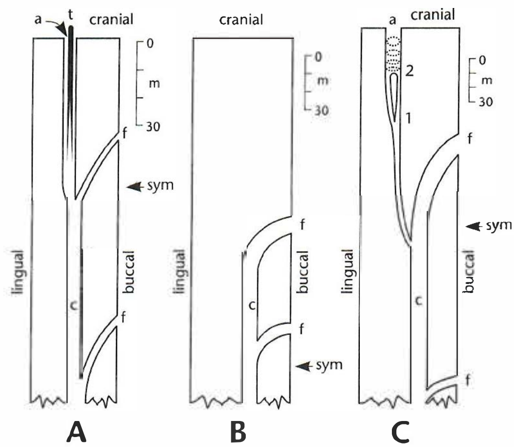

Figure 1. Internal structure of proboscidean mandibles, cranial end: **A,** American mastodon (*Mammut americanum*), juvenile, Idaho Museum of Natural History specimen 71005/27988; **B,** Asian elephant (*Elephas maximus*), mature female, Buffalo Museum of Science Vert. Zool. specimen 1828; C, American mastodon (*M. americanum*), mature female, New Jersey State Museum specimen 11907, with dotted lines to show distal broadening of canal from a slit to an ellipse near alveolar opening; a, alveolus; c, mandibular canal; f, mental foramen; sym, caudal edge of symphysis; t, mandibular tusk; 1, dichotomization of canal; 2, joining of the two canal branches to form dorso-ventrally elongate slit (appearing elongate side-to-side in this diagram due to technical constraints), broadening cranially to form an elliptical alveolus. Scale bars refer to cranio-caudal direction only. Bucco-lingual scale approximate, and proportional within each diagram.

Figure 1A shows the internal structure of a juvenile (less than one African-elephant year old) mastodon mandible bearing tusks. A lingual branch divides from the mandibular canal, the former widening to 1.0 cm while the

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latter abruptly narrows to 0.4 cm before exiting buccally as the anterior mental foramen. The lingual branch remains broad and contains a tusk.

The mandible of a mature female Asian elephant (***Elephas maximus***, Figure 1B) lacks dentition anterior to the cheek region. The mandibular canal exits through two mental foramina, and no branch extends beyond the last of these.

In a mature female mastodon (32–38 African-elephant years, Figure 1C), a very narrow canal (0.5 cm wide vs. 4.0 cm for the main mandibular canal at this level) branches from the lingual side of the mandibular canal and continues forward, as in Figure 1A. Distally, this narrow canal divides into an upper and lower branch, each about 0.25 cm wide. Farther on, these branches unite into a vertical slit which expands to become one of the pair of symphyseal alveoli in the same position as the mandibular tusk sockets in males. Thus, in this mature inferred female mastodon, the alveoli remained in communication with the mandibular canal, and presumably with the inferior dental artery and nerve contained within it (Eales 1926). A similar configuration occurs in Buffalo Museum of Science specimen E23320, an isolated mandible, though the narrow lingual canal does not bifurcate.

Apparently, this female had some sort of dental structure where males had mandibular tusks. The structure must have been diminutive, since the canal leading to the alveolus in this mature jaw was half the diameter of that in the juvenile jaw. Perhaps the dental structure was limited to ameloblasts and odontoblasts with little mineralization, precluding preservation.

The author wishes to thank the following for advancing this study with their advice and services: Arthur R. Clark and Joan G. Manias (Buffalo Museum of Science, Buffalo, N.Y.), staff of Children's Hospital of Buffalo (N.Y.) Radiology Dept., Howard Evans and John Hermanson (New York State School of Veterinary Medicine, Cornell Univ., Ithaca, N.Y.), Edward B. Laub (Lawrenceville, N.J.), Norman Mohl, Brian Preston and Arnold Stern (Dental School, State Univ. of New York, Buffalo), David C. Parris (New Jersey State Museum, Trenton), John Pinsof (Daemen College, Amherst, N.Y.), Quakerbridge MRI (Mercerville, N.J.), and Kevin L. Seymour (Palaeobiology Dept., Royal Ontario Museum, Toronto).

References Cited

Eales, N. B. 1926 The Anatomy of the Head of a Foetal African Elephant, *Elephas africanus (Loxodonta africana). Transactions of the Royal Society of Edinburgh*, 54(3):491-551 + 12 pls.

Haynes, G. 1991 *Mammoths, Mastodonts and Elephants: Biology, Behavior and the Fossil Record.* Cambridge University Press, New York.

Kurtén, B., and E. Anderson 1980 *Pleistocene Mammals of North America.* Columbia University Press, New York.

Laws, R. M. 1966 Age Criteria for the African Elephant, *Loxodonta. a. africana. East African Wildlife Journal* 4:1–37.

Lister, A. M. 1996 Sexual Dimorphism in the Mammoth Pelvis: An Aid to Gender Determination. In *The Proboscidea: Evolution and Palaeoecology of Elephants and Their Relatives,* edited by J. Shoshani and P. Tassy, pp. 254–259. Oxford University Press, New York.

A Saber-Tooth Tiger and the First Record of a Tapir from the Pleistocene of Kansas

Larry D. Martin and Virginia Naples

The discovery in 1975 of a musk ox skull in the Kansas River near Bonner Springs, Kansas, by John Neas called attention to a new source for Ice Age fossils in eastern Kansas. These sandbars have now produced the best collection of fossils from the Symbos-Cervalces Faunal Province (Martin and Neuner, 1978) in Kansas. Extinct animals recovered from these sandbars include ground sloth, *Megalonyx sp.;* giant beaver, *Castoroides sp.;* giant short-faced bear, *Arctodus simus;* dire wolf, *Canis dirus;* American mastodon, *Mammut americanum;* mammoth, *Mammuthus sp.;* stagmoose, *Cervalces sp.;* woodland musk ox, *Bootherium bombifrons;* and the Pleistocene bison, *Bison.* cf. *alleni* and *B. antiquus.* Size stages of bison indicate a nearly continuous sampling of deposits from at least 12,000 years ago to the present. Projectile point typology showing Clovis, Meserve, Scottsbluff, Nebo Hill, and various late-Holocene types demonstrate essentially continuous occupation of the Kansas River valley during this same period.

Recently, the Jerry Ashberger family discovered new fossils on sandbars near Bonner Springs that add significantly to the fauna of eastern Kansas. One of these is the first record of *Smilodon* from eastern Kansas. The discovery is based on an edentulous maxillary, KUVP (Kansas University Vertebrate Paleontology) 129728, showing alveoli for the canine and premolars 3–4. The other is the first record of a Pleistocene tapir for the state of Kansas, based on a fragmentary ramus KUVP 16206 with roots of premolars 2–4 and the first molar. The permanent premolars must still be buried within the jaw.

The range of late-Pleistocene *Tapirus* extends practically to the continental ice front on the eastern side of North America, but dips down south of Oklahoma at about the Arkansas-Oklahoma boundary. It seems likely that this amphibious perrisodactyl is more limited by density of water-marginal vegetation than by temperature. Kansas seems to lie on the western boundary of its distribution, and until now, no Pleistocene tapirs have been reported from the state, although they are known from central Missouri.

Smilodon co-occurs with dire wolves and tapirs over much of its range, and its presence was expected in eastern Kansas. As with the tapir, the density of arboreal vegetation is a factor in the distribution of *Smilodon,* whose short legs required stealthy approach to its prey before discovery. The Kansas specimen has an anteroposterior diameter of 45 mm for the canine alveolus. This compares favorably with the measurements of the Rancho la Brea sample given by Merriam and Stock (1932, Tbl. 6). Only one other record of *Smilodon*

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from Kansas seems to be correctly identified, that of a portion of a ramus, KWP 9977, from a site in Barber County in south-central Kansas that was thought to be early Wisconsinan (Galbreath, 1958). The ramus is unusually small for *Smilodon californicus* (Galbreath, 1958) and may be from an earlier period. The Illinoisan *Smilodon* from Nebraska is more similar in size to the Kansas specimen (Martin, Schultz and Schultz, 1988). The Nebraska material was referred to *Smilodon cf. S. fatalis* by these authors, who distinguish it from S. *californicus* by smaller size. The species of *Smilodon* still need revision, and S. *californicus is* probably a junior synonym of *S. floridanus* (Martin, Schultz and Schultz, 1988).

References Cited

Galbreath, E. C. 1958 A Saber-tooth Cat from South-central Kansas. *Transactions of the Kansas Academy of Sciences,* 61(3):328–329.

Martin, L. D., and A. M. Neuner 1978 The End of the Pleistocene in North America. *Transactions of the Nebraska Academy of Sciences,* 6:117–126.

Martin, L. D., C. B. Schultz, and M. R. Schultz 1988 Saber-toothed Cats from the Plio-Pleistocene of Nebraska. *Transactions of the Nebraska Academy of Sciences,* 16:153–163.

Merriam, J. C., and C. Stock 1932 *The Felidae of Rancho la Brea.* Carnegie Institute of Washington.

Rogers, R. A., and L. D. Martin 1983 American Indian Artifacts from the Kansas River. *Transactions of the Nebraska Academy of Sciences,* 11:13–18.

The Appearance of Bison in North America

Jerry N. McDonald and Gary S. Morgan

The Macasphalt Shell Pit and Inglis 1A vertebrate localities on the west coast of Florida have yielded important vertebrate fossil faunas that date from the latest Blancan and earliest Irvingtonian North American land mammal ages, respectively. Each of these faunas includes a partial horn core of a bovid—both of which we refer to *Bison.*

The Macasphalt Shell Pit, 8 km east of Sarasota, Sarasota County, Florida, is the source of an extremely rich marine molluscan fauna arranged in a sequence of superimposed strata. Unit 4 of this sequence, the "Black Layer" (Petuch 1982), contains a vertebrate fauna including nearly 100 taxa, among which are some 20 taxa of terrestrial mammals (Morgan and Ridgway 1987). A detailed study of the geochronology of the site using magnetostratigraphic, strontium isotopic, and biostratigraphic analyses indicates that Unit 4 accumulated near or slightly above sea level during a period of marine regression between about 2.5 and 1.9 ma (Jones et al. 1991; Morgan 1991).

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The Inglis 1A site is 3 km southwest of Inglis, Citrus County, Florida. The Inglis 1A vertebrate fauna was collected from the north bank of the Cross-Florida Barge Canal from deposits that had in-filled a sinkhole (Klein 1971). The vertebrate fauna includes some 150 taxa, including 53 species of mammals (Morgan and Hulbert 1995; Morgan and White 1995; Webb and Wilkins 1984). Morgan (1991) assigned the Inglis 1A fauna to the earliest Irvingtonian Land Mammal Age, ranging in age from about 1.9 to 1.6 Ma.

The partial horn core from Macasphalt Shell Pit (UF 100486) is a trapezoidally shaped fragment measuring 126 mm in greatest length (along longitudinal axis of core, on dorsal edge) and 46 mm in depth (along dorso-ventral axis of core). This fragment includes the interior and exterior surfaces of the horn core; it is considered to represent the rostral edge of the proximal end of the core. The proximal 20 percent of the exterior surface of the fragment includes a portion of the smooth basal region of the core, including part of the pedestal upon which the core was placed. The remainder of the exterior surface consisting of numerous finely sculpted shallow but acutely defined ridges and valleys of bone arranged parallel to the longitudinal axis of the core. The separation of the smooth basal surface from the surface containing the bony ridges is sharp, but a raised "burr" is not present. The interior of the horn core is hollow; the interior surface of the specimen is uniformly concave and consists of finely porous bone. No evidence of bone struts is present on the interior surface. This specimen curves slightly upward distad.

The partial horn core from Inglis 1A (UF 18286) is also a trapezoidally shaped fragment measuring 128 mm in greatest length (along longitudinal axis of core, on ventral edge) and 60 mm in greatest depth (along dorso-ventral axis of core, at proximal end). This fragment includes the exterior surface and solid interior of the horn core; it is considered to represent a segment from an indeterminate side of the distal portion of the horn core. The exterior surface of the specimen contains three prominent longitudinally oriented ridges, the crests of which are directed ventrad. The dorsal portion of the fragment presents a smooth exterior surface free of bony ridges. This specimen curves upward and tapers to a lesser diameter distad.

The two specimens described here conform to the known morphology of *Bison* horn cores more closely than to that of any other genus of bovid. The Macasphalt specimen represents a hollow-horned bovid; *Bison* is the only hollow-horned bovid known in native North American faunas. In addition, the finely sculptured ridges of the core, distinctly pedestaled base, and transverse and longitudinal curvature patterns are typical of early Paleoarctic *Bison* and atypical of other hollow-horned bovids. The Inglis 1A specimen is morphologically identical to equivalent segments of horn cores of *Bison latifrons*, the largest of North American *Bison*, and unlike the horn cores of other *Bison* and other bovids known from North American faunas (McDonald 1981, 1990). *Bison* are known from late-Pliocene (Blancan and Irvingtonian) faunas in eastern Asia (Tedford and Flynn 1989; Tedford et al. 1990; Repenning pers. comm.) and therefore were geographically well positioned to enter North America via the exposed Bering Land Bridge at and after that time. The recognition of *Bison* in the Blancan and Irvingtonian faunas places the genus in mid-latitude North America more than 2 million years earlier than the presently recognized earliest appearance of ca. 130,000 ka (Repenning pers. comm.).

References Cited

Jones, D. S., B. J. MacFadden, S. D. Webb, P. A. Mueller, D. A. Hodell, and T. M. Cronin 1991 Integrated Geochronology of a Classic Pliocene Site in Florida: Linking Marine and Terrestrial Biochronologies. *Journal of Geology*, 99:637–648.

Klein, J. G. 1971 The Ferungulates of the Inglis IA Local Fauna, Early Pleistocene of Florida. M.S. Thesis, University of Florida.

McDonald, J. N. 1981 *North American Bison: Their Classification and Evolution.* University of California Press, Berkeley and London. On the History of Bovidae in the Western Hemisphere: Genera present and their chronology [Abstract]. *Journal of Vertebrate Paleontology*, 10:35A.

Morgan, G. S. 1991 Neotropical Chiroptera from the Pliocene and Pleistocene of Florida. *Bulletin of the American Museum of Natural History*, 206:176–213.

Morgan, G. S., and R. C. Hulbert, Jr. 1995 Overview of the Geology and Vertebrate Biochronology of the Leisey Shell Pit Local Fauna, Hillsborough County, Florida. In *Paleontology and Geology of the Leisey Shell Pits, Early Pleistocene of Florida,* edited by R. C. Hulbert, G. S. Morgan, and S. D. Webb. *Bulletin of the Florida Museum of Natural History,* 37, Part I:1–92.

Morgan, G. S., and R. B. Ridgway 1987 Late Pliocene (late Blancan) Vertebrates from the St. Petersburg Times Site, Pinellas County, Florida, with a Brief Review of Florida Blancan Faunas. *Papers in Florida Paleontology* 1:1–22.

Morgan, G. S., and J. A. White 1995 Small Mammals (Insectivora, Lagomorpha, and Rodentia) from the Early Pleistocene (Irvingtonian) Leisey Shell Pit Fauna, Hillsborough County, Florida. In *Paleontology and Geology of the Leisey Shell Pits, Early Pleistocene of Florida,* edited by R. C. Hulbert, G. S. Morgan, and S. D. Webb. *Bulletin of the Florida Museum of Natural History,* 37, Part I:397–461.

Petuch, E. J. 1982 Notes on the Molluscan Paleoecology of the Pinecrest Beds at Sarasota, Florida with the Description of Pyruella, a Stratigraphically Important New Genus (Gastropoda: Melongenidae). *Proceedings of the Academy of Natural Sciences of Philadelphia,* 134:12–30.

Tedford, R. H., and L. J. n.d. Flynn Neogene Faunal Succession, Yushe Basin, Shanxi Province, PRC [Abstract]. *Journal of Vertebrate Paleontology*, 9:41A.

Tedford, R. H., L. J. Flynn, N. D. Opdyke, W. R. Downs, Q. Zhanziang, C. Guanfang, W. Wenyue, Y. Defa, Y. Jie, L. Yuqing, and N. Schmidt-Kittler 1990 Yushe Basin, Shanxi: Mammalian Biostratigraphic Standard for the Late Neogene of Eastern Asia. [Unpublished manuscript].

Webb, S. D., and K. T. Wilkins 1984 Historical Biogeography of Florida Pleistocene Mammals. In *Contributions in Quaternary Vertebrate Paleontology: A Volume in Memorial to John E. Guilday*, edited by H. H. Genoways and M. R. Dawson. *Special Publication of Carnegie Museum of Natural History*, 8:370–383.

Spatial Distribution, CAMS Radiocarbon Geochronology, and Taxonomy of Fossil Bison in Montana: An Initial Appraisal

Douglas A. Melton and Leslie B. Davis

The significance of fossil bison skulls and postcranial elements as late-Pleistocene to early-Holocene diagnostics that might be used to locate sedimentary deposits and contexts for possibly associated Paleoindian artifacts can be located is well understood. Bison fossil subspecies, inferred from differentiated skull morphotypes, are thus of considerable diagnostic importance for identifying buried Paleoindian-age kill and processing loci. Fossil bison remains are fairly widespread in Montana except the northwestern part of the state, where no late-Pleistocene or early-Holocene fauna have been reported (Olson 1987). Graham, Wilson, and Graham (1987) point out that faunal records for this period in Montana, Alberta, and Saskatchewan are sparse and relatively incomplete, not for lack of a rich, preserved record but because recovery has been limited. Similarly, Graham and Lundelius (1994) report few fossil bison recoveries from Montana. Based on our accumulation of records and specimens (Melton and Davis 1998), *Bison latifrons*, *B. antiquus*, and *B. occidentalis* have been recovered from Montana localities.

Although biological knowledge regarding genetic integrity, and thereby the actual biological reality that underlies named fossil bison subtypes, is generally lacking, we have found that such morphotypes are nevertheless preserved from widespread contexts in Montana (Graham, Wilson, and Graham 1987; McDonald 1981; Skinner and Kaisen 1947; Walker 1986; Wilson 1969, 1974, 1975, 1980, 1992). Fossil bison skulls and postcranial elements are known from both paleontological and archaeological contexts, the latter as processed bison skeletons associated with Paleoindian artifacts. *Bison latifrons* is represented in paleontological deposits such as the Merrell Locality (24BE1659) in the Centennial Valley south of Dillon at Lima Reservoir (Davis et. al. 1995) and possibly at the Doeden Gravel Pit near Miles City in the lower Yellowstone River valley (Kurtén and Anderson 1980), a Sangamonian-age local fauna dominated by large grazers. A bison skull from the Richey area in eastern Montana, which yielded a radiocarbon age on bone collagen of 19,930 ± 90 yr B.P. (Beta 122116[13C/12C ratio -21.4 per mil.]), might also represent an occurrence of *B. latifrons*.

B. antiquus is slightly more widespread, both as identified from skull morphology and as inferred from in situ radiocarbon-dated humanly utilized bison skeletal assemblages such as Indian Creek (24BW626) (Davis et al. 1997: Folsom complex, 10,410 ± 60 yr B.P.; Wilson 1983); Mill Iron (24CT30) (Kruetzer 1996: Goshen/Plainview, ca. 11,000 yr B.P.; Walker and Frison

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1996); Sheep Rock Spring (24JF295) (Wilson and Davis 1994: 9920 ± 60 yr B.P. [Beta 70940/CAMS 12702]); Machaffie (24JF4) (Davis et al. 1991: Scottsbluff, 9,400 yr B.P., and Folsom, 9730 ± 50 yr B.P [TX 7770]; Forbis and Sperry 1952); and Upper Holter Lake (24LC713). The best *B. antiquus* collection from paleontological context was recovered during excavations for the Fort Peck Dam in the 1930s; however, those remains on loan to the Museum lacked bone collagen and were not radiometrically dateable.

Bison occidentalis is more numerous and widespread in Montana. Remains have been recovered from in situ context, such as Blacktail Cave (24LC151) (Davis et al. 1996; Melton 1979) in the South Fork of the Dearborn River in the upper Missouri River drainage, and elsewhere mostly in stratigraphic context (Melton and Davis 1998). A bison skull with a radiocarbon age of 9510 ± 60 yr B.P. (Beta 122117 [13C/12C ratio of -18.9 per mil]) excavated in the Tongue River area of southeastern Montana is either *B. antiquus* or *B. occidentalis*.

Preliminary findings from our studies of fossil bison skulls recovered from stratigraphic contexts in Montana by problem-oriented excavation and serendipitous discovery encourage ongoing careful, standardized description, radiometric-age analysis, and detailed locality characterization for key specimens. Stable isotope analysis of fossil bison diet holds promising biogeochemical implications. Likewise, we are exploring the technique of extracting DNA from selected specimens for phylogenetic analysis of bison subspecies.

CAMS radiocarbon dating service associated with the Montana Fossil Bison and Paleoindian Project was funded by the Kokopelli Archaeological Research Fund, which supports the Paleoindian Research Program directed by Davis at the Museum of the Rockies.

References Cited

Davis, L. B., J. P. Albanese, L. S. Cummings, and J. W. Fisher, Jr. 1991 Reappraisal of the Machaffie Site Paleoindian Occupational Sequence. *Current Research in the Pleistocene,* 8:17–20.

Davis, L. B., M. F. Baumler, K. M. Bovy, M. D. Cannon, and D. K. Grayson 1997 Folsom Resource Use and Disposal Behavior: Indian Creek, Montana. *Current Research in the Pleistocene,* 14:18–20.

Davis, L. B., and S. T. Grieser 1992 Indian Creek Paleoindians: Early Occupation of the Elkhorn Mountains, Southeast Flank, West-Central Montana. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 225–283. Denver Museum of Natural History and the University Press of Colorado.

Davis, L. B., C. L. Hill, J. P. Albanese, and K. W. Karsmizki 1995 The 1994 Geoarchaeological Assessment of the Merrell Locality (24BE1659), Centennial Valley, Southwestern Montana. Technical Report to the Headwaters Resource Area (Dillon), Butte District, Bureau of Land Management by the Museum of the Rockies, Montana State UniversityBozeman.

Davis, L. B., J. Saysette, D. C. Batten, and J. F. Rittel 1996 Blacktail Cave: A Late-Glacial to Post-Glacial Faunal Catchment at the Southern Outlet of the Ice-Free Corridor, West Central Montana Rockies. *Current Research in the Pleistocene,* 13:101–102.

Forbis, R. G., and J. D. Sperry 1952 An Early Man Site in Montana. *American Antiquity,* 18:127–133.

Graham, R. W., and E. L. Lundelius 1994 *FAUNMAP: A Database Documenting Late Quaternary Distributions of Mammal Species in the United States.* Illinois State Museum Scientific Papers 25(2).

Graham, M. A., M. C. Wilson, and R. W. Graham 1987 Paleoenvironments and Mammalian Faunas of Montana, Southern Alberta, and Southern Saskatchewan. In *Late Quaternary Mammalian*

Biogeography and Environments of the Great Plains and Prairies, edited by R. W. Graham, H. A. Semken, Jr., and M. A. Graham, pp.410–459. Illinois State Museum Scientific Papers No. 22.

Kruetzer, L. A. 1996 Taphonomy of the Mill Iron Site Bison Bonebed. In *The Mill Iron Site,* edited by G. C. Frison, pp. 101–143. University of New Mexico Press, Albuquerque.

Kurtén, B. J., and E. Anderson 1980 *Pleistocene Mammals of North America.* Columbia University Press, New York.

McDonald, J. 1981 *North American Bison: Their Classification and Evolution.* University of California Press, Berkeley.

Melton, D. A., and L. B. Davis 1998 Spatial Distribution, Radiometric Age, and Taxonomic Classification of Fossil Bison in Montana. Draft manuscript in possession of authors.

Melton W. G., Jr. 1979 Late Pleistocene? Mammals and Artifacts Recovered from Blacktail Cave, Lewis and Clark County, Montana. *National Geographic Society Research Reports,* 1978 Projects, pp. 415–421. Washington, D.C.

Olson, D. L. 1987 Late Pleistocene and Holocene Faunas of the Northern Rocky Mountains. In *Prehistoric Land Use in the Northern Rocky Mountains: A Perspective from the Middle Kootenai River Valley,* edited by A. V. Thoms and G. C. Butchard, pp. 175–204. Center for Northwest Anthropology Project Report No. 4. Washington State University, Pullman.

Skinner, M. F., and O. C. Kaisen 1947 Fossil Bison of Alaska and Preliminary Revision of the Genus. *American Museum of Natural History Bulletin,* 89(3):123–256.

Walker, D. N. 1986 *Studies in the Late Pleistocene Fauna of Wyoming.* Ph.D. Dissertation, Department of Zoology and Physiology, University of Wyoming, Laramie.

Walker, D. N., and G. C. Frison 1996 Appendix 1: Mill Iron Site Local Fauna. In *The Mill Iron Site,* edited by G. C. Frison, pp. 217–224. University of New Mexico Press, Albuquerque.

Wilson, M. C. 1969 Problems in the Speciation of American Fossil Bison. In *Post-Pleistocene Man and His Environments on the Northern Plains,* edited by R. G. Forbis, L. B. Davis, O. A. Christensen, and G. Fedirchuk, pp. 178–199. Proceedings of the Archaeological Association the University of Calgary, Calgary, Alberta.

——— 1974 History of the Bison in Wyoming, With Particular Reference to Early Holocene Forms. In *Applied Geology and Archaeology: The Holocene History of Wyoming,* edited by M. Wilson, pp. 91–99. Geological Survey of Wyoming Report of Investigations No. 10.

——— 1975 *Holocene Fossil Bison From Wyoming and Adjacent Areas.* M.A. Thesis, Department of Anthropology, University of Wyoming, Laramie.

——— 1980 Morphological Dating of Late Quaternary Bison on the Northern Plains. *Canadian Journal of Anthropology.* 1(1):81–85.

——— 1983 Faunal Remains from the Indian Creek Site (24BW626), Montana. Report to the Department of Sociology, Montana State University, Bozeman.

——— 1992 Bison in Alberta: Paleontology, Evolution, and Relationships with Humans. In *Buffalo,* edited by J. E. Foster, D. Harrison, and I. S. McLaren, pp. 1–17. Alberta Studies in the Arts and Sciences 3(1). Edmonton, Alberta.

Wilson, M. C., and L. B. Davis 1994 Late Quaternary Stratigraphy, Paleontology, and Archaeology of the Sheep Rock Spring Site (24JF292), Jefferson County, Montana. *Current Research in the Pleistocene,* 11:100–102.

Late-Pleistocene Climatic Change and Neotropical Bat Extinctions

Gary S. Morgan

Bats are seldom included in discussions of late-Pleistocene extinctions. Climatic change and the rise in sea level with the return to interglacial conditions in the latest Pleistocene and early Holocene (i.e., late Quaternary) had a detrimental affect on certain bats in the New World, particularly cave-dwelling species in subtropical and tropical regions such as Florida and the West Indies (Morgan, 1989, 1991). It is unlikely that hunting by Paleoindians was a significant factor in bat extinctions.

Eight species of bats went extinct during the late Quaternary in the Neotropics and in Florida, a subtropical extension of the Nearctic region that has a significant fauna of bats with Neotropical affinities (Morgan, 1991). These bat extinctions included one North American species of Neotropical origin, the large vampire *Desmodus stocki*; six West Indies species including three mormoopids (*Mormoops magna* and *Pteronotus pristinus* from Cuba and an undescribed species of *Pteronotus* from Hispaniola) and three phyllostomids (*Artibeus anthonyi* and *Phyllops vetus* from Cuba and *Phyllonycteris major* from Puerto Rico and Antigua); and one South American species, the giant vampire *Desmodus draculae* (Czaplewski and Cartelle, 1998; Morgan, 1989, 1991; Morgan et al., 1988). Four extinct bats are known from temperate North America (Kurtén and Anderson, 1980): the vespertilionids *Myotis magnamolaris*, *M. rectidentis*, and *Plecotus tetralophodon*; and the molossid *Tadarida constantinei*. At least 25 extant Neotropical bats underwent range contractions or extirpation (i.e., local extinction) during this same time period, particularly on West Indies islands.

Most of the extinctions involved cave-dwelling bats, with the largest number in the endemic Neotropical families Mormoopidae and Natalidae. Besides the three extinct mormoopids, there are locally extinct populations of all eight extant species of mormoopids and five species of natalids. The extant mormoopid *Mormoops megalophylla* is represented by eight late-Quaternary records from outside its current range, including Florida, six islands in the West Indies, and Brazil (Czaplewski and Cartelle, 1998; Morgan, 1989, 1991). Mormoopids, natalids, and several other groups of Neotropical bats not only roost exclusively in caves; they prefer specialized cave microenvironments—hot, humid chambers deep within large caves. Even minor temperature or humidity changes in their cave roosts resulting from late-Quaternary climatic changes may have resulted in extinctions among these bats.

The rise in sea level greater than 100 m that occurred from the late Pleistocene through the early Holocene flooded caves in coastal regions with extensive karst development, particularly Bahamas and southern Florida. In

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the late Quaternary there were numerous local extinctions of cave-dwelling bats on small West Indies islands (Bahamas, Cayman Islands, Tobago) and in southern peninsular Florida, suggesting the former presence of extensive cave systems where today only small caves are found (Morgan, 1989, 1991). During periods of low sea level many shallow submarine banks in the West Indies were large islands that supported diverse chiropteran faunas. In the late Quaternary Great Bahama Bank was a single island nearly the size of Cuba that supported 15 species of bats; now only 7 species inhabit the six major islands that make up the Bank. In addition to flooding of large caves, the species-area effect may have contributed to these bat extinctions: small islands have fewer species than large islands because of smaller land area and reduced habitat diversity.

The two extinct species of large vampire bats, *Desmodus draculae* and *D. stocki*, probably disappeared following the extinction of their principal prey species (large xenarthrans?). *D. stocki* occurred primarily in temperate North America north of the current 10° C winter isotherm (the northern limit of living vampires), suggesting that the more equable climate and milder winters of the late Pleistocene permitted this species to survive where vampire bats no longer occur.

References Cited

Czaplewski, N. J., and C. Cartelle 1998 Pleistocene Bats from Cave Deposits in Bahia, Brazil. *Journal of Mammalogy*, 79:784–803.

Kurtén, B., and E. Anderson 1980 *Pleistocene Mammals of North America*. Columbia University Press, New York.

Morgan, G. S. 1989 Fossil Chiroptera and Rodentia from the Bahamas, and the Historical Biogeography of the Bahamian Mammal Fauna. In *Biogeography of the West Indies: Past, Present, and Future*, edited by C. A. Woods. Sandhill Crane Press, Gainesville, Florida.

——— 1991 Neotropical Chiroptera from the Pliocene and Pleistocene of Florida. *Bulletin of the American Museum of Natural History*, 206:176–213.

Morgan, G. S., O. J. Linares, and C. E. Ray 1988 New Species of Fossil Vampire Bats (Mammalia: Chiroptera: Desmodontidae) from Florida and Venezuela. *Proceedings of the Biological Society of Washington*, 101:912–928.

Pleistocene Continental Mammals from the Present Marine Shelf of Argentina

Eduardo P. Tonni and Alberto L. Cione

Mammal bones included in Pleistocene coquinas were found on the beaches of the Cabo San Antonio (south of Bahía de Samborombón, Pampean

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region; Figure 1). They constitute the first identifiable fossil mammals obtained from the shelf area of Argentina.

The Pampean region is located on the passive margin of the continent. In this region Martín García High, Salado Basin, and Tandil-Ventania High are structural highs and basins mostly oriented NW-SE. Cabo San Antonio is located in the middle of the subsiding Salado Basin. Marine units deposited during late-Cenozoic transgressions and documented in the eastern Pam-

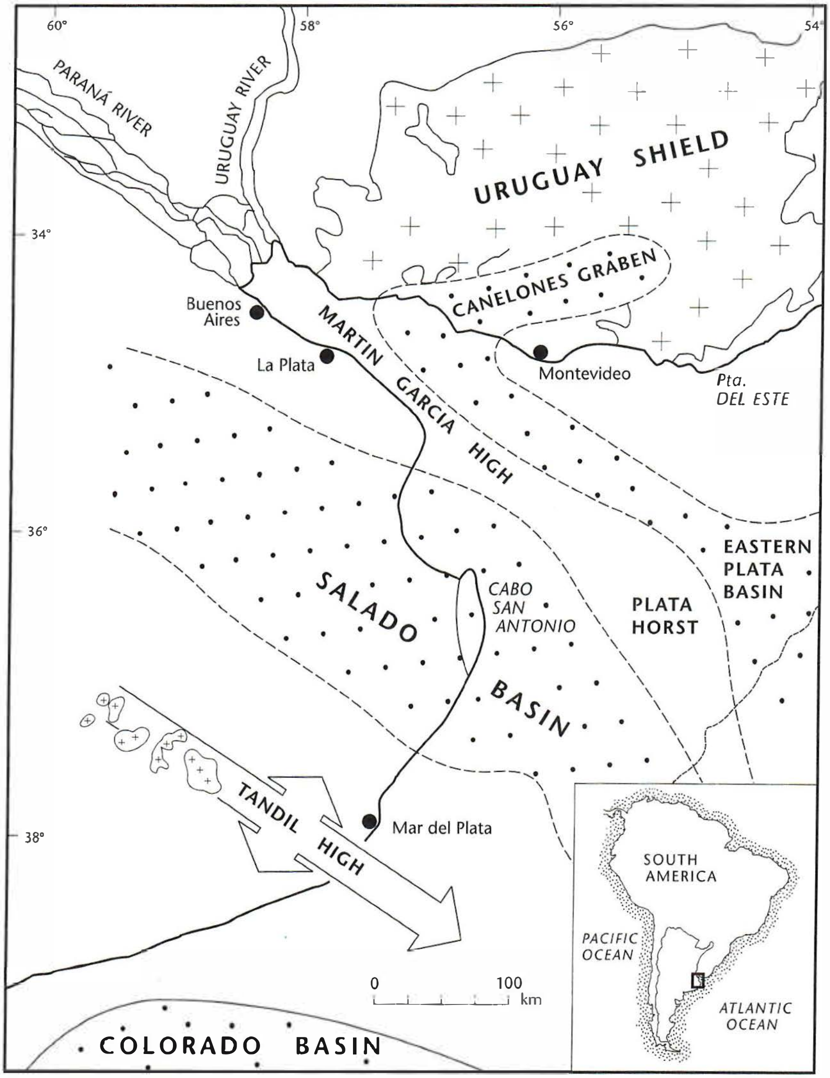

Figure 1. Map showing the Pampean area of Argentina and southern Uruguay including large continental structural features (modified from Zambrano, 1981).

pean region include the Holocene Las Escobas Formation and the Pleistocene Pascua Formation and "Belgranense" (Fidalgo, 1979). In the Salado Basin the Las Escobas Formation is found at the surface, but only limited outcrops of the Pascua Formation were detected (Fidalgo, 1979). The Pozo 10 Formation, a marine marker unit correlative to the Pascua Formation, is exposed on the shelf below sea level (Violante and Parker, 1996).

At Cabo San Antonio the fossiliferous sediments are well consolidated sandy silts with calcium carbonate cement such as those found in the upper part of the Pascua Fm (Fidalgo, 1979). They include numerous invertebrate remains, mostly bivalves (e.g., *Amiantis* sp. and *Glycimeris* sp.). The fossiliferous sediments must have been exposed on the sea bottom because they exhibit abundant borings made by endolithic invertebrates.

Fossil mammals found are Xenartha (*Glyptodon* sp., *Scelidotherium* sp., *Glossotherium* sp., and *Pampatherium* sp.); Perissodactyla (*Hippidion*); and Artiodactyla (Tayassuidae indet.). Mammals of the continental late-Pleistocene biozone characterized by *Equus (Amerhippus) neogeus* are commonly found in the Pascua Formation. Specimens found at Cabo San Antonio belong to extinct taxa (excepting Tayassuidae), which occur for the last time in that biozone.

It is noteworthy that units that correlate to the Pascua Formation do not outcrop in the area from Cabo San Antonio to the north of Mar del Plata. Violante and Parker (1996) attributed this to tectonic subsidence. Certainly the area is located in the middle of the Salado Basin, with more than 6000 m of sediments (Zambrano, 1981: Figure 1). Areas where the marine and continental Pleistocene units mostly outcrop are located on the Martín García and Tandilia-Ventania highs, where tectonic uplift occurred (Pardiñas et al., 1996). Lithology, taxa involved, shelf stratigraphy, and topography suggest that mammal remains come from the Pozo 10 Formation, which corresponds to the Riss-Wurm interglacial (Isotopic Stage 5e, 120 ky B.P.).

We would like to thank D. Ferraris and J. Casciotta for the material; and the ANPCyT, CONICET, CIC and UNLP for financial support.

References Cited

Fidalgo, F. 1979 Upper Pleistocene—Recent Marine Deposits in Northeastern Buenos Aires Province (Argentina). *Proceedings of the 1978 International Symposium on Coastal Evolution in the Quaternary, San Pablo*: 384–404.

Pardiñas, U. F. J., J. N. Gelfo, J. San Cristóbal, A. L. Cione, and E. P. Tonni 1996 Una Tafocenosis de Organismos Marinos y Continentales en el Pleistoceno Superior en el sur de la Provincia de Buenos Aires. *Actas del XIII Congreso Geológico Argentino y III Congreso de Exploración de Hidrocarburos*, 5:95–111.

Violante, R., and G. Parker 1996 Evidencias de una ingresión marina intercalada entre el Interensenadense y el Belgranense ("Pampeano") en las áreas costeras y marinas del noreste bonaerense. *Actas del XII Congreso Geológico Argentino y II Congreso de Exploración de Hidrocarburos, Buenos Aires*: 252–259.

Zambrano, J. J. 1981 Distribución y evolución de las cuencas sedimentarias en el continente sudamericano durante el Jurásico y el Cretácico. Volkheimer, W. and E. Mussachio (Eds.). *Cuencas Sedimentarias del Jurásico y Cretácico de América del Sur*. Comité Sudamericano del Jurásico y Cretácico, Buenos Aires 1: 9–44.

Paleoenvironments: Geosciences

Geomorphological Changes in the Upper Reaches of Sergeant Major Creek, Oklahoma

Kenneth C. Kraft and Warren K. Lail

This research undertaking demonstrates the significant diachronic geomorphological changes to which stream channels, and their corresponding biotic communities, are subjected. Our research objective was to determine the geomorphological history of an intriguing road-cut exposure in Roger Mills County, Oklahoma. Occupying one of the highest points on the landscape (2,150 ft ASL), the exposure faces the modem course of Sergeant Major Creek, a tributary of the Washita River in western Oklahoma (see Thurmond and Wyckoff 1998). We cleared and examined a profile 18 m long by 4 m wide we designated "Sergeant Major Creek Exposure #1" (SMC-1) in order to determine whether an archaeological site, located above, extended into the subsurface strata. Based upon previous research in the area, our expectation was to find post-Altithermal sediment accumulation atop stripped bedrock, a common occurrence in this region. Upon clearing the exposure, we recognized that the expected stripping/accumulation profile was not represented at this locality.

We carefully mapped, photographed, sampled, described, and analyzed SMC-1. In addition, we collected four organic samples for radiocarbon dating (Figure 1). Soil and sediment samples were collected and analyzed for particle size and organic carbon/calcium carbonate equivalent (OC/CCE) content. As expected, the OC/CCE ratios were high, precluding an accurate pollen analysis. The high carbonate levels are indicative of significant wetting and drying episodes following original sediment deposition. In addition, we collected a number of one-liter bulk samples from several locations for snail species identification. Preliminary results from the snail analyses indicate the presence of both aquatic and terrestrial species (James Theler, pers. comm. 1998), suggesting major diachronic changes in the stream environment.

The profile revealed a large number of inter-bedded sediments indicative of significant changes in the stream environment, with each stratum repre-

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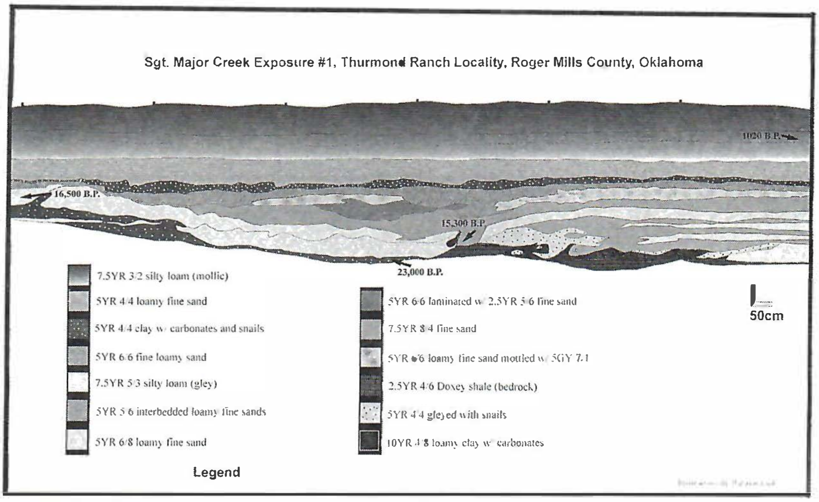

Figure 1. Sergeant Major Creek Exposure #1, Roger Mills County, Oklahoma. Measured C dates (AMS) listed in the figure are as follows: 1,020 ± 70 yr B.P. (Beta-112050); 15,300 ± 60 yr B.P. (Beta-111161); 16,500 ± 60 yr B.P. (Beta-112050) and, 23,000 ± 190 yr B.P. (Beta-111159).

senting concomitant changes in load and content. One explanation for these changes may be found in analogous drainages in the same locality, many of which are in various stages of evolution and devolution and therefore offer insight into long-term stream morphological changes in the region. Many of the Washita River tributaries, meandering at will, proceed through a similar series of cut-and-fill sequences even while overall channel flow remains constant. Moreover, changes in stream environments, such as those proposed for Sergeant Major Creek, significantly affect plant and animal communities along the drainages. During previous field seasons, the authors have observed many similar instances of change in stream biodiversity.

We believe that the evidence details a 23,000-year morphological history of the extinct Sergeant Major Creek drainage now represented by SMC-1. The morphological changes caused corresponding changes in the stream biotic community, demonstrated by the fluctuation from aquatic to terrestrial snails through time. The evidence is supported by direct analogy to modern stream developmental sequences.

The authors thank Brian Carter, James Theler, Peter Thurmond, Peter Wigand, and Don Wyckoff for their assistance in this research endeavor. The authors also acknowledge their colleagues, Jesse Ballenger and Scott Brosowske, who, due to previous commitments, withdrew from the project in its infancy.

References Cited

Thurmond, J. P., and D. G. Wyckoff 1998 Late-Pleistocene Dunes Along the Dempsey Divide, Roger Mills County, Oklahoma. *Current Research in the Pleistocene,* 15:139–141.

Beaver (*Castor canadensis*) and Mastodon (*Mammut americanum*) in a Late-Pleistocene Upland Spruce Forest, Western New York State

Richard S. Laub and John H. McAndrews

The Doerfel site lies 6.5 km north of Springville, New York (Springville 7½′ Quadrangle, 42° 33′ 41″ N, 78° 42′ 51″ W), elevation 517 m ASL. It is a small basin (ca. 20–30 m diameter), one of several along the crest of a ridge. The site is on Valley Heads Moraine, which dates ca. 13,000 yr B.P. (Miller 1973:81), but the oldest organic matter is <12,000 yr B.P.), indicating delayed basin formation. The coincidence of gravel with an abundance of logs just above the basal marly clay (Unit 1) suggests the melting of a buried ice block that persisted for ca. 1,000 years, accompanied by the collapse of an overlying stand of trees (see Florin & Wright 1969). This may explain the inverted radiocarbon dates for the top and bottom of Unit 2.

The basal unit is marly clay, nearly devoid of macro-organics and dominated by spruce (*Picea*) pollen (Figure 1). Numerous conifer logs lie at its upper

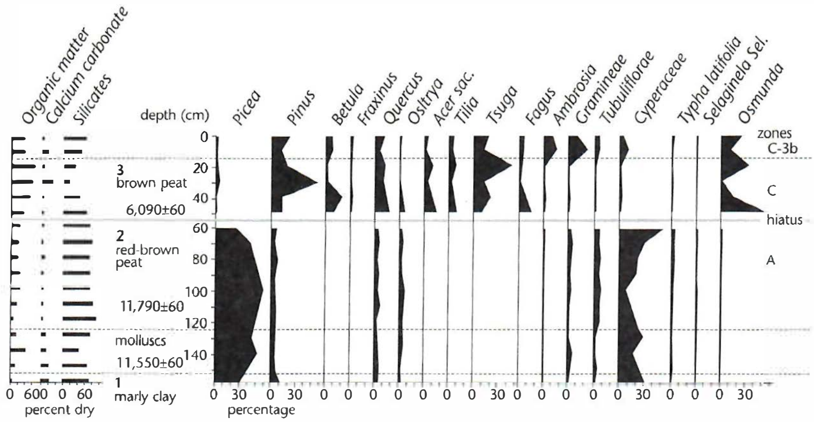

Figure 1. Pollen diagram from the Doerfel mastodon site; only the main pollen and spore types are shown. The percentage sum is 200 upland plants including Cyperaceae but excluding aquatic pollen grains and spores. Four contemporaneous late-Pleistocene pollen sites lie within 40 km of Doerfel: Belmont Bog (Spear & Miller 1976), Nichols Brook (Fritz et al. 1987), and Houghton and Protection bogs (Miller 1973). Geochemical analysis was done by loss-on-ignition.

contact with Unit 2, red-brown "peat." This "peat" (<20 percent organic matter) contains Pleistocene spruce pollen Zone A (Miller 1973). A white spruce (*P. glauca*) cone in the top quarter of the unit was AMS dated to 11,790 ± 60 yr

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B.P. (CAMS-39330, while a cone from its basal contact yielded a date of 11,550 ± 60 yr B.P. (CAMS-43074). Wetland microfossils include cattail (*Typha latifolia*) pollen and spike moss (*Selaginella selaginoides*) spores. Gastropods are common in the lower portion of this unit in deeper areas. Also present are twig fragments similar in appearance to those from a nearby site, which were interpreted as mastodon gastrointestinal contents (Laub et al. 1994).

The uppermost unit (3) is a dark-brown peat up to 50 cm thick. It contains pollen of *Tsuga* and *Fagus*, which identify Holocene Zone C, and *Fraxinus* logs. Peat from the lower half of this unit dated to 6,090 ± 60 yr B.P. (Beta-118010). The absence of a pine (*Pinus*) pollen zone (Zone B) at its base indicates a hiatus of over 4,000 years between the Holocene and Pleistocene beginning sometime before 10,100 yr B.P.

Scattered bones of a mature female mastodon lie at the interface between the marly clay and the red-brown "peat." They were dated to 11,460 ± 60 yr B.P. (CAMS-54734). One bone, nearest the center of the basin, lies 21 cm above this interface, probably reflecting partial in-filling of the basin before the bones were deposited. No cultural artifacts were recognized.

Several logs in the lower half of Unit 2 (Pleistocene) featured conical ends bearing gnaw-marks that match the incisors of beaver. One such log of ash (*Fraxinus*) yielded a date of 11,390 ± 100 yr B.P. (Beta-122837). Several logs, including the dated one, had been chewed at both ends, precluding the likelihood that they were old, partially buried logs gnawed by Holocene beavers. To our knowledge, this is the first report of *Castor* in the New York Pleistocene.

Probable beaver-dug canals are prominent in the grey marl/red-brown "peat" interface toward the basin margin, indicating water depth here of only a few centimeters. The presence of cattail and the absence of water lilies in the late-Pleistocene Unit 2 suggests that the pond was seasonal and therefore an undependable water supply. This may explain the beaver canals. Evidence of contemporaneous drought occurs nearby at the lowland Hiscock Site (Laub and Haynes 1998).

References Cited

Florin, M. B., and H. E. Wright, Jr. 1969 Diatom Evidence for the Persistence of Stagnant Glacial Ice in Minnesota. *Geological Society of America Bulletin*, 80:695–704.

Fritz, P., A. V. Morgan, U. Eicher, and J. H. McAndrews 1987 Stable Isotope, Fossil Coleoptera and Pollen Stratigraphy in Late Quaternary Sediments from Ontario and New York State. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 58:183–202.

Laub, R. S., C. A. Dufort, and D. J. Christensen 1994 Possible Mastodon Gastrointestinal and Fecal Contents from the Late Pleistocene of the Hiscock Site, Western New York State. In *Studies in Stratigraphy and Paleontology in Honor of Donald W. Fisher*, edited by E. Landing. New York State Museum Bulletin 481.

Laub, R. S., and G. Haynes 1998 Fluted Points, Mastodons, and Evidence of Late-Pleistocene Drought at the Hiscock Site, Western New York State. *Current Research in the Pleistocene*, 15:32–34.

Miller, N. G. 1973 *Late-Glacial and Postglacial Vegetation Change in Southwestern New York State.* New York State Museum and Science Service Bulletin 420.

Spear, R. W., and N. G. Miller 1976 A Radiocarbon Dated Pollen Diagram from the Allegheny Plateau of New York State. *Journal of the Arnold Arboretum*, 57:369–403.

Oxidizable Carbon Ratio Dates in Terminal Pleistocene–Holocene Deposits in the Northeastern Buenos Aires Province, Argentina

Hugo G. Nami

At the end of the 19th century and the beginning of the 20th century, Florentino Ameghino identified a sequence grouped into stratigraphical units and confirmed by all subsequent scholars (Cione and Tonni 1995). In this sequence, the Luján or Lujanese and Platense formations are very important for archaeological research. They have a broad distribution in the rivers, creeks, and lagoons of the Buenos Aires province.

The Platense are gray eolian sediments underlying the Luján formation. There is agreement that the Platense is Holocene in age with a modern fauna. Geologists currently recognize different members in the Luján formation with diverse green and brown colors (Cione and Tonni 1995).

The fossil vertebrate assemblage is assignable to the *Lujanense Land mammalage* (Pascual et al. 1965), considered late Pleistocene in age (Cione and Tonni 1995).

The Lujanense is a distinctive unit, therefore an extremely useful marker horizon for late-Pleistocene and early-Holocene sediments and consequently for possible Paleoindian materials (e.g., Fidalgo et al. 1986).

Despite the broad distribution of this formation, there are not many chronological data (see Politis, Prado and Beukens 1994:190). Only four ^{14}C dates obtained on shell samples from the Guerrero member of the Luján formation range between 17,000 and 28,000 yr B.P. (Carbonari *et al.* 1993).

For paleomagnetic investigation and archaeological purposes, sedimentary sequences corresponding to the terminal Pleistocene and to the Holocene were sampled in many parts of Argentina and Chile (cf. Nami 1995, in press). As part of this research program, I took samples at the Arroyo Rodriguez (34° 53.17′ S 58° 02.66′ W) and the banks of Pinazo Creek (34° 26.66′ S 58° 49.26′ W) in northeastern Buenos Aires province.

Both sections show a classical stratigraphic sequence of the Platense and Lujanense formations. The samples for organic carbon dating were taken from the Platense, the upper part of the Lujanense, and the transitional zone between both units.

The samples were dated using the recently developed Oxidizable Carbon Ratio (OCR) method. It produces accurate and precise age estimates for organic carbon in aerobic soil, based on biochemical changes of organic carbon within point-specific spatial and environmental contexts (Frink 1998). The OCR procedure is currently being applied in many parts of the world (Frink 1992, 1994a, 1994b; Saunders et al. 1997, etc.) and was recently used in analyzing the

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Argentinean sedimentary sections (Fabier-Duvois and Borella 1997; Nami 1998; Nami and Favier-Duvois 1998; Nami and Frink 1998). The results proved to be highly coincident with previous radiocarbon dates and other chrono-stratigraphical data such as historical and paleomagnetic records.

The OCR date analyses were conducted using procedures, data format, and formulas presented by Frink (1992, 1994a). The results for these samples are an expression of the "mean residence time" (MRT) of all organic carbon within the samples. Therefore these dates can be considered a minimum age because the apparent MRT of organic components is a significant factor in soil dating (Scharpensell 1971; Stein 1992).

The following are the dates obtained in the Arroyo Rodriguez: 4,430 yr B.P. (ACT-3240); 6,516 yr B.P. (ACT-3239) in the gray sediments; 9,260 yr B.P. (ACT-3238) in the transitional zone; and 10,217 yr B.P. (ACT-3250) in the upper part of the Lujanense. Pinazo Creek gray sediments yielded the following dates: 1,474 yr B.P. (ACT-3348); 4,332 yr B.P. (ACT-3349); 4,513 yr B.P. (ACT-3350); 5,194 yr B.P. (ACT-3347); 5,536 yr B.P. (ACT-3352); 5,958 yr B.P. (ACT-3353); and 6,624 yr B.P. (ACT-3354). The upper part of the Lujanese formation yielded a date of 7,504 yr B.P. (ACT-3355).

These dates closely agree with the expected chronology for the Platense and are especially valuable for estimating the chronology of the upper part of the Lujanense formation, a chronology which was always considered a late-Pleistocene/early-Holocene litho-stratigraphical unit.

My deep gratitude to Durzio and her family for their help and logistic support in the fieldwork. To A. Menegaz for her help during the fieldwork and her discussions on A. Rodriguez's stratigraphy. To M. Cuadrado for her assistance, and finally to D. Frink, who was very helpful with many aspects related with the OCR dating references and bibliography. Finally, to E. Callahan for his help in editing this paper.

References Cited

Carbonari, J. E., R. A. Huarte, and A. J. Figini 1993 Miembro Guerrero, formación Luján (Pleistoceno, Pcia. de Buenos Aires edades ^{14}C. *Terceras Jornadas Geológicas Bonaerenses*, pp. 245–247, Facultad de Ciencias Naturales y Museo, La Plata.

Cione, A. L., and E. P. Tonni 1995 Bioestratigrafía y cronología del Cenozoico Superior de la Región Pampeana. *Evolución Geológica y Climática de la Región Pampeana durante los últimos Cinco Millones de Años*, edited by M. T. Alberdi, G. Leone y E. P. Tonni), pp. 49–74, Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, Madrid.

Favier-Duvois, C., and F. Borella 1997 Estudios geoarqueológicos y tafonómicos en la discusión del registro arqueológico óseo de cetáceos vinculado a evidencia arqueológica en Bahía San Sebastián (Tierra del Fuego). Paper presented at XII Congreso Nacional de Arqueología Argentina, La Plata.

Fidalgo, F., L. M. Meo Guzmán, G. G. Politis, M. C. Salemme, E. P. Tonni, J. E. Carbonari, G. J. Gómez, R. A. Huarte, and A. J. Figini 1986 Investigaciones arqueológicas en el sitio 2 de Arroyo Seco (Pdo. de Arroyos-Pcia. de Buenos Aires- República Argentina. *New Evidence for the Pleistocene Peopling of the Americas* (edited by A. L. Bryan), pp. 221–269, Center for the Study of the Early Man, Orono, Maine.

Frink, D. 1994a The Oxidizable Carbon Ratio (OCR): A Proposed Solution to Some of the Problems Encountered with Radiocarbon Data. *North American Archaeologist,* 15(1):17–29.

——— 1994b Application of the Newly Developed OCR Dating Procedure in Pedo-Archaeological Studies. Paper presented at the Second International Conference on Pedo-Archaeology, Columbia, South Carolina.

——— 1995 Application of the Oxidizable Carbon Ratio Dating Procedure and its Implications for Pedogenic Research. *Pedological Perspectives in Archeological Research*, pp. 95–106, Soil Science Society of America, Special Publication 44, Madison.

——— 1998 Temporal Values in a Universe of Turbations: Application of the OCR Carbon dating Procedure in Site Formational Analyses. Paper presented at the 1998 Annual Meetings of the Mid-South Archaeological Conference, Memphis, Tennessee.

Frink, D. S. 1992 The Chemical Variability of Carbonized Organic Matter Through Time. *Archaeology of Eastern North America*, 20:67–79.

Nami, H. G. 1995 Holocene Geomagnetic Excursion at Mylodon Cave, Ultima Esperanza, Chile. *Journal of Geomagnetism and Geoelectriticty*, 47:1325–1332

——— in press Possible Holocene Excursion of the Earth's Magnetic Field in Southern South America: New Records from Archaeological Sites in Argentina. *Earth, Planets and Space*, 51.

Nami, H. G., and C. Favier-Duvois 1998 Valores de tiempo de residencia media de la materia orgánica obtanidos en horizontes de suelo de dos secuencias fluviales cuaternarias del norte de la provincia de Buenos Aires. Consideraciones cronológicas.

Nami, H. G., and D. Frink in press Cronología obtenida por la tasa del carbono orgánico (OCR) en Markatch Aike 1 (Cuenca del río Chico, Santa Cruz). *Anales del Instituto de la Patagonia*, 27, Punta Arenas.

Pascual, R., E. J. O. Hinojosa, D. Gondar, and E. P. Tonni 1965 Las edades del Cenozoico mamlífero de la Argentina, con especial atención a aquellas del territorio bonaerense. *Anales de la Comisión de Investigaciones Científicas de Buenos Aires*, 6:165–193.

Politis, G., J. L. Prado, and R. P. Beukens 1994 The Human Impact in Pleistocene-Holocene Extinctions in South America. The Pampean Case. In *Ancient Peoples and Landscapes*, edited by E. Johnson, pp. 187–205, Texas Tech University, Lubbock.

Saunder, J. W., R. D. Mandel, R. T. Saucier, E. T. Allen, C. T. Hallmark, J. K. Johnson, E. H. Jackson, C. M. Allen, G. L. Stringer, D. S. Frink, J. K. Feahers, S. Williams, K. J. Gremillion, M. F. Vidrine, and R. Jones 1997 A Mound Complex in Louisiana at 5400–5000 Years Before the Present. *Science*, 277:1796–1799.

Scharpenseel, H. W. 1971 Radiocarbon Dating of Soils: Problems, Troubles, Hopes. In *Paleopedology. Origin, Nature and Dating*, edited by D. H. Yaalon, pp. 77–88, International Society of Soil Scientists and Israel University Press, Jerusalem.

Stein, J. K. 1992 Organic Matter in Archaeological Contexts. In *Soils in Archaeology*, edited by V. T. Holliday, pp. 193–216, Smithsonian Institution Press, Washington, D.C.

New Applications of Luminescence Dating to Late-Quaternary Lunette Deposits on the American Southern High Plains

Julie Rich and Stephen Stokes

Exploitation of lunettes in palaeoenvironmental reconstruction has been hampered by a general absence of age control in estimating the timing of

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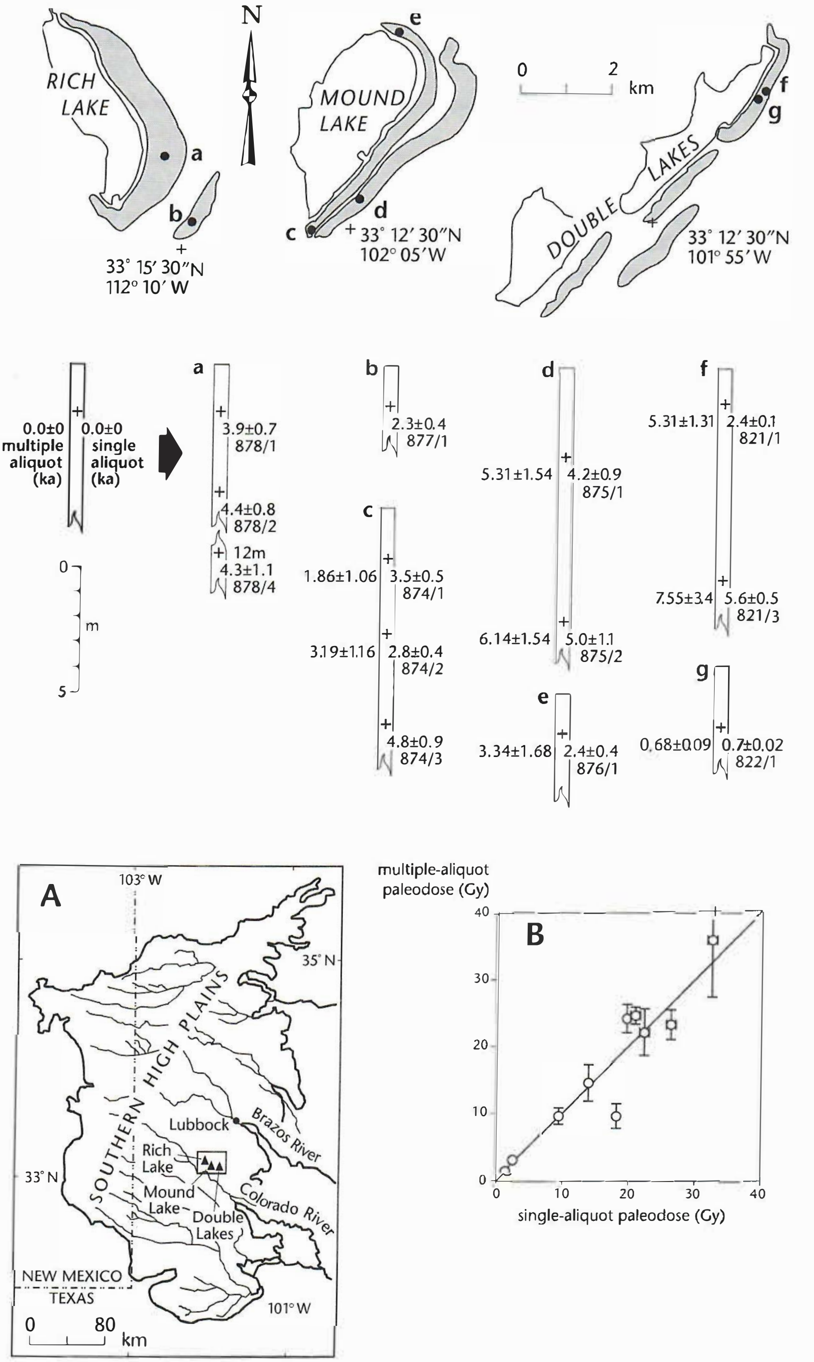
accretion. While ^{14}C dating of soil constituents within the dunes has partially addressed this problem (e.g., Holliday, 1997), data on lunette accumulation and manner of sedimentation (i.e., episodic versus continuous) remain generally lacking.

Optical dating techniques have recently provided chronologies for lunette and other aeolian sediments (e.g., Stokes, 1992, 1994; Stokes and Gaylord, 1993; Wintle, 1993), but have been hindered by typically moderate to low precision (±10–25 percent). Experimental single-aliquot methodologies introduced by Huntley et al. (1985), Duller (1991), Stokes (1994), and Murray et al. (1997) differ from conventional (multiple-aliquot) optical dating procedures because the accumulated radiation dose estimate is based on a single sub-sample (in this case, 2–5 mg of quartz grains, 90–150 μm) of the dosimeter. Advantages of the technique include increased processing speed, improved precision of averaged paleodoses, and the potential for exploring paleodose distributions from repeated analyses of context, all of which provide insight into bioturbation and bleaching histories (Stokes, 1994).

Research concentrated on single-aliquot testing procedures to generate chronologies for selected large playa lunettes on the Southern High Plains of Texas. Thirteen samples were extracted from dune ridges at depths of 2 to 12 m below modern surface; 8 had previously been dated using multiple-aliquot methods (Figure 1A). Comparison of the single- and multiple-aliquot paleodose estimates revealed no systematic differences (average ratio = 1.0) (Figure 1B). The error of the paleodose estimates ranged from 6 to 26 percent for multiple-aliquot to 1 to 2 percent for single-aliquot, demonstrating that age estimates obtained from the single-aliquot technique are markedly higher in precision. This makes it possible to identify individual depositional events that were previously indistinguishable using multiple-aliquot procedures (Stokes, 1994).

Chronological data obtained for the lunettes adjacent to Double, Rich, and Mound Lakes, Texas, indicate that their emplacement occurred during the middle to late Holocene, ca. 5–6 to <1ka. In contrast, ^{14}C ages derived from soil horizons within lunettes associated with small playa lakes on the Southern High Plains indicate that episodic deposition occurred 25,000 to 5,000 yr B.P. (Holliday, 1997). Our research program is presently expanding to explore these contrasts in depositional chronologies for both large playas and small ephemeral lake basins by testing for regional coherence of depositional events and by interpreting the playa-lunette systems in the context of changing ideas on the regional and global evolution of late-Quaternary climatic change.

Figure 1 (opposite). **A,** Southern High Plains, Texas, including selected research sites of Rich, Mound, and Double Lakes. Sampled lunettes are shown with associated large playa lake basins. Stratigraphic columns indicate optical age estimates derived from single-aliquot procedures (right) and, in some instances, multiple-aliquot age estimates (left). Sediment samples were taken from the locality marked with a cross. **B,** Plot of single-aliquot versus multiple-aliquot paleodose estimates. Shown are the paleodoses for eight lunette samples from Rich, Mound, and Double Lakes and for two additional paleodose estimates for samples taken from nearby Lubbock Lake archaeology site. Averaged ratio for the plotted values is 1.0.


RICH
LAKE
a
b
33° 15′ 30″N
112° 10′ W
N
MOUND
LAKE
e
c
d
33° 12′ 30″N
102° 05′W
0
2
km
DOUBLE
LAKES
f
g
33° 12′ 30″N
101° 55′ W
0.0±0
multiple
aliquot
(ka)
0.0±0
single
aliquot
(ka)
0
m
5
a
3.9±0.7
878/1
4.4±0.8
878/2
12m
4.3±1.1
878/4
b
2.3±0.4
877/1
c
1.86±1.06
3.5±0.5
874/1
3.19±1.16
2.8±0.4
874/2
4.8±0.9
874/3
d
5.31±1.54
4.2±0.9
875/1
6.14±1.54
5.0±1.1
875/2
e
3.34±1.68
2.4±0.4
876/1
f
5.31±1.31
2.4±0.1
821/1
7.55±3.4
5.6±0.5
821/3
g
0.68±0.09
0.7±0.02
822/1
A
103° W
35° N
SOUTHERN HIGH PLAINS
Lubbock
Brazos River
Rich
Lake
Mound
Lake
Double
Lakes
Colorado River
33° N
NEW MEXICO
TEXAS
101° W
0
80
km
multiple-aliquot
paleodose (Gy)
B
40
30
20
10
0
0
10
20
30
40
single-aliquot paleodose (Gy)

References Cited

Duller, G. A .T. 1991 Equivalent Dose Determination Using Single-aliquots, *Nuclear Tracks and Radiation Measurements* 23:641–646.

Holliday, V. T. 1997 Origin and Evolution of Lunettes on the High Plains of Texas and New Mexico, *Quaternary Research,* 47:54–69.

Huntley, D. J., D. I. Godfrey-Smith, and M. L. W. Thewalt 1985 Optical Dating of Sediments, *Nature,* 313:105–107.

Murray, A. S., R. G. Roberts, and A. G. Wintle 1997 Equivalent Dose Measurement Using a Single-aliquot of Quartz, *Radiation Measurements,* 27(2):171–184.

Stokes, S. 1992 Optical Dating of Independently-dated Late Quaternary Aeolian Deposits from the Southern High Plains, *Current Research in the Pleistocene,* 9:125–129.

——— 1994 Optical Dating of Selected Aeolian Sediments from the South-western United States. Ph.D Thesis, University of Oxford, Oxford, 660 pp.

Stokes, S., and D. Gaylord 1993 Optical Dating of Holocene Dune Sands in the Ferris Dune Field, Wyoming, *Quaternary Research,* 39:274–281.

Wintle, A. G. 1993 Luminescence Dating of Aeolian Sands: an Overview. In *the Dynamics and Environmental Context of Aeolian Sedimentary Systems,* ed. K. Pye, Geological Society of London, Special Publication 72:49–58.

Information for Contributors

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Categories of notes are: 1) Archaeology, 2) Physical Anthropology, 3) Lithic Studies, 4) Taphonomy–Bone Modification, 5) Methods, 6) Paleoenvironments (with subsections: Plants, Invertebrates, Vertebrates and Geosciences), and 7) Special Focus. The last category is reserved for a pre-selected topic for which CSFA solicits manuscripts. No more than 65 papers will be accepted for each issue. Each contributor will have no more than two papers published in each issue, and only one paper as senior author.

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The following are some preferred abbreviations, words and spellings: Paleoindian (or Paleoamerican), archaeology, ca. (circa), yr B.P. (years before present), early-, mid-, late- (i.e., early-Holocene), ^{14}C (radiocarbon 14; ^{16}C, etc.), in situ, et al., pers. comm., CRM (cultural resource management), and AMS or TAMS (accelerator mass spectrometer technique of radiocarbon dating). Metric units should be used and abbreviated throughout: mm, cm, m, km, ha, m^2, etc.

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Radiocarbon dates should be expressed in ^{14}C years before present (yr B.P.) and should include the standard error and the laboratory number, i.e., 11,000 ± 250 yr B.P. (A-1026).

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ISSN 8755–898X